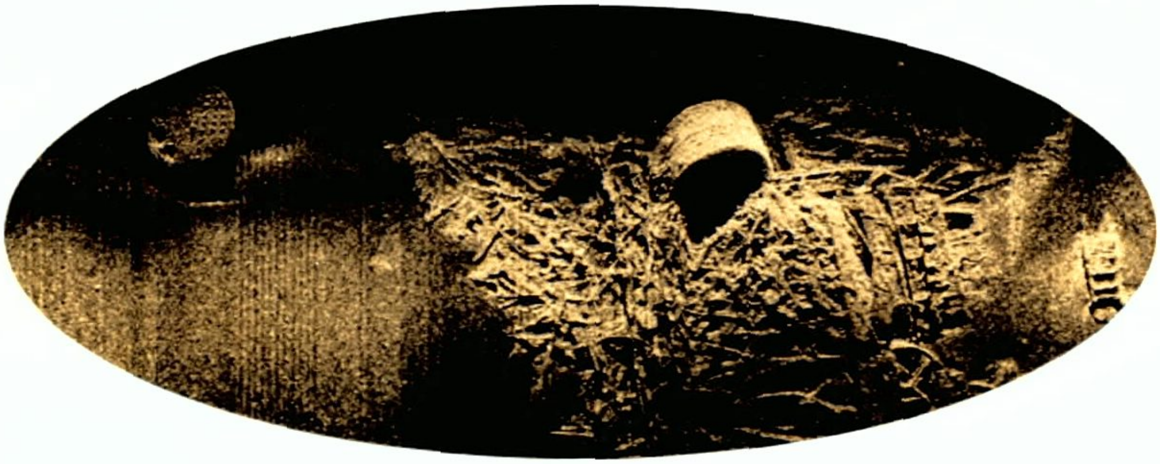
Contract No. W912DS-07-D-0005
Delivery Order No. 0003

U.S. Army Corps of Engineers
New York District

REMOTE SENSING SURVEY OF PORTIONS OF AMBROSE CHANNEL AND SANDY HOOK PILOT AREA IN CONNECTION WITH THE NEW YORK AND NEW JERSEY HARBOR NAVIGATION STUDY, KING AND RICHMOND COUNTIES, NEW YORK



PREPARED FOR:

U.S. Army Corps of Engineers,
New York District

UNDER SUBCONTRACT TO:

Tetra Tech, Inc.
Portland, Maine

PREPARED BY:

Panamerican Consultants, Inc.
Memphis, Tennessee

DRAFT REPORT
JULY 2008

DRAFT REPORT

REMOTE SENSING SURVEY OF PORTIONS OF AMBROSE CHANNEL AND SANDY HOOK PILOT AREA IN CONNECTION WITH THE NEW YORK AND NEW JERSEY HARBOR NAVIGATION STUDY, KING AND RICHMOND COUNTIES, NEW YORK

Authored by:

Andrew D.W. Lydecker and Stephen R. James, Jr.

Prepared for:

Environmental Analysis Section
U.S. Army Corps of Engineers, New York District
26 Federal Plaza
New York, New York 10278

Contract No. W912DS-07-0005
Delivery Order No. 0003

Under Subcontract to:

Tetra Tech, Inc.
451 Presumpscot Street
Portland, Maine 04103

Prepared by:

Panamerican Consultants, Inc.
91 Tillman St.
Memphis, Tennessee 38111

Andrew D.W. Lydecker, RPA
Principal Investigator

JULY ♦ 2008

ABSTRACT

In the spring of 2008, maritime archaeologists with Panamerican Consultants, Inc. in Memphis, Tennessee (Panamerican) conducted an intensive remote sensing survey of the U.S. Army Corps of Engineers, New York District's (the Corps) proposed dredging areas of the Ambrose Channel and selected locations within the Sandy Hook Pilot Area. Constructing navigation improvements in New York and New Jersey Harbor, the Corps' overall Navigation Project plan is to deepen the main channels in the harbor to 50 feet, which will require widening of the channels approximately 30 feet on each side of the channel. This action has the potential to affect any historic shipwrecks that might be located within and along the current channel edges. As a result, the Corps has conducted numerous remote sensing surveys, diving evaluations, and recordation of vessels and salvage of maritime artifacts as part of the Section 106 compliance for this project. Furthermore, the associated Programmatic Agreement signed in 2000 and amended in 2003 was developed with the assumption that all relevant harbor channels under study have been maintained through periodic dredging and no historic vessels would be present in these channels. Ambrose Channel, the main entrance channel to the Port of New York and New Jersey, is naturally deep. Much of the channel has not been dredged historically due to its natural depth, although portions of it have been mined for sand and gravel. However, since construction in Ambrose Channel began, one wreck (the remains of the HMS *Fort Victoria*) and one potential wreck have been encountered.

To ascertain the nature of the potential shipwreck that was encountered and identify additional potential historic resources and debris fields that must be removed during construction, the Corps requested that Panamerican conduct an intensive remote sensing survey of two sections of Ambrose Channel that had not been previously dredged or mined, the previously encountered potential shipwreck site, and three obstructions in the Sandy Hook Pilot Area, which is located offshore of the channel. Comprised of archival research, a review of previous cultural resources reports, and an intensive remote sensing survey, the investigation was implemented by the Corps and performed under subcontract to Tetra Tech, Inc. of Portland, Maine, under Contract No. W912DS-07-0005 as Delivery Order No. 0003.

Results of the remote sensing survey of the two Ambrose Channel areas identified 16 magnetic anomalies and 51 sidescan sonar targets, none of which are considered to represent potentially significant resources or are within the Area of Potential Effect (APE). However, two of the obstructions in the Sandy Hook Pilot Area appear to represent potentially significant cultural resources. One represents the remains of an iron-hulled steamship tentatively identified as the site of the *Daghestan*, an iron-hulled vessel sunk in 1908. It is recommended that if the site cannot be avoided by adverse project activities, it should be assessed as to its historic significance and eligibility for National Register of Historic Places (NRHP) status before dredging activities. The second obstruction at the Pilot Area is an area of debris piles. Unidentified, it is recommended that this area also be assessed as to its historic significance and its eligibility for the NRHP by a qualified maritime archaeologist prior to dredging activities.

In addition to the *Daghestan* site and the debris fields, based on electronic signature characteristics, the previously encountered potential shipwreck may indeed represent a wreck site. Listed in AWOIS as a "wreck, old ship hull, debris piles," sections of an iron-hulled vessel were recovered from this location by the Corps. While it is possible that a portion of the site is a debris field resulting from dumping, the site also likely represents the location of significant submerged cultural resources, and it is recommended that this site be evaluated by a qualified maritime archaeologist before additional construction activities.

TABLE OF CONTENTS

ABSTRACT ... i

LIST OF FIGURES ... iii

LIST OF TABLES ... v

1. INTRODUCTION ... 1

2. HISTORICAL OVERVIEW ... 5

POTENTIAL FOR SUBMERGED PREHISTORIC SITES ... 5
GENERAL NAVIGATION HISTORY OF THE PROJECT AREA ... 7
SHIPWRECK INVENTORY OF THE PROJECT AREA ... 12
AWOIS LISTINGS ... 22
PREVIOUS INVESTIGATIONS ... 24

3. METHODS ... 29

ENVIRONMENTAL CONDITIONS ... 29
PERSONNEL ... 29
REMOTE SENSING SURVEY EQUIPMENT ... 29
Differential Global Positioning System ... *29*
Magnetometer ... *31*
Sidescan Sonar ... *32*
Subbottom Profiler ... *32*
Survey Vessel ... *33*
SURVEY PROCEDURES ... 34
DATA ANALYSIS PROCEDURES ... 36
Magnetometer Analysis ... *37*
Sidescan Analysis ... *39*
Subbottom Profiler Analysis ... *39*
TARGET RELOCATION AND REFINEMENT METHODS ... 41

4. RESULTS ... 43

REMOTE SENSING SURVEY ... 43
IDENTIFICATION OF POTENTIALLY SIGNIFICANT HISTORIC SITES ... 43
Magnetic Data ... *43*
Sidescan Sonar Targets ... *64*
ADDITIONAL TARGETS ... 81

5. CONCLUSIONS AND RECOMMENDATIONS ... 105

SHOALS C AND D ... 105
HIGH SPOT A (WK52) ... 107
HIGH SPOT B (OBSTN53) ... 110
HIGH SPOT C (OBSTN52) ... 110

6. REFERENCES CITED ... 111

APPENDIX A: SCOPE OF WORK

APPENDIX B: REMOTE SENSING SURVEY PLAN

APPENDIX C: HEALTH, SAFETY, AND ACCIDENT PREVENTION PLAN

LIST OF FIGURES

Figure 1-01. General project area location map 2
Figure 1-02. Ambrose Channel survey area in red 3
Figure 1-03. Sandy Hook Pilot Area survey locations in red 4
Figure 2-01. An 1875 photograph showing the advent of steam in the age of sail 9
Figure 2-02. Excerpt from the 1870 Coastal Survey map, "New York Entrance" 10
Figure 2-03. Outlined excerpt shown in Figure 2-02 above 11
Figure 2-04. Excerpt from the 1913 Coastal Survey map, "New York Bay and Harbor" 12
Figure 2-05. *Fort Victoria* ca. 1920 21
Figure 2-06. Map showing location of known dive sites and wrecks near the southern end of the project area 22
Figure 2-07. Map showing locations of AWOIS listings for the project area 23
Figure 2-08. The 2001 channel edge survey area 25
Figure 2-09. Map of Panamerican's 2002 investigation targets near the current project area 26
Figure 2-10. Acoustic image of the wreck site with location of targets dived 27
Figure 2-11. SS *Willochra* ca. 1920 after extensive refit and rechristening as SS *Fort Victoria* 27
Figure 3-01. Trimble Navigation DSM 212H global-based positioning system used for this project 29
Figure 3-02. Equipment schematic illustrating layback 30
Figure 3-03. Marine Magnetics Sea Spy magnetometer 31
Figure 3-04. Marine Sonic Technology (MST) Sea Scan sidescan sonar system 32
Figure 3-05. The Edgetech subbottom SB 424 towfish used during the survey 33
Figure 3-06. Research vessel, *Venture III*, provided support for all aspects of the investigation 33
Figure 3-07. Pre-plotted tracklines for current survey area in Hypack® software 34
Figure 3-08. Pre-plotted tracklines detail – north area 35
Figure 3-09. Pre-plotted tracklines detail – south area 36
Figure 3-10. Example of subbottom profiler images of known eighteenth-century oak vessel HMS *Invincible* 40
Figure 3-11. Example of the refinement pattern including planned and completed trackline 42
Figure 4-01. Northern survey area overview showing locations of anomalies 44
Figure 4-02. Northern survey area close-up 45
Figure 4-03. Northern survey area close-up 45
Figure 4-04. Northern survey area close-up 46
Figure 4-05. Northern survey area close-up 46
Figure 4-06. Southern survey area overview showing locations of anomalies 47
Figure 4-07. Southern survey area close-up 47
Figure 4-08. Southern survey area close-up 48
Figure 4-09. Example of incidental anomaly caused by passing cargo vessel 48
Figure 4-10. Magnetic contour map of Anomaly 1 49
Figure 4-11. Magnetic contour map of Anomaly 2 50
Figure 4-12. Magnetic contour map of Anomaly 3 50
Figure 4-13. Magnetic refinement map of Anomaly 3 51
Figure 4-14. Sidescan sonar refinement image of Anomaly 3 51
Figure 4-15. Subbottom profiler refinement image of Anomaly 3 52
Figure 4-16. Magnetic contour map of Anomaly 4 and Anomaly 5 53
Figure 4-17. Magnetic refinement map of Anomaly 4 and Anomaly 5 53
Figure 4-18. Sidescan sonar refinement image of Anomaly 4 54
Figure 4-19. Subbottom refinement image of Anomaly 4 54
Figure 4-20. Sidescan sonar refinement image of Anomaly 5 55
Figure 4-21. Subbottom refinement image of Anomaly 5 55
Figure 4-22. Magnetic contour map of Anomalies 6, 7, 8, and 9 56
Figure 4-23. Magnetic refinement map of Anomalies 6, 7, and 9 56
Figure 4-24. Sidescan sonar refinement image of Anomaly 6 57
Figure 4-25. Subbottom refinement image of Anomalies 6 and 7 57

Figure 4-26. Sidescan sonar refinement image of Anomaly 7 58
Figure 4-27. Sidescan sonar refinement image of Anomaly 9 59
Figure 4-28. Subbottom refinement image of Anomaly 9 60
Figure 4-29. Magnetic contour map of Anomaly 10 60
Figure 4-30. Magnetic contour map of Anomalies 11 and 12 61
Figure 4-31. Sidescan sonar refinement image of Anomaly 11 61
Figure 4-32. Subbottom refinement image of Anomaly 11 62
Figure 4-33. Magnetic contour map of Anomaly 13 63
Figure 4-34. Magnetic contour map of Anomaly 14 63
Figure 4-35. Magnetic contour map of Anomalies 15 and 16 64
Figure 4-36. Sidescan sonar targets 65
Figure 4-37. Sidescan sonar targets 65
Figure 4-38. Sidescan sonar targets 66
Figure 4-39. Sidescan sonar targets 66
Figure 4-40. Sidescan sonar targets 67
Figure 4-41. Sidescan sonar targets 67
Figure 4-42. Location of Shoals A, B, C, and D 82
Figure 4-43. Shoal areas A, B, C, and D 82
Figure 4-44. Three obstructions investigated in the pilot area at the easternmost end of Ambrose Channel 83
Figure 4-45. Shoals A and B 84
Figure 4-46. Magnetic contour map of Shoals A and B 84
Figure 4-47. Sidescan sonar mosaic of Shoals A and B 85
Figure 4-48. Close-up of Shoals A and B 86
Figure 4-49. Magnetic contour map superimposed over sidescan sonar mosaic 87
Figure 4-50. Subbottom image of Shoals A and B 87
Figure 4-51. Shoal C and Shoal D 88
Figure 4-52. Magnetic contour map showing Shoal C and Shoal D 89
Figure 4-53. Sidescan sonar mosaic of Shoals C and D 90
Figure 4-54. Close-up of Shoal C (north) and Shoal D (south) 91
Figure 4-55. Shoals C and D mosaic with magnetic contour map 92
Figure 4-56. Subbottom image of Shoals C and D 92
Figure 4-57. Sketch map of High Spot A, taken in 1986 93
Figure 4-58. Magnetic contour and refinement tracklines of High Spot A 94
Figure 4-59. Sidescan sonar mosaic of High Spot A 95
Figure 4-60. Multiple boilers present at High Spot A 96
Figure 4-61. Boiler A close-up 96
Figure 4-62. Boiler B close-up 97
Figure 4-63. High Spot A (WK52) sidescan sonar mosaic with magnetic contour map 97
Figure 4-64. Magnetic contour map of High Spot B (OBSTN53) 98
Figure 4-65. Sidescan sonar image of High Spot B (OBSTN53), northernmost section 99
Figure 4-66. Sidescan sonar image of High Spot B (OBSTN53), central section 99
Figure 4-67. Sidescan sonar image of High Spot B (OBSTN53) southernmost section 100
Figure 4-68. Sidescan sonar mosaic of High Spot B (OBSTN53) showing relative positions of debris piles 100
Figure 4-69. Subbottom profile image of High Spot B, northernmost section (OBSTN53) 101
Figure 4-70. Magnetic contour map of High Spot C (OBSTN52) showing lack of magnetic anomalies 101
Figure 4-71. Sample sidescan sonar image of High Spot C (OBSTN52) 102
Figure 4-72. Subbottom image of High Spot C (OBSTN52) 103

LIST OF TABLES

Table 2-01. Eighteenth-century shipping data for the Port of New York 8
Table 2-02. Vessel losses documented in or near the project area 14
Table 2-03. AWOIS listings within or immediately adjacent to the current project area 24
Table 3-01. Magnetic data from shipwrecks and non-significant sources 38
Table 4-01. Magnetic anomalies located during the current remote sensing survey 44
Table 4-02. Sidescan sonar targets 68
Table 4-03. Additional targets investigated 81
Table 5-01. Targets recommended for further investigation 105

1. INTRODUCTION

In April and May of 2008, maritime archaeologists with Panamerican Consultants, Inc. (Panamerican) conducted an intensive remote sensing survey of the U.S. Army Corps of Engineers, New York District's (the Corps) proposed dredging areas of the Ambrose Channel and selected locations within the Sandy Hook Pilot Area (Figure 1-01). Constructing navigation improvements in New York and New Jersey Harbor, the Corps' overall Navigation Project plan is to deepen the main channels in the harbor to 50 feet, which will require widening of the channels approximately 30 feet on each side of the channel. This action has the potential to affect any historic shipwrecks that might be located within and along the current channel edges. As a result, the Corps has conducted numerous remote sensing surveys, diving evaluations, and recordation of vessels and salvage of maritime artifacts as part of the Section 106 compliance for this project. Furthermore, the associated Programmatic Agreement signed in 2000 and amended in 2003 was developed with the assumption that all relevant harbor channels under study have been maintained through periodic dredging and no historic vessels would be present in these channels. Ambrose Channel, the main entrance channel to the Port of New York and New Jersey, is naturally deep; much of it has not been dredged historically due to its natural depth, although portions of the channel have been mined for sand and gravel. However, since construction in Ambrose Channel began, the remains of the HMS *Fort Victoria* (see Lydecker 2008) and one potential wreck have been encountered.

In order to ascertain the nature of the potential shipwreck that was encountered during construction and assess its potential to meet National Register of Historic Places (NRHP) eligibility criteria, and to identify additional potential historic resources and debris fields that must be removed during construction, the Corps requested that Panamerican conduct an intensive remote sensing survey of the sections of Ambrose Channel that had not been previously dredged or mined. Consisting of a northern and a southern area, the two survey areas together measured approximately 6 miles by 1,000 feet (Figure 1-02). Located adjacent to but outside of the northern survey area, the potential shipwreck may correspond to NOAA charted obstructions and may correspond to Shoals C and D. In addition to the Ambrose Channel survey areas and the potential wreck, three obstructions in the Sandy Hook Pilot Area, located offshore of the Ambrose Channel, were also surveyed to ascertain their nature and potential NRHP eligibility (Figure 1-03).

Comprised of archival research, a review of previous cultural resources reports, and an intensive remote sensing survey, the current investigation was implemented by the Corps in partial fulfillment of their obligations under various federal statutes. As an agency of the Federal government, the Corps is entrusted with the protection and preservation of all cultural resources that may be adversely affected by their project activities. Federal statutes regarding these responsibilities include: Section 106 of the National Historic Preservation Act of 1966, as amended; Executive Order 11593; the Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800); and the Abandoned Shipwreck Act of 1987. Performed under subcontract to Tetra Tech, Inc. of Portland, Maine, this investigation was conducted for the Corps in response to their Scope of Work (SOW) entitled *Remote Sensing Survey Of Portions of Ambrose Channel and Sandy Hook Pilot Area In Connection With the New York and New Jersey Harbor Navigation Project, Kings and Richmond Counties, New York* (Appendix A), under Contract No. W912DS-07-0005, Delivery Order 0003.

As detailed in the Remote Sensing Survey Plan that was developed and accepted for the project prior to the implementation of fieldwork (Appendix B), remote sensing equipment employed in the near-shore survey areas included a magnetometer, sidescan sonar, subbottom profiler, fathometer, and a Differential Global Positioning System (DGPS); also, a land magnetometer and DGPS were employed in the onshore re-nourishment area. Recorded magnetic anomalies were prioritized as to the probability of representing historic shipwreck remains based on characteristics such as anomaly strength, duration, and relative association with other remote sensing data. Sidescan sonar records were reviewed for features such as linearity, structure, height off the ocean bed, and association with other remote sensing data.

Results of the remote sensing survey of the stipulated northern and southern channel areas identified 16 magnetic anomalies and 51 sidescan sonar targets. Of the 16 anomalies, none are considered to represent potentially significant resources. Of the 51 acoustic targets, only one, a wooden barge, is considered potentially significant. It is located in 90 feet of water and thus outside the Area of Potential Effect (APE), and is not recommended for further investigation.

With regard to the three obstructions in the Sandy Hook Pilot Area, one represents the remains of an iron-hulled steamship. Although unconfirmed, it is tentatively identified as the site of the *Daghestan*, an iron-hulled vessel sunk in 1908. It is recommended that if the site cannot be avoided by adverse project activities, it should be assessed as to its historic significance and its eligibility for NRHP status prior to dredging activities.

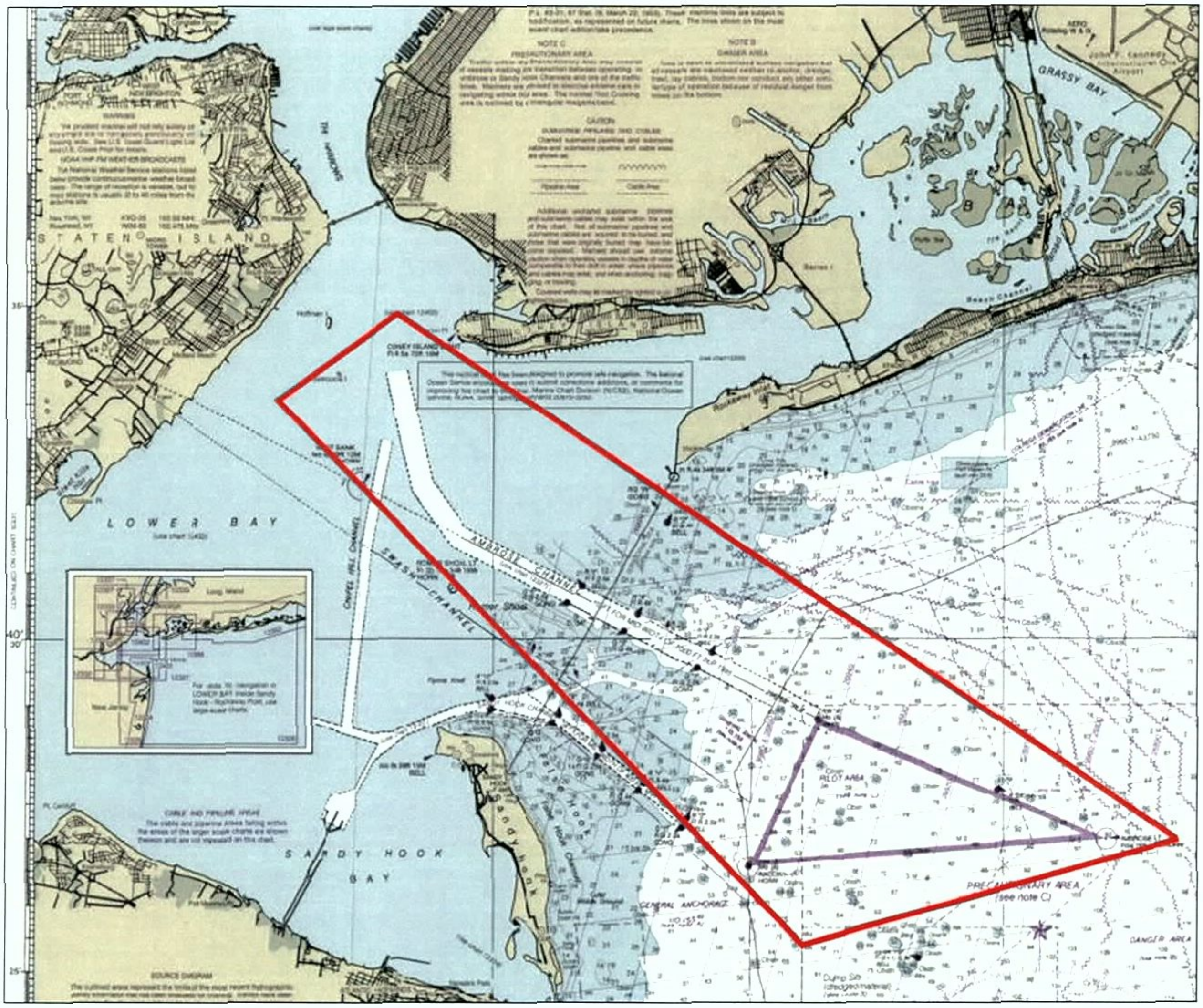


Figure 1-01. General project area location map (base map: NOAA navigation chart no. 12326: Approaches to New York Fire Island Light to Sea Girt).

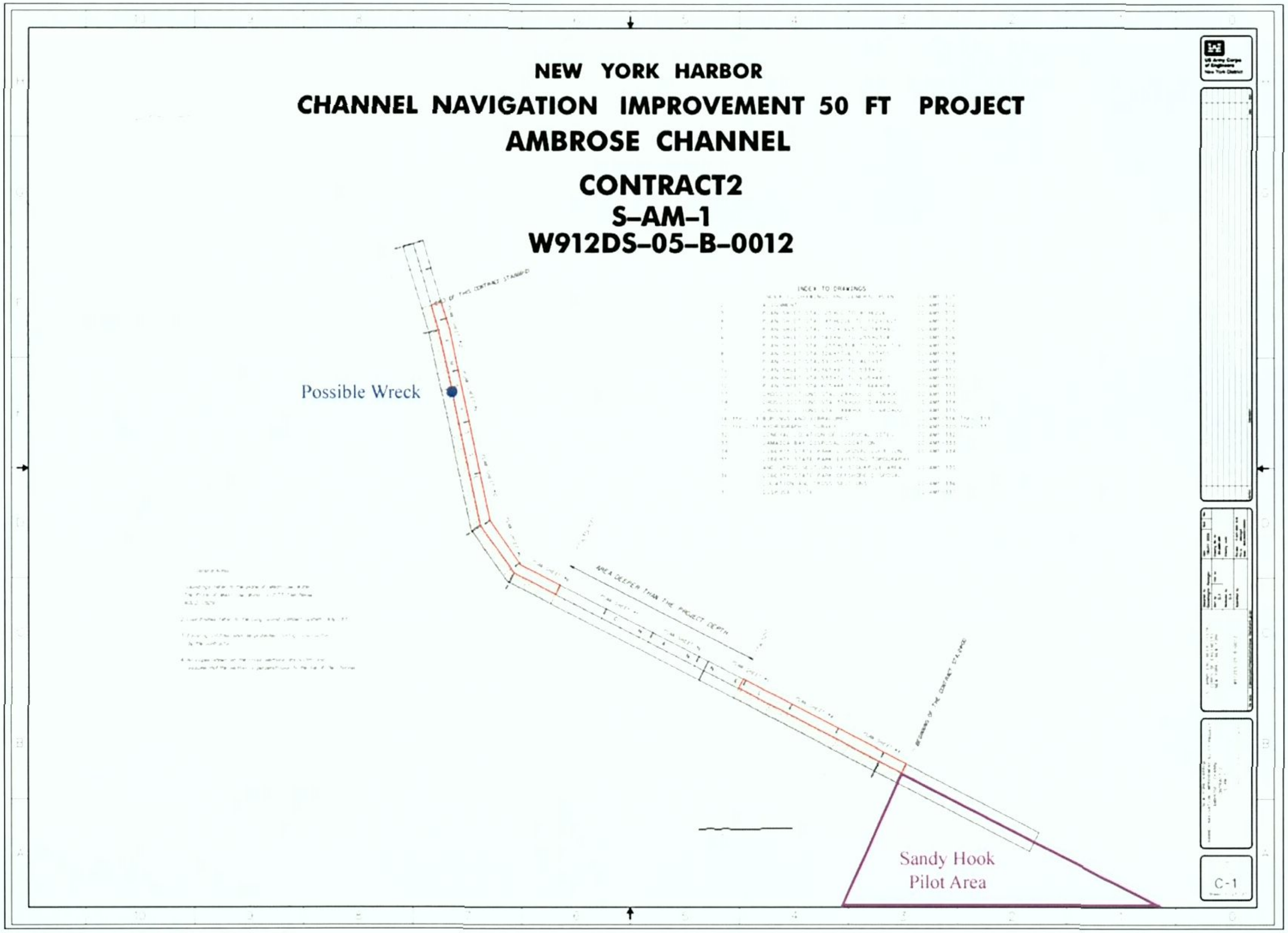


Figure 1-02. Ambrose Channel survey area in red. Potential wreck location is in blue (base map courtesy of the U.S. Army Corps of Engineers, New York District).

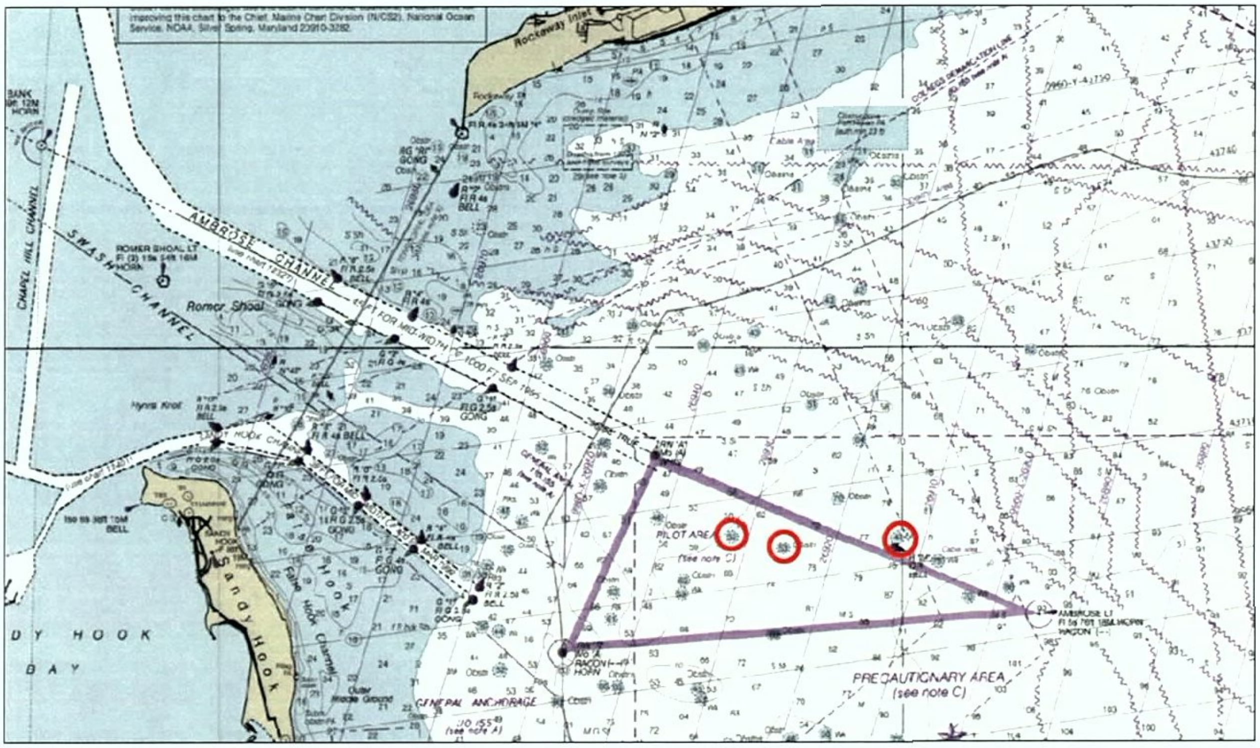


Figure 1-03. Sandy Hook Pilot Area survey locations in red (base map: NOAA navigation chart no. 12326: Approaches to New York Fire Island Light to Sea Girt).

A second obstruction at the Sandy Hook Pilot Area is an area of debris piles. Unidentified, it is also recommended that it be assessed as to its historic significance and its eligibility for NRHP status by a qualified marine archaeologist prior to dredging activities.

In addition to the *Daghestan* site and the debris fields—both located at the Sandy Hook Pilot Area—the potential shipwreck may in fact represent a wreck site, based on electronic signature characteristics. Listed in AWOIS as a "wreck, old ship hull, debris piles," sections of an iron-hulled vessel were recovered from this location by the Corps. While it is possible that a portion of the site is a debris field resulting from dumping, the site also likely represents the location of significant submerged cultural resources, and it is recommended that this site be evaluated by a qualified maritime archaeologist before additional construction activities.

2. HISTORICAL OVERVIEW

Pursuant to guidelines established by the National Historic Preservation Act of 1966 and the National Environmental Policy Act of 1969, potential impacts to any significant cultural resources in a proposed borrow area must be addressed. In conjunction with the remote sensing survey, archival research was conducted to identify the location and/or possibility of the existence of cultural resources in the area. Significant cultural resources potentially found within the project area include both prehistoric and historic resources, the latter represented by shipwrecks. To identify these resources or their potential presence, numerous agencies, archives, and references were contacted or researched.

The information gleaned from these sources has been synthesized into a prehistoric and historic overview that, when employed during the assessment of actual remote sensing data, enables the researcher to determine the potential for resources in the project area and thus allows an accurate interpretation of the data. The archival information has been divided into sections on the general navigational history, specific project area history, previous studies, and a shipwreck inventory.

POTENTIAL FOR SUBMERGED PREHISTORIC SITES

Consideration of the potential for cultural resources within the project area focuses on two distinct types: prehistoric sites and historic shipwrecks. Although the location of shipwreck sites can be realized through the employment of an array of remote sensing equipment like that currently being utilized within the project area, the location of submerged prehistoric sites with the current technology is highly unlikely. Rather, the emphasis during a study of this nature is more hypothesis than reality, the investigation basing potential submerged site locations on known above current sea level site locational parameters (i.e., land forms such as river terraces), as well as data on Pleistocene environments and resources for the area (e.g., estuaries, food types). However, it is possible to identify relict submerged landforms to some extent with the sidescan sonar and subbottom profilers and then apply known parameters from above-sea-level sites to these landforms.

With this in mind, the potential for prehistoric resources within the project area directly relates to the geological morphology of the area resulting from post-Pleistocene sea-level changes. The last Pleistocene glacial stage was the Wisconsin glaciation; the project area is just south of the maximum southerly limit of this glaciation (Ferguson 1986). Between 18,000-14,000 years before present (B.P.), sea level was more than 100 m (325 ft.) lower than it is now. Depending on the source quoted, by 12,000 B.P. sea level had risen to between 60 m and 30 m below its current level. Hunter et al. (1985:3-28) illustrate that all of the project area was above sea level during the Holocene, or termination of the Pleistocene. With human occupation believed to have begun in this area ca. 12,000 B.P. (a conservative estimation), current speculation suggests the entire project area would have been available for prehistoric occupation (Ferguson 1986:6).

During an early investigation, Roberts et al. (1979:Volume II) indicated that evidence for Pleistocene megafauna and relic shellfish beds has been reported from offshore areas, both representing Pleistocene resources and environments favorable or conducive to prehistoric population utilization, but there was no actual evidence for prehistoric occupation or utilization during the Holocene for offshore areas. Megafauna certainly could have been a resource exploited by prehistoric peoples. There are three regions in the area where megafauna remains appear to be clustered offshore. Mammoth teeth have been found at a depth of approximately 80 meters. Mastodon teeth have been found in two separate belts from 20-25 meters and 40-50 meters below present sea level. These clusters of terrestrial remains may corroborate with past sea levels, indicating possible areas for human occupation (Miller et al. 1990:7).

The potential for submerged prehistoric sites on the continental shelf has been treated by several authors since Roberts et al.'s research (Stright 1990, 1995; Pickman 1994; Thieme 2000). Stright (1990) listed numerous sites found in a shallow water context and then went on to create some predictive modeling as to where sites could be located. Later (1995), Stright focused her studies on the effect of sea-level change on potential archaeological site location and expected levels of preservation. Pickman (1994) also focused on the potential location of prehistoric sites relative to sea-level change in the Long Island, New York area. In his study of the New York harbor region, Thieme (2000) indicates that there are known Late Paleoindian or Early Archaic sites on Staten Island. He believes that the sites represent only a small portion of actual settlement in the region and settlement extended across the inundated surfaces of the harbor region (Thieme 2000:3).

Many submerged prehistoric sites have been located in various regions of the continental shelf. Stright's (1990) compilation of 34 submerged prehistoric sites indicated the potential for the resource to be found on the continental shelf. Although the definition of site is "...used to designate any locality of archaeological material, not necessarily an in situ archaeological deposit," and the sample is admittedly biased—from shallow water areas—the data support the thesis that there are early prehistoric sites located in a submerged context (Stright 1990:439). Supporting this hypothesis, artifactual materials in the New England/Long Island Sound area were located due to dredging activity and were assigned to the Archaic period (Stright 1990: 441-442). Thus, there is a body of evidence to support the contention that there may be submerged prehistoric resources in the present project area.

It is believed that past dredging activity off Sandy Hook may have exposed and redeposited portions of a prehistoric site. An assemblage of over 200 prehistoric artifacts was collected by a shell seeker on the beaches of Monmouth, New Jersey, well south of the park. The area where the artifacts were located had recently been re-nourished by sands dredged from offshore of the lower end of the park and south of the current project area. The dredging took place in an area approximately one mile east off the southern portion of Sandy Hook in depths of 35 to 40 feet below mean low water. It is believed that the artifacts came from a layer within the first five feet of the seabed from the Weeks 1 Borrow area (COE Memo, September 21, 1995). The lithics, including numerous projectile points, have been cautiously identified as ranging from the Early Archaic to the Late Woodland periods, with a large portion from the Archaic. It is tentatively considered that the concentration of the artifacts, most from the Archaic period, can be considered to consist of a site that had been dredged from the borrow area and deposited with sands onto the beach at Monmouth (Merwin, personal communication 2001).

Comparable submerged sites have been found and investigated in Florida. Most artifacts have not been found by archaeologists, but by diver/collectors. Some of the extinct faunal remains found in a submerged context show evidence of butcher cuts and other evidence of human shaping (Faught 2001). However, in general the Florida environment is much more benign than the conditions found offshore in New Jersey. Lower sedimentation, clearer and warmer waters, milder or no tides, and less dynamic conditions have allowed the Florida sites to be more easily found and investigated (Merwin, personal communications 2001). Although the environment is presently quite different between New Jersey and Florida, the evidence of Holocene occupation existing in now-submerged portions of the continental shelf may be applicable to the Holocene environment of the present project area.

With the knowledge that there are other submerged prehistoric sites located on previously terrestrial Holocene environments, there is potential for sites to be located in the present project area. This is evidenced by the assemblage of prehistoric cultural artifacts recovered from a re-nourished beach context, the original *in situ* location of the artifacts being considered an offshore borrow area south of the current project area. This would indicate that there are indeed submerged prehistoric sites in proximity to the project area. The question then is how to identify prehistoric sites that cannot be recorded during a typical marine remote sensing investigation.

The equipment utilized for this project (i.e., magnetometer and sidescan sonar) cannot positively identify prehistoric sites that are non-magnetic nor protruding from the seabed. Alternate methods and techniques may have better results. The application of a subbottom profiler survey, with parameters to identify relict landforms, in conjunction with coring could possibly identify likely locations for submerged prehistoric sites. Rather than using these instruments in a broad survey to look for specific sites, which would be difficult, their application should be to indicate past submerged Holocene landforms with potential to contain cultural material. Subsequent testing for prehistoric sites (i.e., coring) could concentrate on the areas of higher potential, increasing the chance to contact these materials.

General Navigation History of the Project Area

Europeans' first exposure to the New York Bay came during the voyages of Verrazano. Originally from Florence, Italy (sailing for Francois I, the King of France), Verrazano left on a voyage to find a route to China in January of 1524. His vessel *La Dauphine* (named after the French heir to the throne) was manned by a crew of 50. After a tempest-tossed crossing, he fetched up close to Cape Fear, North Carolina in early March. By mid-April, Verrazano had coasted far enough north and east to enter New York Bay. After some brief reconnaissance, he continued on his voyage and returned to France in July. Being a competent seaman and navigator, Verrazano was able to conclude that he did not reach China, but a new world (Morrison 1971:299-302). However, the French did not follow up on Verrazano's discovery of what would later become the best harbor in the Americas.

Henry Hudson, an Englishman employed by the Dutch East India Company, investigated portions of the American east coast in 1609 (Labaree et al. 1999:38). Hudson was the next European to enter New York Harbor, sailing 150 miles up the river that still bears his name. The Dutch were a bit more industrious and inaugurated an expanding European control of the region. Headquartered at "Manhattan" (Native American term for the current-day island of Manhattan), private trading operations were established on the Hudson in 1613. Various exploratory ventures occurred after the trading post was founded; by 1615, much of the area was well traveled. The Dutch named this region New Netherlands in 1614, and private fur-trading operations expanded into the surrounding area. In 1623, the Dutch West India Co. took over the region's trading operations, founding the town of New Amsterdam in 1625 (Roberts et al. 1979:A-12, A-13).

The Dutch expansion east toward New England caused conflict with the English. To the south, the Dutch took over the Swedish settlement at present-day Wilmington, Delaware and established various trade connections between Chesapeake Bay colonists, South America, and Europe. New Amsterdam grew quickly and rivaled Boston as a center for maritime trade, with furs, fish, beef, and flour being exported and tobacco, slaves, and sugar being trans-shipped. European goods continued to account for most imports. New Amsterdam seemed to be the rising star of American colonial ports. However, with the restoration of Charles II in England and a more aggressive colonial policy, England overtook the colony in 1664 (Labaree et al. 1999:46).

Soon after the beginning of British rule (when New Amsterdam was renamed New York), flour replaced furs as the port's main export, being shipped mainly to the West Indies. During the eighteenth century, other exports included whale oil, beaver pelts, and some tobacco to England; while pork, bread, peas, and horses were shipped to the West Indies. Imports from England and the West Indies included manufactured goods, rum, molasses, and sugar (Watts 1986:11-12). Shipping continued to increase considerably during the mid-1700s. Additional imported goods included "fish oil, blubber, whale fins, turpentine, seal skins, hops, cider, bricks, coal, lamp black, wrought iron, tin, brasury [*sic*], joinery, carriages and chairs" (Roberts et al. 1979:B-9).

New York did not confine shipping activities to trade; sailing vessels were also heavily involved in privateering. Preying on enemy commerce inevitably led to the often-glamorized activity of pirating. The infamous Captain Kidd and various lesser-known pirates made New York a rendezvous around 1700 (Albion 1984:2-5). Not only was New York a rendezvous, merchants also supported the trade and reaped a profit by supplying pirates inhabiting such far-off places as Madagascar in the Indian Ocean (Cordingly 1995:182). Frederick Philipse, a merchant of New York, loaded ships with clothing, liquor, naval stores, guns, and ammunition, then had his local agent Adam Baldridge sell them to the pirates in return for their ill-gotten gain (Ritchie 1986:113). Commerce, with varying levels of ethics, was driving the growth of the port.

By the second decade of the eighteenth century, the interior settlements surrounding New York had become sufficiently established to allow for the production of significant amounts of export goods. As a result of the increased trade, the port expanded accordingly, as did its need for larger, more economical vessels with which to ship goods. Port records indicate that prior to 1720, few vessels entering port registered over 100 tons, while within the next few years larger vessels were common (Watts 1986:11-12). In 1770, New York stood fourth among the American ports in total tonnage arriving and clearing after Philadelphia, Boston, and Charleston (Albion 1984:2-5). Data relative to the increase in number and nationalities of vessels entering New York throughout the eighteenth century are presented in Table 2-01.

Table 2-01. Eighteenth-century shipping data for the Port of New York.

Destination/Origin	Year				
Outward bound (Clearances)	**1726**	**1739**	**1754**	**1768**	**1772**
Great Britain	12	9	31	56	39
Ireland	--	15	23	30	19
Europe	8	21	19	45	48
Africa	--	4	2	--	9
Bahama Islands	--	1	3	4	5
Bermuda	3	3	3	7	3
Caribbean	95	113	180	156	199
Thirteen Colonies	90	97	51	125	324
Other American Colonies	5	10	12	55	54
Totals	***213***	***273***	***324***	***478***	***700***
Inward bound (Entries)					
Great Britain	31	27	28	79	61
Ireland	1	4	10	15	11
Europe	10	22	25	31	38
Africa	--	--	5	2	--
Bahama Islands	--	1	6	9	11
Bermuda	9	14	3	3	5
Caribbean	85	105	177	158	208
Thirteen Colonies	69	93	23	139	352
Other American Colonies	5	11	7	26	24
Totals	***210***	***277***	***284***	***462***	***710***

(as presented in Roberts et al. 1979:B-13)

By the last decade of the eighteenth century, the Port of New York had surpassed Boston in importance; by the first decade of the nineteenth century, the port was larger than Philadelphia. With intercolonial trade well established and foreign imports and exports on the increase, the Port of New York continued to grow. Population growth mirrored the increase in shipping activities; it was held in check and/or declined only through war and epidemics. Associated reductions in maritime commerce occurred during the British occupation of the port including the Revolutionary War, the yellow fever epidemics of 1795 and 1798, the Embargo Act of 1807, and the British closure of the port during the War of 1812 (Ferguson 1986:17).

"Of North America's many coastal towns, New York was most favored by nature to become a major seaport, as the nineteenth century would make abundantly clear" (Labaree et al. 1999:74). Two-thirds of all the nation's imports and one-third of its exports went through the port by 1860. Only London and Liverpool exceeded the port in the volume of shipping which entered and cleared, as well as the value of its imports and exports (Albion 1984:336; Ferguson 1986:17).

During the nineteenth century, sailing vessels of all types carrying cargoes and people utilized the Port of New York. These vessels included sloops, coastal schooners, merchantmen, and packet ships, which increased in size as time and technology progressed. The late 1840s and 1850s saw the famous clipper ships entering the port, followed in the 1890s by the last of the American square-rigged, deep-water sailing ships, the "down-easters," which in turn were followed by large, multi-masted schooners, the largest sailing vessels ever constructed. In addition to these major vessel categories, other vessel types in the area included schooner barges, pilot boats, lighters, fishing boats, and other types of small craft (Morris and Quinn 1989:87-88).

The invention of the steam engine in the late eighteenth century and its application on vessels at the turn of the century played a profound role in the history of the port and cut into the trades previously controlled by sailing vessels (Figure 2-01). After Fulton's steamer *Clermont* completed its successful voyage from New York to Albany in 1807, steam power became the dominant method of vessel propulsion and would form the catalyst for the evolution of not only vessel shape and type, but trade and economics as well (Brouwer 1987).

Figure 2-01. An 1875 photograph showing the advent of steam in the age of sail. Taken from the Brooklyn Bridge, numerous tall ships can be seen in the background, and schooners and sloops, as well as steam tugs and a sidewheel ferry transit the East River (as presented in Johnson and Lightfoot 1980:65).

The advent of steam heralded the creation of the famous river and coastal sidewheel steamers, several of which are listed as having wrecked near the approaches to New York. Huge transatlantic liners followed in the wake of the sidewheel steamers, making New York the center for passenger travel to and from foreign ports. Steam also allowed the ever-important "tug boat" to evolve; after 1860 and by the 1870s the tug boat industry expanded rapidly, with steam being employed on the tugs until just after World War I (Morris and Quinn 1989:87-88).

With the Port of New York immediately to the north, some of the numerous vessels transiting the waters were wrecked by storm, accident, or poor seamanship. Many are known to have wrecked while approaching or leaving New York. Long Island (to the east) and the shores of New Jersey (to the south) act as a funnel through which vessels enter New York Harbor. During the age of sail, vessels depended on capricious winds for motive force, and many were reported lost due to contrary winds. However, early steam vessels, lacking modern navigation aids such as radar, loran, or GPS, had accidents in the ever confining, shoal-filled waters marking the approaches to New York, especially in periods of dense fog or storm-reduced visibility (Figures 2-02 and 2-03). In the modern era, technology has yet to abolish accidents caused by human error.

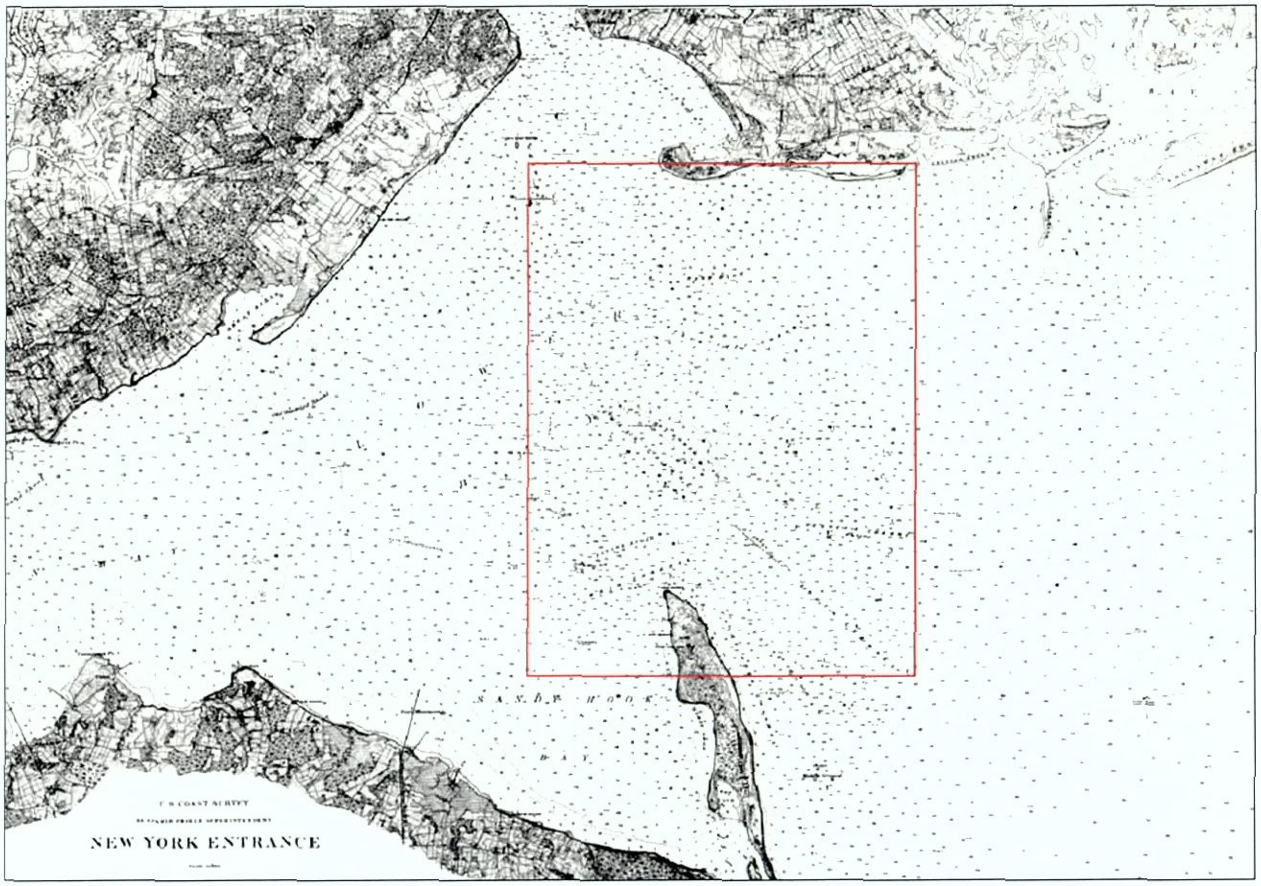


Figure 2-02. *Excerpt from the 1870 Coastal Survey map,* "New York Entrance." The entrance with shoals and channels is outlined in red (see Figure 2-03 below).

To ameliorate the affects of maritime disasters, numerous organizations were incorporated around the coasts. Local organizations took the responsibility of aiding the victims of shipwrecks. In an era of a small federal government, each locality took responsibility for situations occurring within its immediate jurisdiction. However, during the mid-nineteenth century, the Port of New York rose to such prominence in commercial and emigration activities that the local resources could not sustain a full service for wrecked mariners and passengers. A Congressman from New Jersey, William Newell, once witnessed a shipwreck where no effective rescue was possible. In 1847 he persuaded Congress to appropriate money to provide lighthouses with lifeboats. However, the money was not spent for that purpose. The next year he obtained more funds for life-saving equipment to be used between Sandy Hook and Little Egg Inlet, New Jersey, under the direction of the Revenue Marine (Bennett 1998). The following year Congress extended the network of stations to include the rest of the New Jersey shore and to the coast of Long Island, New York. Thus, the Federal government took its first tentative steps toward a remedy for mariners in distress.

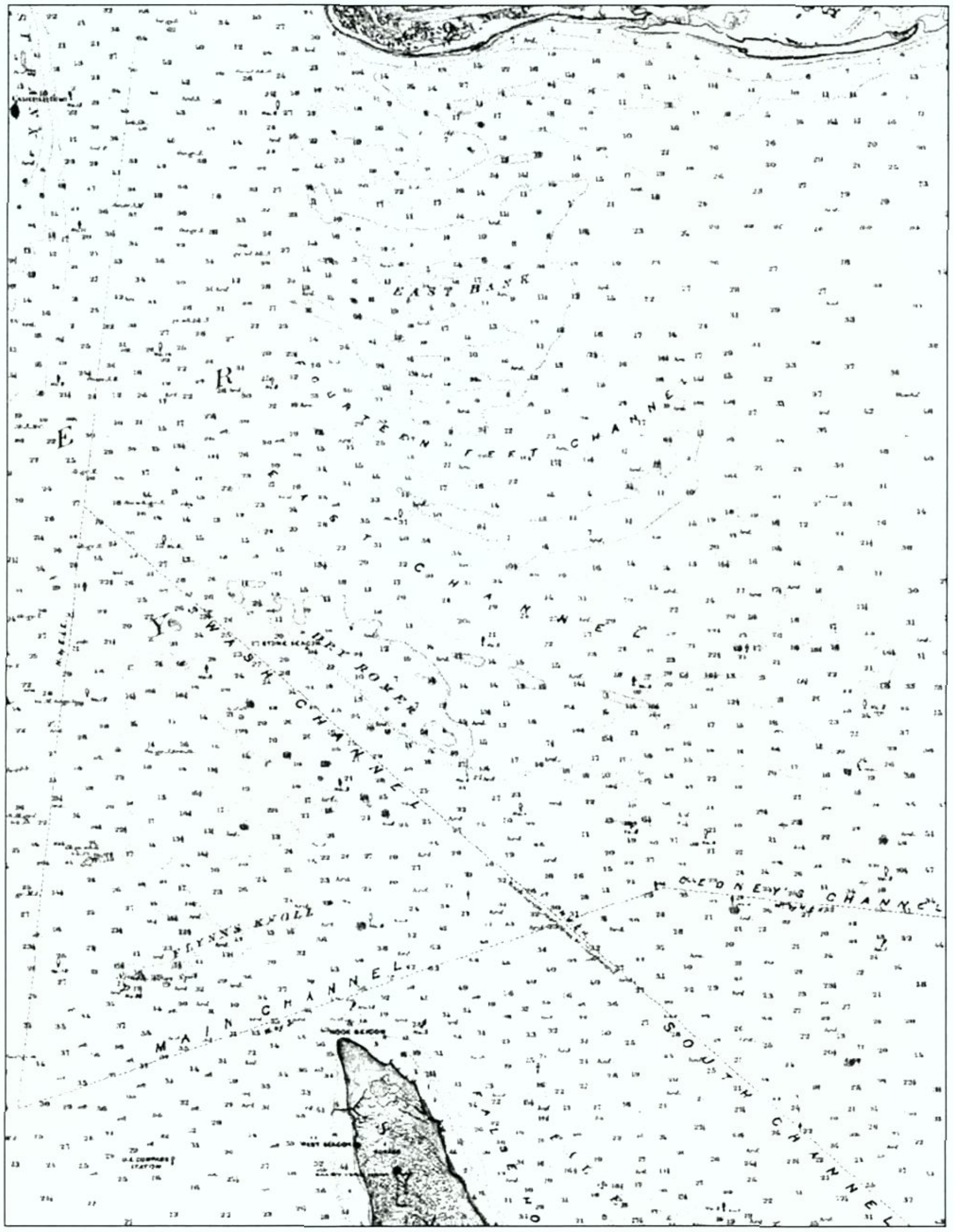


Figure 2-03. Outlined excerpt shown in Figure 2-02 above. Note the numerous shoals that greeted all leaving or arriving vessels at the entrance to New York Harbor. The East Channel, just to the north of the main Swash Channel, would become the location for the dredged and maintained Ambrose Channel. Note also the Gedney's Channel and South Channel both lower right.

Dredged through the shoals at the entrance to the harbor, the creation of the Ambrose Channel would help to further reduce accidents. Named for the Irish immigrant who championed its cause, John Wolfe Ambrose, president and founder of the Brooklyn Wharf and Dry Dock Company, recognized the need for a deep draft entrance channel to keep New York at the forefront of world harbors. Ambrose organized a prominent delegation to lobby the River and Harbor Committee of the House of Representatives, and subsequently the Committee on Commerce, where he was successful. By 1912, a channel 2,000 ft. wide and 40 ft. deep had been dredged. By 1935, it was deepened to 45 feet (Figure 2-04).

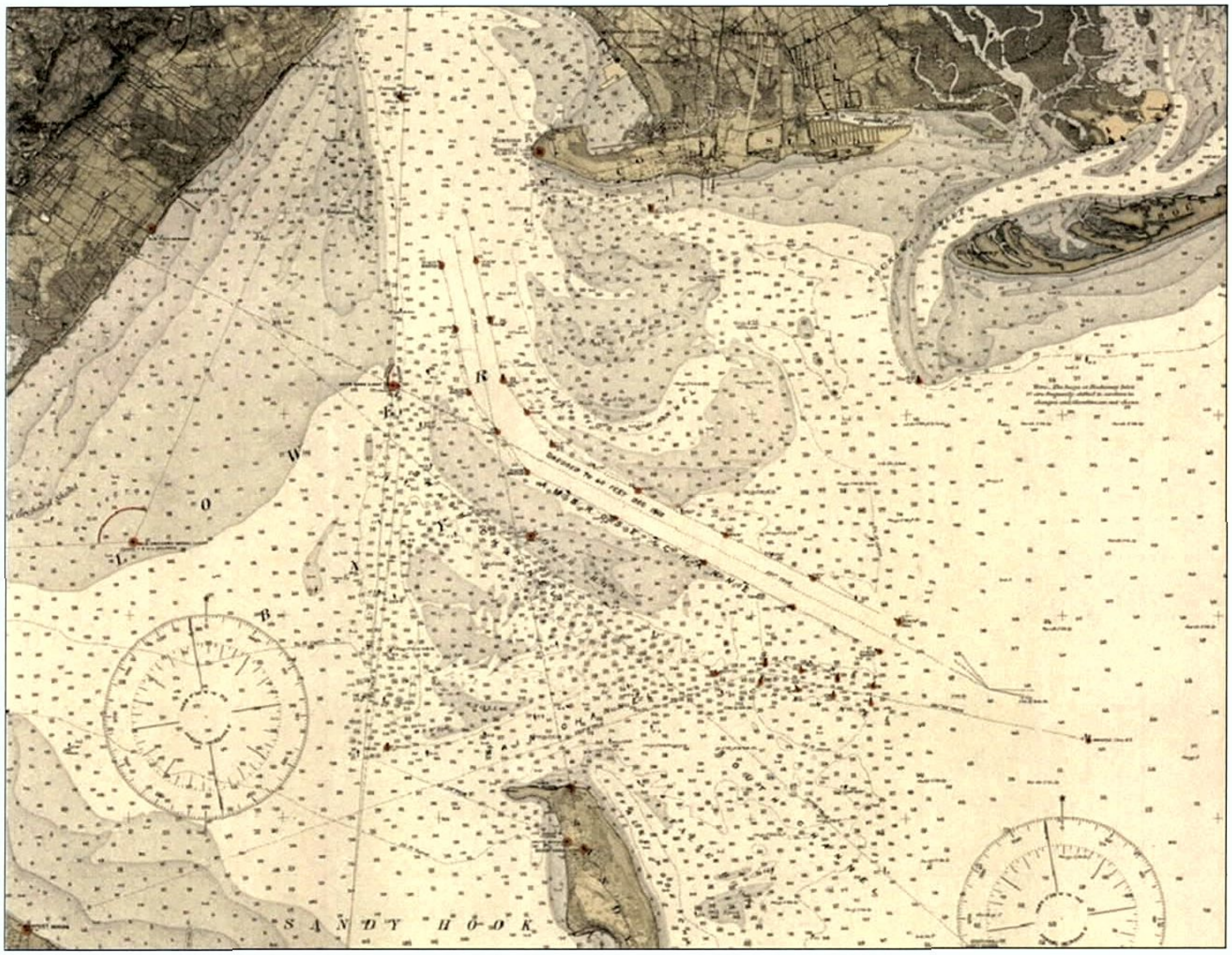


Figure 2-04. Excerpt from the 1913 Coastal Survey map, "New York Bay and Harbor" showing the location of the newly dredged and marked "Ambrose Channel."

Shipwreck Inventory of the Project Area

A number of sources have been written concerning the history of the approach to New York Harbor and the subsequent loss of numerous vessels due to foul weather, lack of navigational aids, marine accidents, or simply being grounded out near the surf zone (followed by the subsequent degradation of the hull if the vessel could not be removed). Rattray mentions that the south shore of Long Island is well known for shifting sandbars that parallel the whole length of the island (1973:50). Any and all of these factors helped to make both the approach to New York Harbor and the harbor itself a haven for shipwreck disasters.

Considering the volume of shipping that moved in and out New York Harbor for the last three centuries the probability of shipwreck remains within the project area can be considered high. The report written by the Harvard University Institute for Conservation Archaeology (ICA) study of the Atlantic Coast titled *Summary and Analysis of Cultural Resource Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras* (1979) supplies some useful information regarding the final disposition, durability, historic shipping, data, and categories of shipwrecks:

A. Shipwreck locations

(1) References to shipwreck location are often vague, owing principally to the difficulty of locating things at sea. Even as late as World War II it was not customary or feasible for merchant ships to maintain their position at sea with any great accuracy. Thus, a position reported at the time of the vessel's distress often refers to the last known position rather than the actual position at the time of the wreck.

(2) The change from sail to steam power during the mid-nineteenth century seems not to have affected shipwreck location.

B. Construction material and durability of shipwrecks

(1) Wooden shipwrecks tend to break up and disintegrate due to the effects of storms and/or attacks of marine organisms, with their remains scattered over an area much larger than the original dimension of the ship.

(2) Steel-vessel shipwrecks tend to retain a greater degree of structural integrity than wooden vessels.

(3) The early steel (actually iron) vessels of the 1860s were generally made of thin sheets of metal and tended to sink rapidly and scatter their remains over larger areas than the later, more-rigidly constructed steel vessels.

C.) Historic shipping

(1) The Harvard University study presents a brief history of shipping in the Greater New York Harbor area and makes predictions as to probable primary locations for shipwrecks for the various periods. New York Harbor has been an active port since the first Dutch settlements, and in fact since the early 1800s it has been a leading--often the leading--American port for commercial shipping. Because modern aids to navigation appeared only toward the latter part of the nineteenth century, it is probable that yearly vessel losses peaked during the period 1850-1880 (That the data contained in this shipwreck inventory does not show a peak towards the latter part of the nineteenth century is problematic, but perhaps is due only to the onset of record keeping in the twentieth century).

D.) Shipwreck data sources through time

(1) Pre-1800: there are not many records of any sort pertaining to shipwrecks during this period; what records do exist tend to be located now in European archives, since the ships involved, until 1776, were of European registry. Potential shipwreck locations are derived from analysis of shipping routes, trade, and settlement patterns.

(2) 1800-1880: coastal newspapers are the major source for information about ship arrivals and departures and about ship losses during this period.

(3) 1880-present: By 1880 the U.S. Life-Saving Service was publishing lists of casualties in its annual report. By 1910 a list of vessels lost was also included in Merchant Vessels of the United States, an annual record of registered vessels published by various government branches. By 1915 the U.S. Life-Saving Service was taken over by the U.S. Coast Guard, which also published annual reports of casualties and assistance.

4.) Categories of areas of expected shipwrecks

a. Primary: locations where popular shipping route pass through hazardous waters and/or close to shorelines.

b. Secondary: coastal and shoal areas less frequently utilized but known to contain submerged hazards and lee shores.

c. Tertiary: deep-water areas of major shipping channels, where shipwreck density relates directly to traffic density (as presented in Engebretsen 1982:2-3).

These factors (compiled by ICA) aided in establishing a shipwreck inventory for Lower New York Bay in a report titled *New York Harbor and Adjacent Channels Study Shipwreck Inventory* compiled by Jan Engebretsen in 1982. In cooperation with the Corps and Port Authority of New York, this study established the potential for shipwrecks within navigation channels (and adjacent areas) in and near New York Harbor. Engebretsen created the inventory "of all known shipwrecks in the Greater New York Harbor area" (1982:3) using several shipwreck compendiums, lesser inventories, and government reports. The four major sources consulted include (but were not limited to) Lonsdale and Kaplan (1964); Marx (1971); Berman (1972); and Rattray (1973). Engebretsen's principal purpose was to inventory shipwrecks "known or presumed to have occurred in the New York Harbor project area" (Engebretsen 1982:7). Additional purposes of the inventory were to:

• Assess the potential magnitude of the overall "shipwreck problem" with regard to deepening the navigation channels.

• Predict which areas have a high density of shipwrecks and which areas have a low density of wrecks.

• Predict the likelihood that a wreck encountered comes from a particular century and possibly predicting the parent material it is likely to be made from.

• Begin to track down and pinpoint the name and history of any shipwreck encountered (Engebretsen 1982:7).

Illustrating that New York Harbor was an area of numerous historic vessel losses, Engebretsen's inventory is presented in Table 2-02 below. It has been modified slightly by deleting those wrecks listed for areas known to be well away from the current project area.

Table 2-02. Vessel losses documented in or near the project area.

Name	Rig	Tons	Built	Date	Comment
A.C. Nickerson	steam screw	64	1864	3-25-1891	lost, NY, NY
A.J. Sinonfcon	schooner			6-25-1873	collided, off Long Island
Abangarez	steamship			3-11-1955	collided in fog, Gravesend Bay
Abraham Leggett	pilot boat			"1879"	becalmed in lee of steamship, which rolled over & crushed her
Abrao Collerd	barge	217	1869	9-11-1905	collided with steamer *Maine*, NY, NY
Absecon	barge	911	1918	5-9-1911	collided with Sta. *Sterlington* & Sts. *Empire Curzon*, NY Harbor
Adelaide	steam sidewheel	731	1853	6-19-1880	collided, sank; NY, NY
Admiral Dewey	steamship			11-22-1908	smashed into a steamer off Coney Island
Adolph Obrig	bark	1,118	1881	11-10-1907	sailed from NY & not heard from
Adriatic	or It. steamer			10-21-1874	collided in NY Bay; damaged
Adventure	Scot. merchantman			1760	lost in Lower NY Bay
Aetna	Citizen's line steamer			5-15-1821	exploded in NY Harbor; complete wreck
African Star	Farrell line's freighter			12-18-1956	collided in NY Harbor; sank
Albany	schooner	650	1889	11-16-1922	stranded, Man-O-War Rock, NY Harbor
Alexa	Brit. schooner			1-23-1904	total loss, Rockaway Point, LI
Alice Roy	bark			8-1887	abandoned, off NY

Name	Rig	Tons	Built	Date	Comment
Alice Sheridan	coal barge	373	1919	10-1-1915	sunk in NY Harbor after collision off Staten Island (St. George)
Ambrose Snow	pilot boat			5-13-1912	rammed & sunk in Lower Bay
American Leader	freighter			1-15-1953	collided, NY Harbor, in fog
American Press	freighter			0-29-1959	collided in NY Harbor
Andrew Fletcher	steam aid wheel	160	1865	12-20-1872	burned, Quarantine landing, Staten Island
Annie Bulge?	barge	233	1906	2-26-1918	foundered, NY Harbor
Arbitrator	schooner	106	1897	12-13-1916	sailed from NY, not heard from
Ariel	sloop	54	1857	9-21-1908	burned, NY, NY
Avon	ship	1,573	1884	4-5-1918	sailed from NY, not heard from
Ayuruoca	steam freighter (ft.)	6,872		"1940", 6-11-1945	
B.W. O'Hara	barge	227	1903	5-11-1914	foundered, NY Harbor
B.Y. 11	barge	157		1-15-1926	foundered, NY, NY
Benj. E. Weeks	schooner	77	1867	11-1-1920	stranded, NY, NY
Benaore	bark	1,178	1870	7-10-1921	foundered, NY, NY; iron vessel
Bertha L. Barker	schooner		1895	11-7-1916	foundered, NY, NY
Betsey	Brit., troop-transport			1780	wrecked on rooks, Lower NY Bay
Betty B	fishing boat			7-28-1951	exploded & sank in Lower NY Bay
Bit Bob	Oas yawl	51	1905	2-23-1920	burned, NY, NY
Bohemian	steam screw	72	1906	6-13-1935	collided, NY Harbor
Boston City	Brit. screw steamship			1-31-1901	collided in Lower NY Bay
Boyle	schooner			1-30-1900	wrecked west of Rockaway Ft, LI
Broadway	steam sidewheel	755	1869	9-19-1917	burned, NY, NY
Buffalo (R,B)	steam sidewheel	1,129	1854	6-29-1854	foundered, NY, NY
Buffalo	steam screw	131	1885	11-21-1913	burned, Staten Island
C1	barge	518	1906	8-31-1928	foundered, NY, NY
C.W. Horae	steam screw	509	1889	7-17-1916	sailed, NY, never heard from
Capt. Mathlasen	steam screw	117	1899	4-20-1925	burned, Gravesend Bay, NJ.
Carrie C. Miles	schooner	106	1871	10-15-1907	stranded, Dry Rooer Shoal NY.
Carrie S. Webb	schooner			3-1-1881	sand, Homer Shoals, alongside *Auguste*; wrecked
Carrie Winslow	brig			2-11-1878	wrecked NY Bay
Caatlefcon	barge	1,112	1899	10-1-1907	collided w/*Rochester*, NY, NY
Castor	steam screw	73	1891	3-7-1923	foundered, NY, NY
Chaleur	HM sloop			7-10-1761	burned by mob in NY
Charlie & Willie	schooner	123	1849	10-30-1923	burned, NY, NY
Charter Oak	steam sidewheel	439	1838	3-1-1850	burned, NY, NY
Chatham	ferry			8-29-1960	collided in fog in NY Harbor
Christ!ane	Danish bark			12-27-1866	panned & sunk 6 miles E of Sandy Hook
Cincinnati	merchantman			11-10-1810	wrecked on Governor's Island
City of Albany	steam sidewheel	1,158	1863	10-6-1894	burned, NY, NY
City of Worry	Amer. ship			1761	sunk in Narrows; crew saved
Columbia	pilot boat			12-3-1883	run over; all lost
Columbia	steam screw	174	1890	12-24-1909	sailed from NY; not heard from since
Commerce	pilot boat			1852	lost with all on board
Copia	schooner			9-18-1882	total loss off Rockaway Pt, Cargo coal
Daghestan	steamship			12-18-1908	collided, sank ¼ mile SE of Gedney Channel buoys, blown up by Coast Guard
Dolphin	gas screw			1960	unknown cause, 830 yd., 192° from Coney Island Light. Depth 27'

Name	Rig	Tons	Built	Date	Comment
Dom Pedro	barge	193	1876	2-21-1906	collided with dock, NY, NY
Duchess J	steamer			8-26-1902	burned, NY
E.G. Hay	schooner	63	1873	6-28-1906	collided off Debrosses St., NY, NY
EX-PC 469	oil screw			1961	unknown cause, Swinburne Island area, NY Harbor; 40° 43.3' N, 74° 03.4' W Navy vessel
East Wreck	3 coal barges			1917	in triangle within 5 miles of shore, near Rockaway Point
Edwin Collyer	schooner			1903	sunk, Gravesend Bay; cargo sand
Economy	steam sidewheel	239	1853	6-30-1851	burned, NY, NY
El Sol	steam screw	6,108	1910	3-11-1927	collision in fog in NY Harbor; sank
Elizabeth	steam sidewheel	1,079	1867	10-22-1901	burned, NY, NY; ferryboat
Ellis P. Rogers	barge	68	1878	12-23-1907	collided w/*Mauretania*, NY, NY
Enna R.	barge	251	1903	9-8-1906	foundered, NY, NY
Enmett McLoughlin	barge	331	192'!	9-21-1938	stranded, Gravesend, NY
Escape	schooner			7-6-1916	sank after collision off Ambrose Lightship
Europe	Ger. bark			10-7-1876	fire in hold at NY
Evelyn	schooner			11-30-1900	wrecked west of Rockaway Pt, LI
Evelyn	ferry			1-13-1917	wrecked in explosion
Evening Star	?			1866	foundered at sea, out of NY
Fly	pilot boat			1813	lost with all hands
Fort Victoria	passenger boat			12-18-1929	collided; sank at entrance to NY Harbor 0° 28.6" N 73° 53.2' W Depth 12
Frank Pendleton	schooner	1,393	1874	3-8-1917	foundered, Ambrose Channel, NY
Gen. Meigs	steam screw	267		10-27-1926	foundered, NY, NY; steel vessel
George L. Garlick	steam tug			5-25-1897	wrecked, Coney Island
George W. Beale	steamer			10-1887	collided, NY Harbor
Glide	schooner			1905	lost at Rockaway, LI
Governor	tug			3-12-1888	sunk between Rockaway Pt. & Swash Channel
Halcyon	steam screw	89	1875	10-18-1923	foundered, Coney Island
Harry Bum	steam screw	51	18611	5-27-1872	exploded, NY, NY
Henry Eckford	steamer	153	1824	11-27-1841	exploded, NY, NY, used as coal barge
Herbert Parker	oil screw	137	1919	5-16-1932	burned off Ambrose Channel Lightship
Hopafccong	barge	563	1885	12-6-1910	foundered, NY Bay; iron vessel
Hudson	liner			5-29-1912	rammed in NY Harbor; "began to sink"
Idle Time	cabin cruiser			9-10-1951	capsized off Rockaway Point
Idler	steam screw		1886	7-24-1912	collided w/*Old Colony*, NY
Ilion	barge	113	1890	12-14-1917	stranded, Coney Island
Isabella	schooner			11-1-1837	foundered in gale near NY
Isabella Gill	schooner	585	1891	8-17-1906	sailed from NY & not heard from
J.A. Reynolds	tug			12-13-1940	collided, NY Harbor; sank
J.H. HcLaren	bark			11-25-1871	sunk in Lower Bay off Staten Island, probably total loss; cargo coal
Jacob A. Stamler		1,198	1856	2-17-1916	burned, NY
James Logan	steam screw	201	1914	11-17-1917	collided w/*Lexington*, NY, NY
Janes Runsey	steam sidewheel	341	1845	11-11-1853	burned, NY, NY. Ferryboat
James Rumsey	steam sidewheel	671	1867	2-20-1891	sank, NY, NY. Ferryboat
Jane	pilot boat			4-2-1873	ashore on West Bank, Lower Bay; filled
Japanese	pilot boat			3-12-1888	collided; damaged
Jenny	merchantman			1798	wrecked in Lower NY Bay
John A. Hadgeman	steamer			2-19-1890	burned, NY

Name	Rig	Tons	Built	Date	Comment
John D. Jones	pilot boat			3-18-1871	run down by City of Washington; all saved
John E. Berwind	steam screw	75	1888	2-16-1931	foundered, Stapleton, Staten Island
John Mckeon	pilot boat			7-18-1939	off NJ; lost at sea in hurricane
John Nelson	barge	341	1849	8-19-1905	stranded, NY, NY
Josephine Elliot	schooner	391	1890	1-9-1908	sailed from NY, NY, not heard from
Joaiah Johnaon	pilot boat			3-6-1869	"Run down & sunk by schooner sunk in bay"
Josle Mildred	bark			8-1873	run into at anchor in Lower Quarantine, cut through from waterline up
Juanita	tug			12-27-1917	sank in collision. NY Bay
Julia	schooner	57	1878	9-13-1907	collided, Coney Island
Kaoikawa Maru	Jap. freighter			6-9-1966	collided in fog with Nor. freighter *Nordvind* near Ambrose Lightship
Kaskaskia	steam screw	2,931	1918	1-31-1920	burned, NY, NY
Kate Dyer	?			1866	sank about 10 miles off Fire Island after colliding w/*Scotland*; cargo cotton
Kelsey	barge	203		11-28-1904	foundered, NY, NY
Kenneth W. KcNeil	barge	261	1903	5-2-1907	foundered, NY, NY
Kenyon	schooner			11-30-1900	wrecked off (W) of Bockaway Pt., LI
Knoxville	steam sidewheel	1,210	18511	12-22-1856	burned, NY, NY
L.A. Buzby	?	117	1892	1-31-1919	collided w/*McAllister*, NY, NY
Lamartlne	schooner			1888	lost in East Bay, NY
Lanarkshire	freighter			2-15-1943	collided in main ship channel. Upper Bay, w/U.S. destroyer *Hobpy*
Liguria	Ital. liner			12-1906	collided, NY Bay, with *Peconic*
Lizzie D	steam screw	122	1907	10-19-1922	sailed from Brooklyn; not heard from
Lloyd H. Dalzell	steam screw	202	1927	1-19-1951	burned at commercial wharf, foot of Atlantic Basin, Brooklyn
Lord Dufferin	freighter			2-28-1919	sunk in NY Bay by *Sultana*
Louis	steam screw	89	1863	10-16-1876	stranded, Coney Island
Louise	steam sidewheel	1,351	1864	5-11-1933	foundered, Brooklyn; steel vessel
Lucy & Elizabeth	amer. ship			1812	lost in Lower NY Bay; all saved
Mamie K	motor boat			11-25-1919	total loss 1 mile W of Rockaway Beach
Mandalay	steam screw	1,120	1889	5-28-1939	rammed/sunk by Acadia, NY Bay, iron vessel
Manhattan	U.S. Coast Guard cutter			1-13-1932	collided w/*Guayaouil*. NY
Margaret Julia Howard	bary	500	11(8	11-27-1920	collided w/Brit *Clifftower*. NY
Maria Dagwell		110	1890	7-19-1919	collided w/*Townsman*. NY
Marigold	steam screw	115	1863	11-30-1875	burned, NY, NY
Martha Ogden	steamer			11-12-1832	stranded, NY
Martha Stevens	steam screw	283	1862	7-20-1909	collided w/*Confidence*, NY Harbor; iron vessel
Mary	dutch ship			1802	lost in Lower NY Bay
Mary	steam tug	58	1859	3-15-1875	collided with Harlem passenger boat *Shady Side*, NY Harbor; sank
Mary A. Hall	schooner	381	1882	5-29-1919	burned, NY Harbor
J Mary Heitman	schooner			3-11/12-1888	last seen going through narrows
Masootta	bark			2-18-1891	wrecked in collision. NY Harbor
Matthew Kinney	schooner			2-5-1872	in narrows, bow port stove in by ice; vessel filled

Name	Rig	Tons	Built	Date	Comment
McCall	U.S. destroyer			12-3-1917	collided w/*Comanche* below narrows in high wind
Metinio	schooner	261	1901	2-26-1916	sailed from NY Harbor, not heard from
Michael Howard	barge	502	1918	3-18-1912	foundered, NY Harbor
Mississippi	merchantman			1807	wrecked, Lower NY Bay; crew/some cargo saved
Mohawk	yacht			7-20-1876	capsized in bay near NY; lost
Mohawk	USN revenue cutter			10-1-1917	lost in collision off NY
Mohawk	schooner	913	1882	1918	sailed from NY & not heard from
Montague	steam sidewheel	110	1853	12-8-1853	burned, NY. Used as ferryboat
Morning Star	Brit. ordnance sloop			8-1-1778	blew up near NY coffeehouse; believed struck by lightning
Mosea B. Bramhall	schooner			10-21-1891	unknown: entrance to NY Harbor
Mutual	tug			4-30-1929	collided w/ferry *Youngstown*; sunk
Mystery	gas boat	137	1905	2-23-1920	burned, NY. Steel vessel
N.B. Starbuck	steam screw	101 (72)	1863 (65)	10-17-1928	burned, NY (2 listings in B, with variances)
Nathaniel Bacon	U.S. cargo ship			11-21-1942	damaged in collision w/*Esso Belgium* in NY Harbor
Navesink	U.S. dredge			5-7-1928	sank after collision; NY Harbor
Nelson	Brit. merchantman			1815	sank in Lower NY Bay
Nifadelos	bark			12-16-1865	collided & sank. NY Harbor
Northfleld	Staten Island ferry			6-14-1901	radioed sunk in NY Harbor
Northumberland	oil screw	169	1897	10-24-1955	foundered, 40° 22' M 73° 31' W
No. 7	schooner	957	1907	10-6-1918	collided w/USS *Monitor*. NY
Ohio	steam sidewheel	1,112	1829	7-6-1842	exploded, NY
Ohioan	steam ship			11-22-1933	collided w/SS *Liberty*; Ambrose Channel; settled on shoals
Old Glory	Hontauk Steamboat Co. steamer			1921	destroyed by fire, NY
Oliver A. Arnold	steam screw	50	1863	2-11-1890	burned, NY, NY
Oreanfcan	steam screw	2,293	1880	11-3-1915	sailed from NY & not heard from
Ovidia	steal ship			11-19-1930	sank off Ambrose Lightship
P.W. fiprague	steamer			10-1880	burned, NY
Palnella	steam screw	595	1867	6-30-1870	lost, NY, NY
Passaic	barge	552	1922	5-8-1930	burned, Bayonne, NJ
HKS Penfcland Firth	Brit. oil screw	500		9-22-1942	torpedoed/sunk, Rockaway Inlet 40 25' 19" N 73° 52' 05" w. Patrol craft Depth 50' (70'-Rattray)
Phantom	pilot boat			3-11/12-1888	lost in storm
Philip J. Kenny	steam screw	142	1884	1-19-1923	burned, off Ambrose Channel
Phoenix	schooner	901	1898	2-3-1926	stranded, NY, NY
Pilot	pilot boat			12-16-1917	caught in submarine net off NY; rammed, sunk, by steamer *Berkshire*
Pilot Boat	pilot boat	361		4-27-1939	collided w/Oslofjord off Sandy Hook. NJ. IO" 27' 45" N 73^9' 30" W. Depth BO
Portland Packet	schooner	91	1885	7-16-1916	sailed from NY & not heard from

Name	Rig	Tons	Built	Date	Comment
Port Philip	Brit. steamer	4,060		10-16-1918	rammed/sunk by USS *Proteus*, Ambrose Channel
Queens	steam sidewheel	802	1877	11-9-1918	burned, NY, NY
Quickstep	bark			unknown	run down/sunk in Lower NY Harbor, wreck removed & buoy placed on spot to mark shoal, near West Bank
R.S. Lindsay	schooner			11-10-1887	sank SW of Rockaway Life Saving Station
Rundlet	schooner	271	1892	6-29-1916	foundered, NY, NY
Red Ash	steam screw	117	1888	7-7-1927	burned, Staten Island, NY
Reichers Bros.	steam screw	85	1873	9-3-1930	burned, NY, NY
Relief Lightship No. 5				6-211- 1960	hit on Ambrose Station in fog; sank; wreck site marked, but moved
Relief Lightship UAL				1961	unknown; in vicinity of Ambrose Channel Lightship Station
Rhea	Nor. bark			5-31-1871	collided w/*Hansa*; sank
Richard Jaokaon	barge	230	1880	3-6-1913	foundered, NY, NY
Richard Morrell	schooner			10-12-1888	unknown; Coney Island, NY
Robt.. Rodo«rs	steam screw	142	1881	10-11-1913	burned, NY, NY
Rose McLoughlin	barge	199	1912	9-21-1938	stranded, Gravesend Bay, NY
Rudolph	steam screw	200	1898	9-25-1918	collided w/USS *St. Louis*, NY, NY
S.M. Hayena	schooner			8-30-1887	collided, NY Bay
S.S. Wyckoff	steam screw	267	1860	3-13-1913	collided w/*Heroine*, NY Harbor
Sb. Vincent	tug			11-23-1917	damaged in collision, NY Harbor
Sallle E. Ludiam	schooner	237	1873	6-17-1917	collided w/ Corozal, NY Harbor
San Jacinbo	pilot boat			18/12	lost with all hands
San Jose II	Pan. tanker			7-23-1956	damaged in collision, 3 miles south of Ambrose Lightship
Sander-art	steamer	2,054	1918	7-2-1950	sank after collision w/*Melrose*, entrance to narrows; steel vessel; Depth 47'
Sandy Hook	pilot boat steamer	361	1902	4-27-1939	collided w/*Oslofjord*, 1 mi. outside Ambrose Lightship, steel; 40° 27' 45" M 73° 49' 30" W
Santa Barbera	steam ship			9-17-1935	collided w/Ambrose Lightship
Satellite	steam screw	381	1894	11-20-1915	burned, NY Harbor
Sea Bird	steamer			5-9-1932	burned, NY
Sea Wave	scow			3-18-1950	capsized off Ambrose Lightship
Seneca	steam sidewheel	313	1819	6-30-1872	burned, NY, NY; ferryboat
Seneca	steam screw	2,963	1894	1-9-1928	burned, NY, NY
Shamokin	barge	829	1904	5-11-1925	foundered, Scotland Lightship
Shepherd Knapp	steam sidewheel	186	1845	1856	burned, NY, NY
Silveryew	Brit. motor vessel			3-18-1931	damaged in collision, narrows
Soaeraefc	schooner	629	1905	2-10-1918	foundered off Ambrose Light, NY
Speculator	schooner			7-21-1831	sank off Coney Island
Spitfire	steam sidewheel	221	1846	10-12-1819	burned, NY, NY
Springhill	tanker			2-5-1915	on fire after collision in Lower NY Bay
Star	barge	89		9-12-1905	foundered, NY, NY
Staten Island	steamer			7-30-1871	exploded, NY, NY; ferryboat
Teka	barge	389	1917	1-13-1942	collided, NY, NY
Tempest	steam sidewheel	80	1849	10-1-1866	burned, NY, NY
Thomas E. Hulae	steam sidewheel	314	1851	3-30-1875	damaged by ice, NY, NY
Thonas Hale	barge	207	1896	2-5-1917	foundered, Brooklyn
Tloellne	steam screw	99	1896	11-22-1920	collision, w/*Correction*, NY, NY

Name	Rig	Tons	Built	Date	Comment
Titania	Brit. steamer			11-19-1881	collided in Narrows w/*Hypatla*
Trojan	steam sidewheel	280	1812	8-9-1851	burned, NY, NY
True American	merchantman			2-20-1809	wrecked near the narrows, Upper NY Bay
U.S. Lightship, Ambrose Channel	Coast Guard lightship			winter 1961-62	disappeared
Umberto Prino	bark			3-13-1891	unknown; Romer Shoal; cargo hides and wool
Union	steam sidewheel	296	1811	12-15-1878	burned, NY
Union Star	steam sidewheel	163	1861	10-16-1862	burned, NY, NY
Universe	barge	120	1915	1-2-1926	foundered, NY, NY
(unknown)	sloop			8-20-1798	struck lightning off west end of Long Island
(unknown)	many			1839	many wrecks, Coney Island, in gale
(unknown)	?			1890s	suck in wreck miles NE from Ambrose Channel Lightship; found 1893
(unknown)	?			1920 vintage	charted as obstruction, 5 miles off Sandy Hook in Ambrose Channel. Depth 40'
(unknown)	?			unknown	5 miles off Sandy Hook, In 60' of water
(unknown)	?			11-22-1933	rammed off Coney Island; sank on Craven Shoals
(unknown)	?			unknown	40° 21' 18" N 73° 56' 06" W, Depth 35'
(unknown)	?			unknown	40° 21' 24"-M 73° 49' 18" W, Pre WWII
(unknown)	?			unknown	40° 25' 12" N 73° 45' 18" W, Depth 70'
(unknown)	?			unknown	40° 27' 22" N 73° 59' 13" W
(unknown)	?			unknown	40° 27' 24" N 73° 53' 06" W Derrick barge
(unknown)	?			unknown	40° 30' 08" N 73° 51' 40" W Depth 7'
(unknown)	?			unknown	40° 32' 00" N 73° 51' 90" W Depth 24'; pro WWI
(unknown)	barge			1946	5 miles off Sandy Hook
Vallderooaa J	steamer			5-11-1944	collided w/*Woodrow Wilson*, approaching NY
Violet BloasoB	barge	371	1907	2-20-1913	collided w/McAlliater Bros. NY
Vivi	Nor. tanker			2-5-1915	collision, NY Harbor
W.A.L. 505 Lightship				6-21-1960	struck by freighter *Green Bay* on Ambrose Station; sank. wreck site marked, but moved
V. J. Tracy	tug			9-8-1931	foundered in narrows
M.S. & A.L. Rogera	?	106	1889	12-1916	foundered, NY
Waubesa J	freighter			3-17-1919	sank after collision, NY Harbor; cargo grain
Wellesley Victory	tanker			1-31-1917	collision, off Ambrose Lightship
White Rook	schooner			7-25-1890	unknown cause; NY Bay
Wm. Dinsdale	steamer			1-24-1911	collided w/*Conoho*. NY Harbor
Wm. F. Havemeyer	steamer	110	1875	7-28-1907	burned, NY, NY
Wm. H. Vanderbilt	barge	211	1871	8-19-1905	stranded, NY, NY
Wm. J. Rooer	pilot boat			1863	struck submerged wreck & sank
Wm. O'Brien	steamer	5,211	1915	1-18-1920	sailed from NY & not heard from
Wm. V.R. Smith	steamer	207	1905	3-11-1920	stranded, NY, NY
Wo. Voorhia	schooner	89	1866	11-2-1907	collided w/dock. NY, NY
WH. H. Clark	schooner			unknown	lost in Gravesend Bay
Yeada	yacht			5-25-1890	wrecked, NY Bay

(after Engebretsen 1982)

Since the 1982 Engebretsen inventory, a number of more recent publications regarding historic vessel losses have been published as diver's guides and as narratives to some of the many vessels that met their demise in and near the approaches to New York Harbor (i.e., Berg and Berg 1993, Gentile 2000, and Sheard 1998). While these sources include a plethora of information for many wrecks, only those wreck sites presented below have been identified by the authors as being near the current project area.

Daniel Berg has written several sport diving guidebooks of wrecks within the general vicinity of the current project area including *Wreck Valley Vol. II* (1990) *Long Island Shore Diver* (Berg and Berg 1993), and *New Jersey Beach Diver* (Berg et al. 1993). Berg provides historical background, water depths, currents, visibility, and types of aquatic life on over 90 shipwrecks within the New York Bight or "Wreck Valley."

Another source of wreck accounts off Long Island is titled *Lost Voyages: Two Centuries of Shipwrecks in the Approaches to New York* by Bradley Sheard (1998). Sheard's book covers the evolution of oceangoing vessels, the tragedy of shipwrecks, and documents a number of wrecks located near the approaches to New York Harbor. While Sheard's book provides a useful glimpse into numerous wreck sites strewn throughout the approach to New York Harbor, no history or loss accounts (besides the date and general location) of any of the vessels listed above are provided in the book. Sheard does acknowledge that:

> Estimates of the number of shipwrecks in the region run from the hundreds into the thousands. The Long Island and New Jersey coastlines form the two sides of a "funnel" directing traffic into New York's great harbor, and have witnessed more shipwrecks than anywhere else along the East Coast of the United States, with the possible exception of Cape Hatteras, along the Carolina Outer Banks (Sheard 1998:8).

Of all the regional publications (Gentile 1988, 1996; Berg and Berg 1990, 1993; Berg et al. 1993; and Sheard 1998), none mention any wrecks not listed in the AWOIS list, and only those by Gentile (1988, 2000) mention vessels known to be lost within the current project area. These include the *Fort Victoria* and the *Daghestan*. Discussed below in the "Previous Investigations" section, the *Fort Victoria* collided with the American coastal steamer *Algonquin* and sank in 1929 as she departed New York in a heavy fog (Figure 2-05). Located at the southern end of Ambrose Channel, archaeological investigations were conducted and indicated that the site lacked integrity and was not considered historically significant (Lydecker 2008).

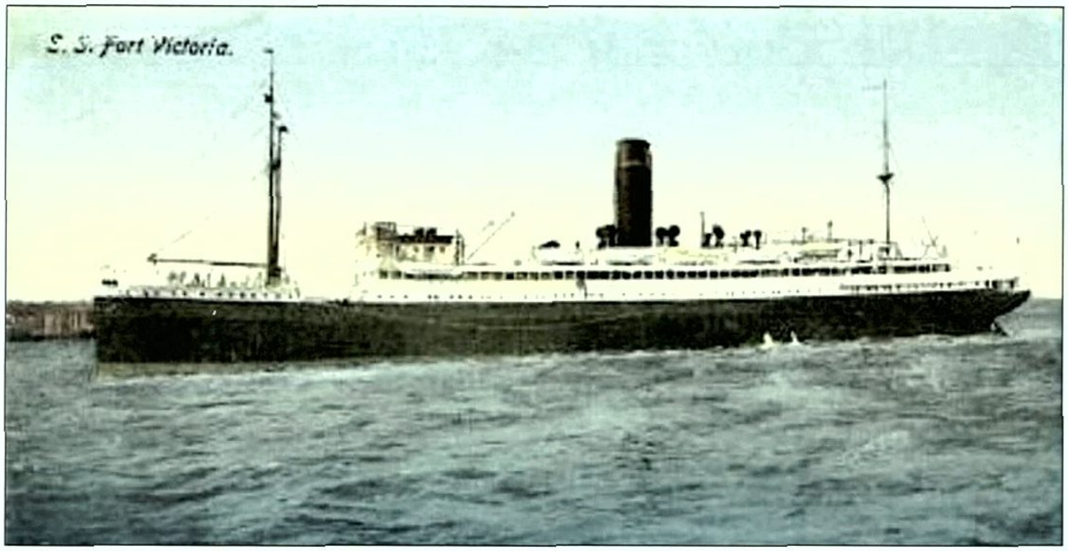


Figure 2-05. ***Fort Victoria*** **ca. 1920 (as presented in Lydecker 2008:34).**

The wreck of the *Daghestan* occurred on December 18, 1908 when she collided with the SS *Catalone* about one-quarter of a mile from the end of Gedney Channel in dense fog while outbound with a cargo of grain destined for Marseilles, France. This vessel was identified during the current survey as representing the source for High Spot A (WK52), one of three obstructions located in the Sandy Hook Pilot Area. A coal-fired, steel-hulled freighter, the *Daghestan* was built in 1900 in Sunderland, England by the Short Brothers, and was 353 feet long with a beam of 45 feet and depth of hold of 18 feet. The *Catalone* was relatively unhurt after the collision but the *Daghestan* sank in 60 feet of water, but with no loss of life from her crew of 35. Given up as a total loss, she was later demolished as a hazard to navigation (Gentile 2000:55-56).

Although not a publication, the website of New Jersey Scuba (njscuba.net), "The Online Resource for Divers in New Jersey and Long Island New York–Wreck Valley," lists numerous wrecks in and near the southern end of the current project area on their North New Jersey Chart (Figure 2-06). The site gives their location as well as history and dive recommendations. As illustrated in this dynamic wreck map from their website, the *Daghestan* and *Fort Victoria* are depicted, as are several unidentified AWOIS listings potentially within the current survey area (denoted with a "u"). Others, such as the *Bronx Queen*, *Sandy Hook*, and *Relief*, are shown on the dynamic website to be just outside the current survey area.

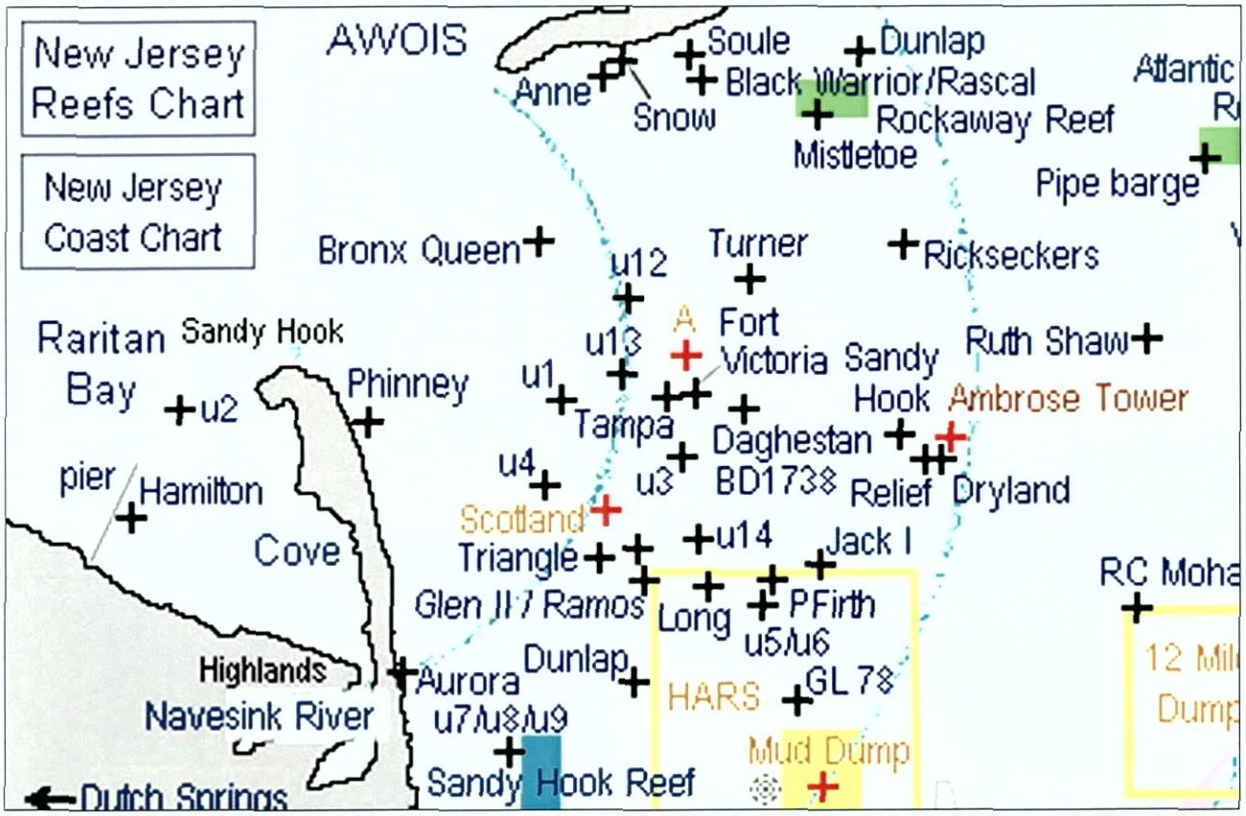


Figure 2-06. Map from NJSCUBA.net web site showing location of known dive sites and wrecks near the southern end of the project area (excerpt from the "New Jersey North" chart at njscuba.net/sites/index.html).

AWOIS Listings

The most comprehensive source of shipwrecks for the United States is the NOAA Automated Wrecks and Obstructions Information System (AWOIS). This list can be accessed from the Internet at http://anchor.ncd.noaa.gov/awois/search.cfm. An interactive page appears and queries the user for information to aid in the search of shipwrecks such as name, navigation chart, or coordinates. The AWOIS was queried for the area within and immediately adjacent the survey corridor. As presented in Figure 2-07 and Table 2-03, a total of 30 obstructions, unknowns, and wrecks are listed. Of these, 14 are listed as the remains of vessels or wrecks including the *Fort Victoria*, the *Bronx Queen*, and the *Zephyr II*. While the latter two vessels are fairly modern losses, the *Fort Victoria* (discussed in detail below) sank in a collision in 1929 and was previously studied in 2007. Apart from these named vessels, several of the obstructions represent wrecks or wreckage and several may correspond to targets located during this survey. Potentially representing the possible shipwreck located at Shoal C near the northern end of the survey, a focus of the current investigation, AWOIS listing 744, identified as "wreck, old ship hull, debris piles," and 11500, identified as "debris piles, both fall near Shoal C and Shoal D. The coordinates of AWOIS 744 locate the obstruction closer to Shoal C than does AWOIS 11500 (see Figure 2-07).

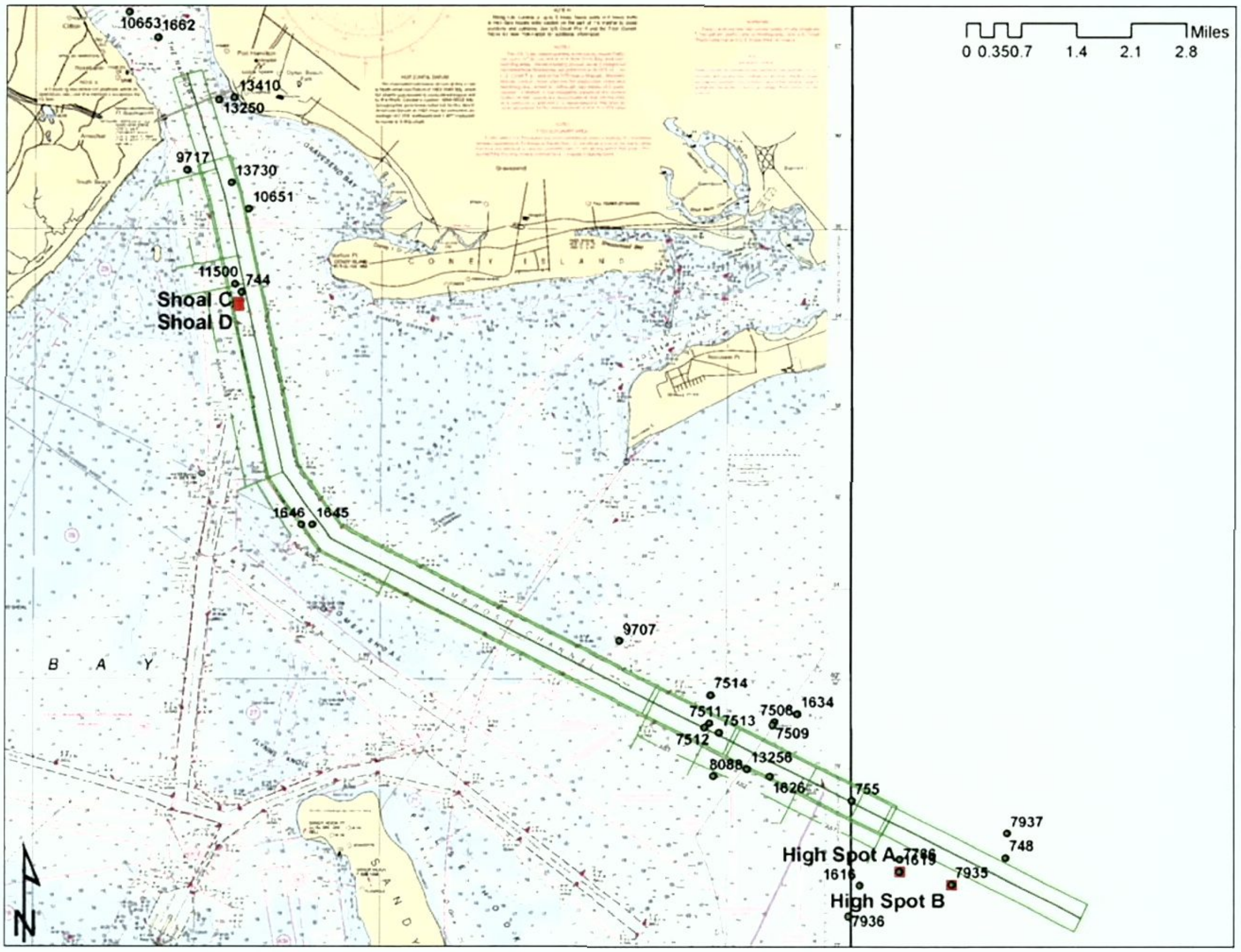


Figure 2-07. Map showing locations of AWOIS listings for the project area.

In addition to AWOIS 744 possibly representing the wreckage at Shoal C, it is thought that at least one of the three obstructions in the Sandy Hook Pilot Area, a second focus of the current investigation, may represent a wreck. It is believed, although as yet unconfirmed, that AWOIS 1619, noted as "High Spot A" in Figure 2-07, represents the remains of the *Daghestan* that sank in 1908 (discussed above). Listed as the remains of a "derrick barge and another wreck with three boilers" (see Table 2-03), dive clubs and dive boat operators know this location as the site of the *Daghestan* (Hepler 2008, personal communication).

Table 2-03. AWOIS listings within or immediately adjacent to the current project area.

ID	Listing	Depth	Year	LATDEC	LONDEC	Description
744	Unknown	49	1997	40.57157222	74.03361389	Wreck, old ship hull, debris piles
748	*ZEPHYR II*	?	1974	40.46677222	73.84957778	51-ft. fishing vessel
755	Obstruction	42	1950	40.47732778	73.88652222	Debris
1616	Obstruction	40	1991	40.46177222	73.88457778	Unknown – 1 mile accuracy
1619	*BD 1738*	52	1946	40.46425556	73.87505556	Derrick barge, another wreck w/ 3 boilers
1626	*FORT VICTORIA*	47	1929	40.48192500	73.90626111	*FORT VICTORIA*
1634	Unknown	?	1985	40.49343889	73.89958056	Wreckage
1645	Obstruction	47	1929	40.52843889	74.01625000	Unidentified - Dredge Pipe?
1646	Obstruction	?	1918	40.52843889	74.01891667	Unidentified
1662	Obstruction	?	2006	40.61871389	74.05375000	Lost Anchor and chain
7508	Obstruction	39	2002	40.49197500	73.90515000	Wreckage
7509	Obstruction	39	2006	40.49138333	73.90553889	Wreckage
7511	Unknown	49	1989	40.49174722	73.92061667	Wreck
7512	Obstruction	51	1989	40.49092778	73.92192500	Anchor
7513	Obstruction	49	1989	40.49000833	73.91838611	Wreckage
7514	Obstruction	37	2006	40.49700000	73.92035000	Unidentified – rock outcrops?
7786	Unknown	?	?	40.46653889	73.87491667	Unknown
7935	Obstruction	53	1991	40.46183611	73.86251667	Construction Debris
7936	Obstruction	62	2006	40.45601389	73.88729167	Dump sites?
7937	Obstruction	70	2006	40.47129167	73.84913611	Stud-link chain
8088	Unknown	52	2006	40.48196667	73.91976111	Undetermined buried wreckage
9707	*BRONX QUEEN*	35	1989	40.50694444	73.94222222	Wood fishing vessel sank in 1989
9717	Unknown	36	1941	40.59416667	74.04666667	Cleared wreckage
10651	Unknown	?	?	40.58693611	74.03191667	None
10653	Obstruction	53	2003	40.62344444	74.06061111	Unknown
11500	Obstruction	51	2002	40.57305278	74.03518889	Debris Piles
13250	Obstruction	NA	2005	40.60725000	74.03911667	Current Meter
13256	Obstruction	44	2005	40.48330833	73.91165833	Obstruction
13410	Unknown	?	2005	40.60764444	74.03535278	Dangerous wreck
13730	Unknown	76	2006	40.59182500	74.03608056	Sunken barge

PREVIOUS INVESTIGATIONS

Directly relevant to the current investigation, during 2001 Panamerican conducted a cultural resources remote sensing survey of the edges of Ambrose Channel, which are bordering sections of the channel that are the focus of the current survey (Figure 2-08). The survey was conducted for the New York District under subcontract to Vittor and Associates of Mobile, Alabama. The survey area consisted of an area extending 100 feet past each edge of the channel. Employing magnetometer, sidescan sonar, satellite positioning, and subbottom profiler, the survey recorded 93 magnetic anomalies and 24 sidescan sonar targets. Of these targets, 28 magnetic anomalies and 11 sidescan targets were determined to have signal characteristics indicative of potentially significant cultural resources. These targets were subsequently recommended for avoidance or further investigation to determine their identity and NRHP significance (Lydecker and James 2002).

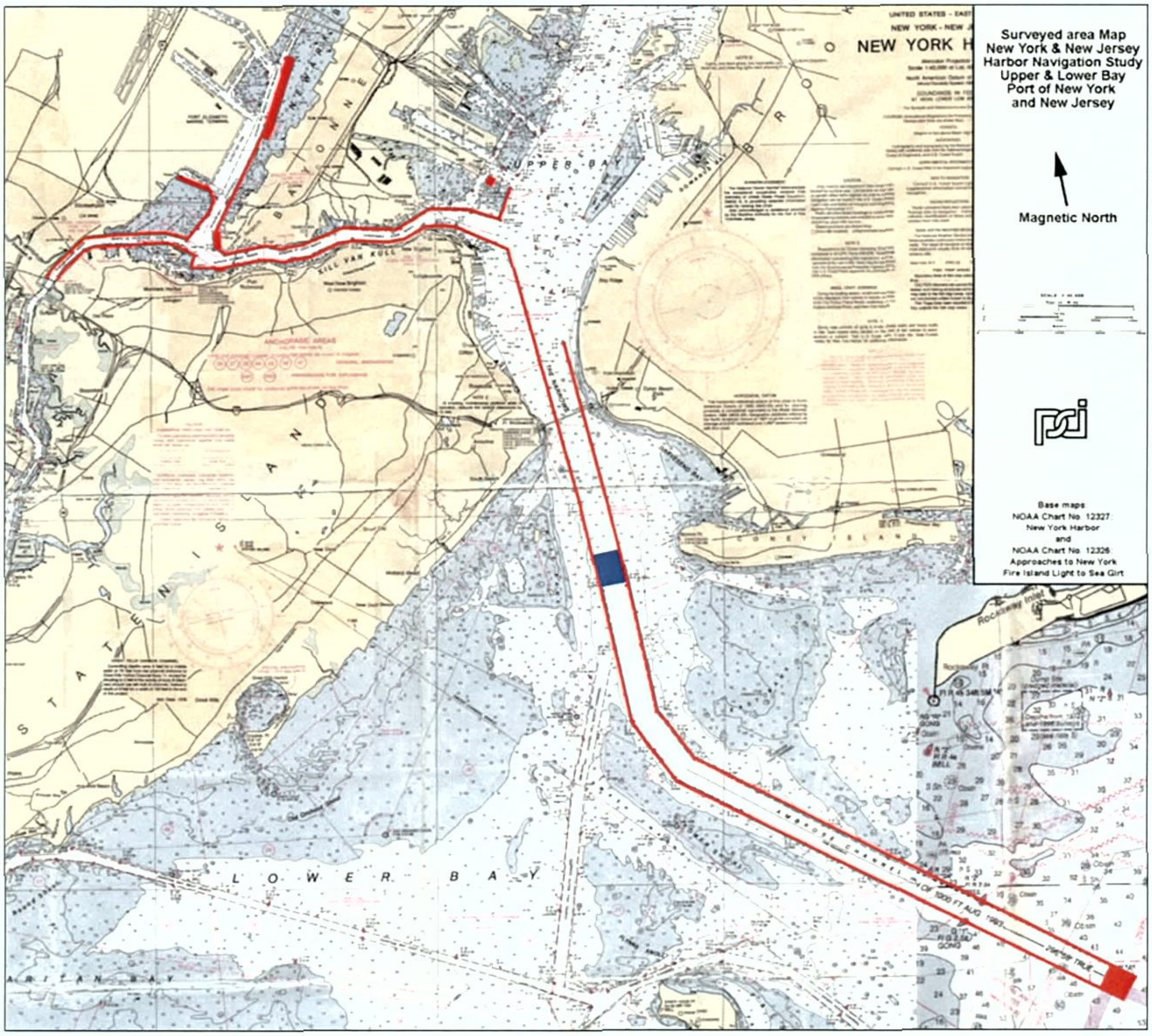


Figure 2-08. The 2001 channel edge survey area (as presented in Lydecker and James 2002:3).

In 2002, under subcontract to Matrix Environmental and Geotechnical Services, Inc., of Florham Park, New Jersey, Panamerican returned to examine the sources of the 11 acoustic targets and 28 magnetic anomalies previously recommended for further investigation. The diving investigation revealed that of the 28 magnetic anomalies, 6 were pipelines, 10 were miscellaneous non-historic modern debris, 6 were non-significant modern structures, 2 were non-significant submerged marine resources, 1 had a refined location outside the project area, 1 was not relocated on refinement, and 2 were not dived or refined due to safety concerns. Of the 11 acoustic targets, 3 were non-significant modern structures, 6 were non-significant submerged marine resources, 1 was determined to be outside the project area on refinement, and elements of 2 were recommended for Phase III investigation. However, as illustrated in Figure 2-09, only three targets were located adjacent to the current project area. Of these three, Anomaly A81 was dived and determined to be an extensive unrecognizable debris field consisting of both large and small pieces of heavily concreted riveted iron. Obviously, from an iron-hulled vessel, the main portion of the hull was not present, and what was *in situ* lacked any obvious structure or integrity, and therefore was not recommended as significant (Lydecker and James 2004).

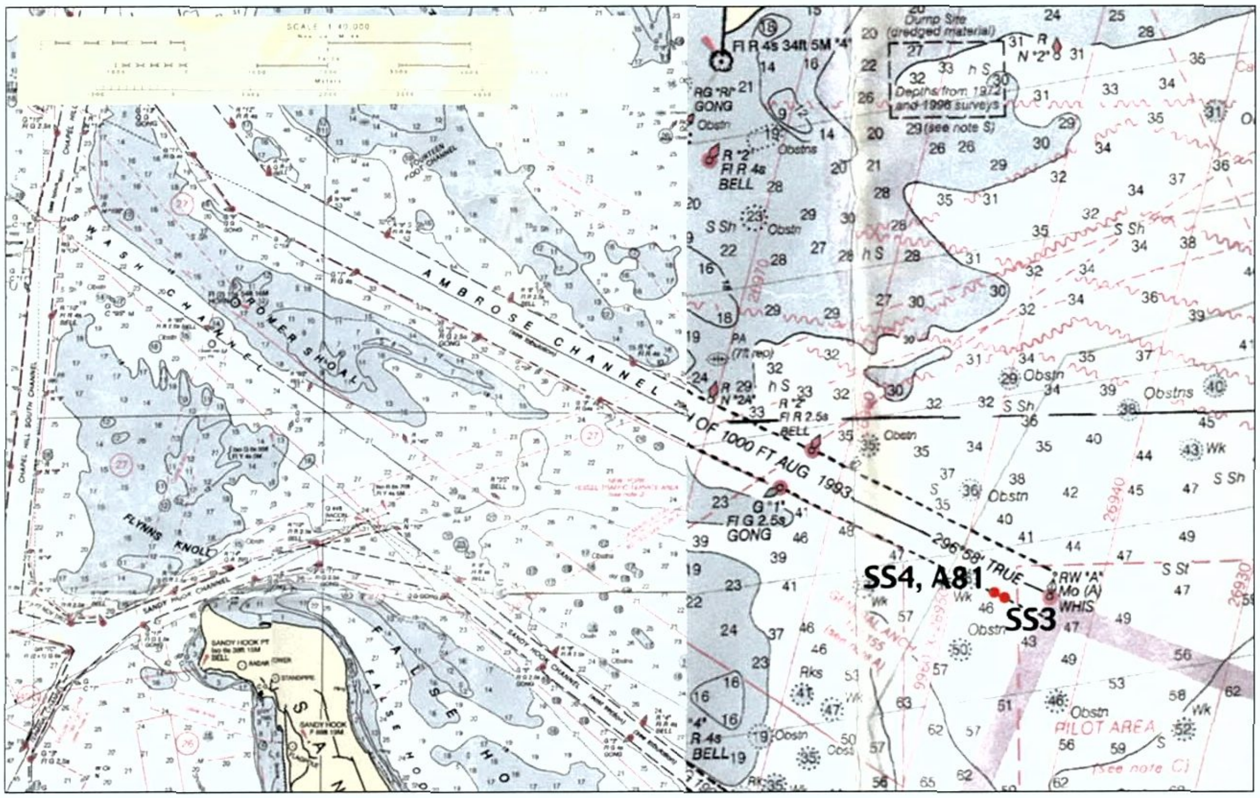


Figure 2-09. Map of Panamerican's 2002 investigation targets near the current project area (as presented in Lydecker and James 2004:76).

In 2006, during preparations for dredging the Ambrose Channel, hydrographic data revealed the presence of what appeared to be a wreck on the edge of the channel. Located opposite the A81 anomaly investigated in the 2002 study, multi-beam bathymetry and acoustic imagery revealed a significant mass of material extending from the upper edge of the channel slope to approximately 300 feet into the channel (Figure 2-10). In 2007, under subcontract to Great Lakes Dredge and Dock, Panamerican performed an archaeological investigation of the potential wreck site, and diver investigations revealed the presence of articulated iron plating. Findings from the 2007 investigation of the wreck indicated that the site lacked integrity and was not considered historically significant. Therefore, further investigations were not recommended (Lydecker 2008).

Archival research coupled with data collected at the site indicates very strongly that the site represents the wreck of the RMS *Fort Victoria.* Built in 1913 on the Clyde River by William Beardmore and Company of Glasgow, Scotland for the Adelaide Steamship Company of Adelaide, NSW, Australia, she was originally named *Willochra.* The *Willochra*, 411.7 feet long and 56.7 ft. in the beam with a 34.1-foot draft, was 7,784 gross tons and 4,532 net tons burden, and was equipped with a quadruple-expansion steam engine and twin screws. Sold to the Furness Group and placed on the New York/Bermuda run, the vessel's name was changed to *Fort Victoria* (Figure 2-11). On the morning of December 18, 1929, as she departed New York in a heavy fog, she collided with the American coastal steamer *Algonquin.* Although the crew and passengers escaped without serious injury, the *Fort Victoria* sank rapidly on her side in the middle of the channel. A serious hazard to navigation, she was dynamited with 20 tons of explosives and wire dragged to a clearance depth of 46 feet within a few years (Lydecker 2008).

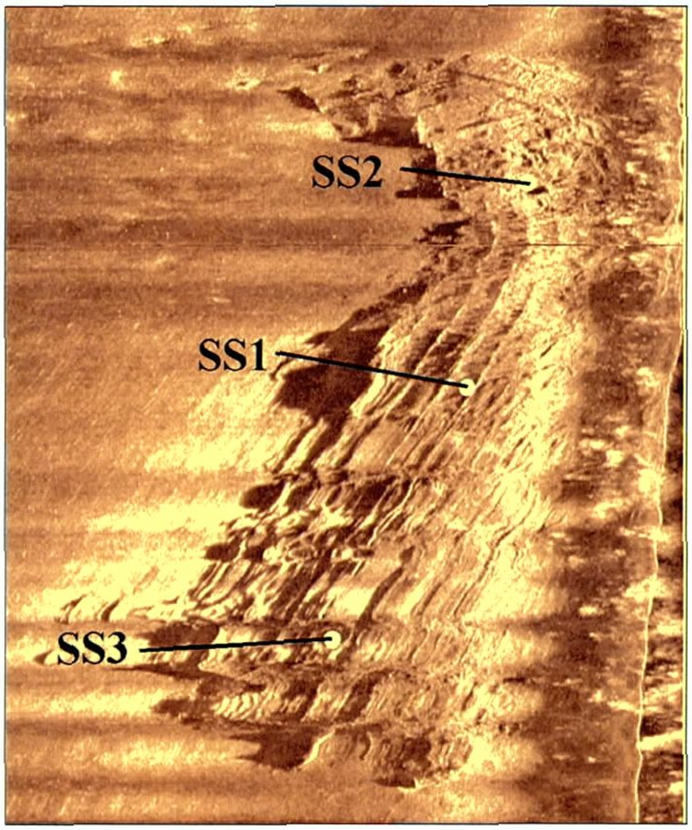


Figure 2-10. Acoustic image of the wreck site with location of targets dived (as presented in Lydecker 2008).

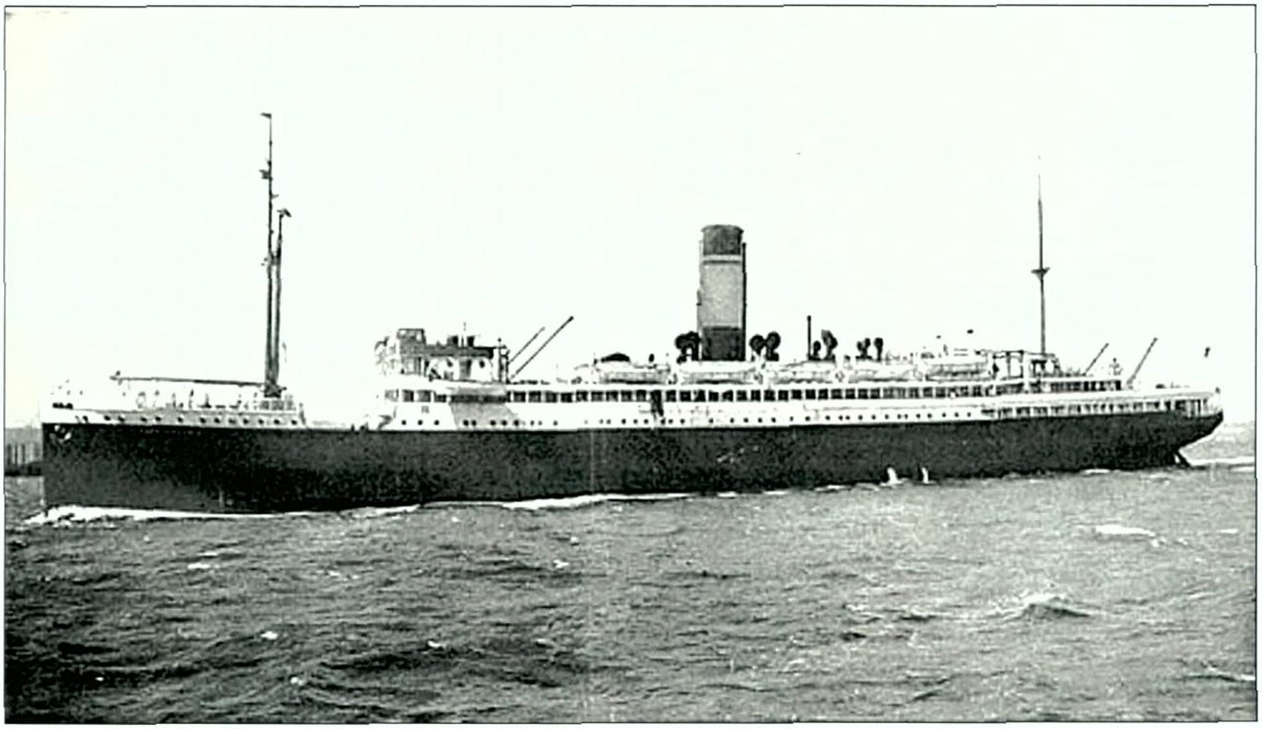


Figure 2-11. SS *Willochra* ca. 1920 after extensive refit and rechristening as SS *Fort Victoria* (as presented in Lydecker 2008).

3. METHODS

As stated previously, the field investigation consisted of both an intensive remote sensing survey and target relocation and refinement utilizing a marine magnetometer, sidescan sonar, subbottom profiler, and DGPS positioning. The following is a description of the equipment and methods employed for these investigation aspects.

ENVIRONMENTAL CONDITIONS

The conditions encountered during the project can be deemed typical for New York Harbor during the early spring. Daytime temperatures ranged from 60-70 degrees, and conditions were sunny. Winds were typically out of the east, often creating waves that were 2-3 feet.

Commercial and pleasure vessel traffic was generally moderate to heavy. Heavy commercial vessels often passed near the survey areas, creating waves or magnetic interference, sometimes necessitating the rerunning of survey lines. Numerous pleasure boats were present, but did not present a problem.

PERSONNEL

Personnel involved with the survey had the requisite qualifications and experience to efficiently and safely complete the project under U.S. Army Corps of Engineers' standards and requirements. Mr. Stephen R. James, Jr., served as the Project Manager; Andrew D.W. Lydecker served as Principal Investigator, and Dr. Michael Faught and James Duff served as remote sensing survey specialists.

REMOTE SENSING SURVEY EQUIPMENT

DIFFERENTIAL GLOBAL POSITIONING SYSTEM

A primary consideration in the search for, and remote sensing survey and relocation of, magnetic anomalies is positioning. Accurate positioning is essential for returning to recorded locations for supplemental remote sensing operations or ground-truthing activities. These positioning functions were accomplished on this project with a Trimble Navigation DSM212H global-based positioning system (Figure 3-01).

Figure 3-01. Trimble Navigation DSM 212H global-based positioning system used for this project.

The Trimble DSM 212H is a global positioning system that attains differential capabilities by internal integration with a Dual-channel MSK Beacon receiver specifically designed for survey positioning. This device interprets transmissions from satellites in Earth's orbit and from shore-based differential stations utilizing Radio Technical Commission for Maritime Services (RTCM) 104 corrections, providing accurate coordinate positioning data for offshore surveys. The shore-based differential station monitored the difference between the position that the shore-based receiver derived from satellite transmissions and that station's fixed position. The DGPS aboard the vessel provided real-time corrections to any variation between the satellite-derived and actual positions of the survey vessel. The geodetic parameters for this project (and all locational data herein) were in New York State Plane Long Island coordinates, projected on the 1927 North American Datum (NAD 83) in feet.

Both the satellite transmissions and the differential transmissions received from the shore-based navigation beacon were entered into a Sony Vaio laptop computer with an auxiliary display screen aboard the survey vessel for accurate navigation. The computer with associated hardware and software calculated and displayed the corrected positioning coordinates every second and stored the data. Computer software (Hypack Max®, version 6.2) used to control data acquisition was written and developed by Coastal Oceanographics, Inc. specifically for marine survey applications. Positioning information was stored on magnetic disk aboard the survey vessel.

All positioning coordinates are based upon the position of the DGPS antenna. The magnetometer location was measured from the antenna and its orientation relative to the antenna (known as a layback or offset) was noted (Figure 3-02). This information is critical in the accurate positioning of targets during the data analysis phase of the project and repositioning for any subsequent archaeological activities. The layback of the magnetometer sensor for this project was 60 feet aft, and for the sidescan sonar was 0 feet forward (of the DGPS antenna) and 2 feet starboard.

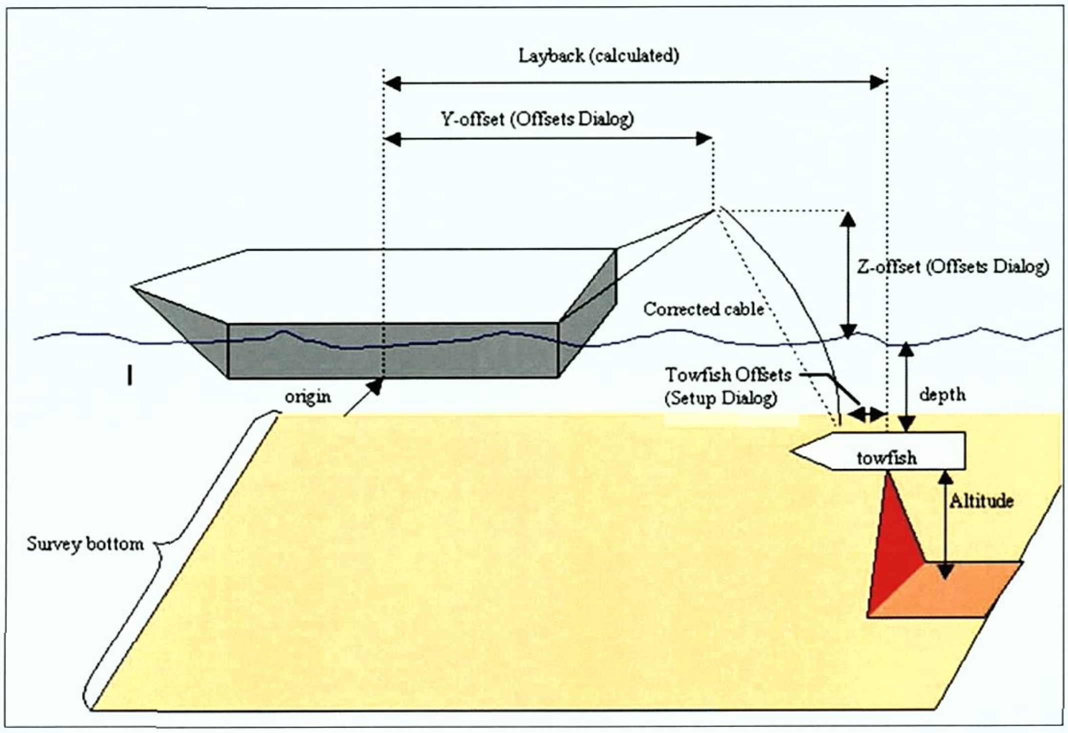


Figure 3-02. Equipment schematic illustrating layback (courtesy of Coastal Oceanographics, Inc.).

MAGNETOMETER

The remote sensing instrument used to relocate ferrous objects on or below the ocean floor of the project area was a Marine Magnetics Sea Spy overhauser magnetometer (Figure 3-03). The magnetometer is an instrument that measures the intensity of the magnetic field below the sensor. The sensor measures and records both the Earth's ambient magnetic field and the presence of magnetic anomalies (deviations from the ambient background) generated by ferrous masses and various other sources. These measurements are recorded in gammas, the standard unit of magnetic intensity (equal to 0.00001 gauss). The Sea Spy is capable of sub-second repeatability, but data was collected at one-second intervals both digitally and graphically, providing a record of both the ambient field and the character and amplitude of anomalies encountered. This data was stored electronically in the navigation computer and subsequently backed up to CD-ROM.

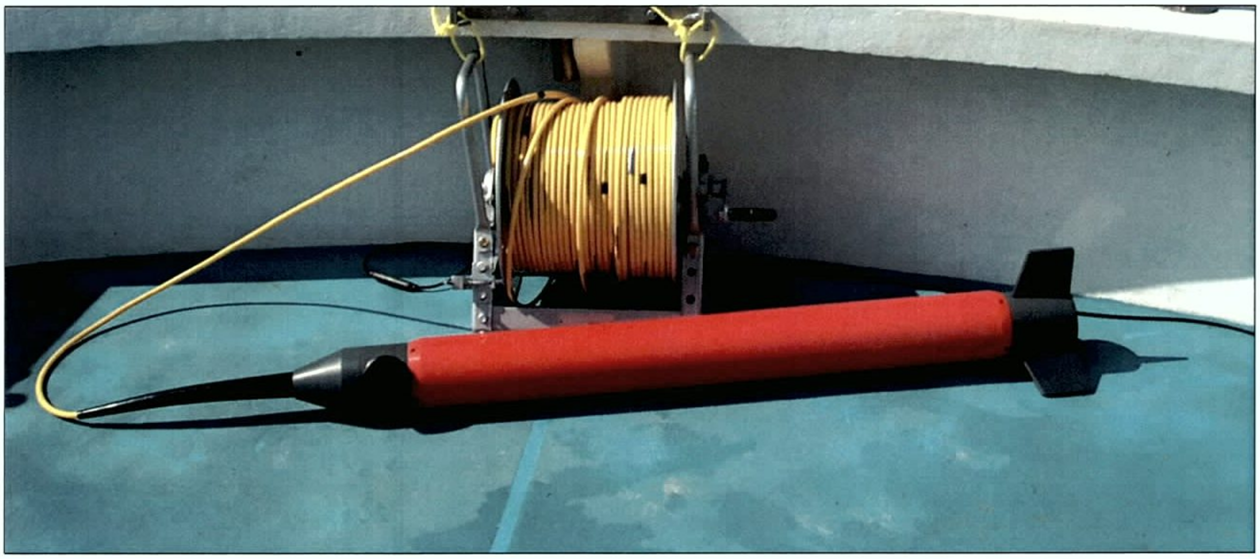


Figure 3-03. Marine Magnetics Sea Spy magnetometer.

The ability of the magnetometer to detect magnetic anomalies, the sources of which may be related to submerged cultural resources such as shipwrecks, has caused the instrument to become a principal remote sensing tool of marine archaeologists. While it is not possible to identify a specific ferrous source by its magnetic field, it is possible to predict shape, mass, and alignment characteristics of anomaly sources based on the magnetic field recorded. It should be noted that there are other sources, such as electrical magnetic fields surrounding power transmission lines, underground pipelines, navigation buoys, or metal bridges and structures, that may significantly affect magnetometer readings. Interpretation of magnetic data can provide an indication of the likelihood of the presence or absence of submerged cultural resources. Specifically, the ferrous components of submerged historic vessels tend to produce magnetic signatures that differ from those characteristic of isolated pieces of debris. While it is impossible to identify, specifically, the source of any anomaly solely from the characteristics of its magnetic signature, this information in conjunction with other data (historic accounts, use patterns of the area, diver inspection), and prior knowledge of similar targets, can lead to an accurate estimation.

For this project, the magnetometer was interfaced with the Sony Vaio laptop, using Hypack® software for data storage and management. It was also interfaced with the positioning system, allowing positioning fix points to be integrated with each magnetometer data point.

SIDESCAN SONAR

The remote sensing instrument used to search for physical features on or above the sea bottom was a Marine Sonic Technology (MST) Sea Scan sidescan sonar system (Figure 3-04). The sidescan sonar is an instrument that, through the transmission of dual fan-shaped pulses of sound and reception of reflected sound pulses, produces an acoustic image of the bottom. Under ideal circumstances, the sidescan sonar is capable of providing a near-photographic representation of the bottom on either side of the tracklines of a survey vessel. The MST Sea Scan sidescan sonar unit utilized on this project was operated with an integrated dual frequency 150 and 600 kHz towfish, alternating frequencies on 100 percent overlapping lines.

Figure 3-04. Marine Sonic Technology (MST) Sea Scan sidescan sonar system.

The Sea Scan PC has internal capability for removal of the water column from the instrument's video printout, as well as a correction for slant range distortion. This sidescan sonar was utilized with the navigation system to provide manual marking of positioning fix points on the digital printout. Sidescan sonar data are useful in searching for the physical features indicative of submerged cultural resources. Specifically, the record is examined for features showing characteristics such as height above bottom, linearity, and structural form. Additionally, potential acoustic targets are checked for any locational match with the data derived from the simultaneous magnetometer survey.

SUBBOTTOM PROFILER

There are several types of subbottom profilers: sparkers, pingers, boomers, and chirp systems. Sparkers operate at the lowest frequencies and afford deep penetration but low resolution. Boomers operate from .5 kHz to 5 kHz and they can penetrate to between 30 m and 100 m with resolution of 0.3 m to 1.0 m. Pingers operate from 3.5 kHz and 7 kHz and penetrate seabeds from a few meters to more than 50 m depending on sediment consolidation, with resolution to about 0.3 m. CHIRP systems operate around a central frequency that is swept electronically across a range of frequencies between 3 kHz to 40 kHz and resolution can be on the order of 0.1 m in suitable near-seabed sediments.

The current survey deployed an Edgetech 424 XSE-500 Shallow Tow X-Star Single-Beam System with topside processor and towfish (Figure 3-05). This system included a Model 3100-G Topside Processor with DISCOVER Subbottom Software and a 4-24 kHz SB 424 towfish.

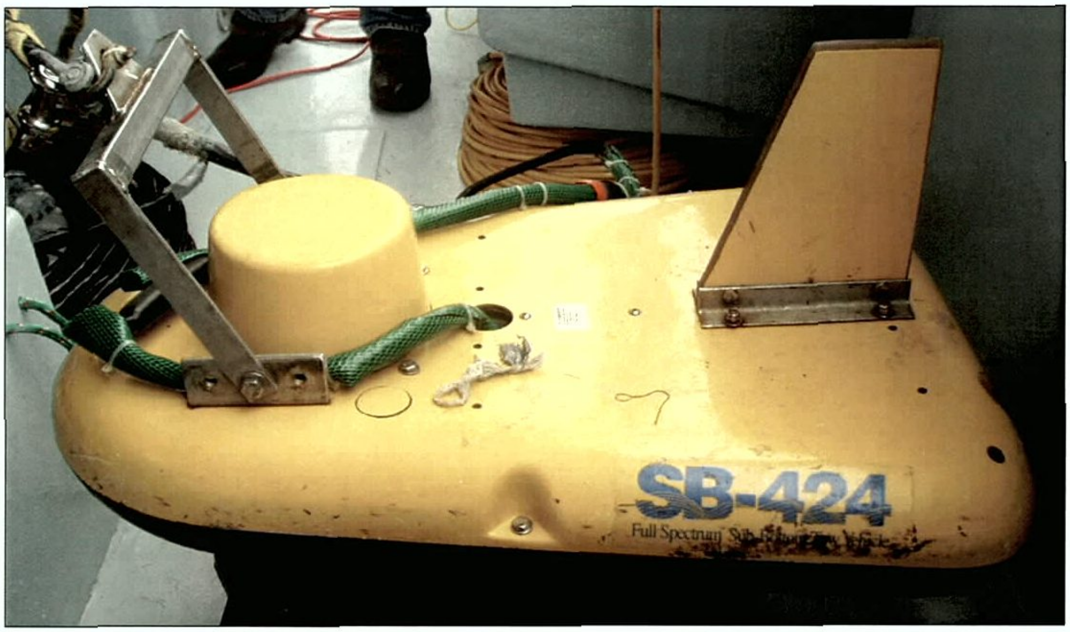


Figure 3-05. The Edgetech subbottom SB 424 towfish used during the survey.

SURVEY VESSEL

The survey vessel used for the project was the *Venture III* (Figure 3-06). The 40-ft. vessel has an enclosed cabin and ample covered deck space for the placement and operation of the survey equipment. The vessel conforms to all U.S. Coast Guard specifications according to class, and carried appropriate emergency supplies including lifejackets, spare parts kit, tool kit, first-aid supplies, flare gun, air horns, and paddles.

Figure 3-06. Research vessel, *Venture III,* provided support for all aspects of the investigation.

SURVEY PROCEDURES

Coordinates for the survey area were entered into the navigation program Hypack® and pre-plotted tracklines were produced with 50-foot offsets (Figures 3-07, 3-08, and 3-09), totaling 198 survey line miles. The magnetometer, the sidescan sonar, and the DGPS were mobilized and tested, and the running of pre-plotted tracklines began. The helmsman viewed a video monitor that was linked to the DGPS and the navigational computer in order to aid in directing the course of the vessel relative to the individual survey tracklines. The monitor displayed the real-time position of the path of the survey vessel along each of the tracklines. The speed of the survey vessel was consistently maintained between 3.5 to 4 knots for the uniform acquisition of data during the running of the tracklines.

As the survey vessel maneuvered down each trackline, the navigation system determined the position of the vessel along the actual line of travel every second. One computer recorded the positioning and magnetometer data every second, while a separate computer recorded all of the sidescan sonar returns during the survey. Vessel speed was between 3 and 4 feet per second, acquiring magnetic readings every second. The positioning points along the trackline traveled were recorded on the computer hard drive, and the resulting magnetic data were also stored digitally.

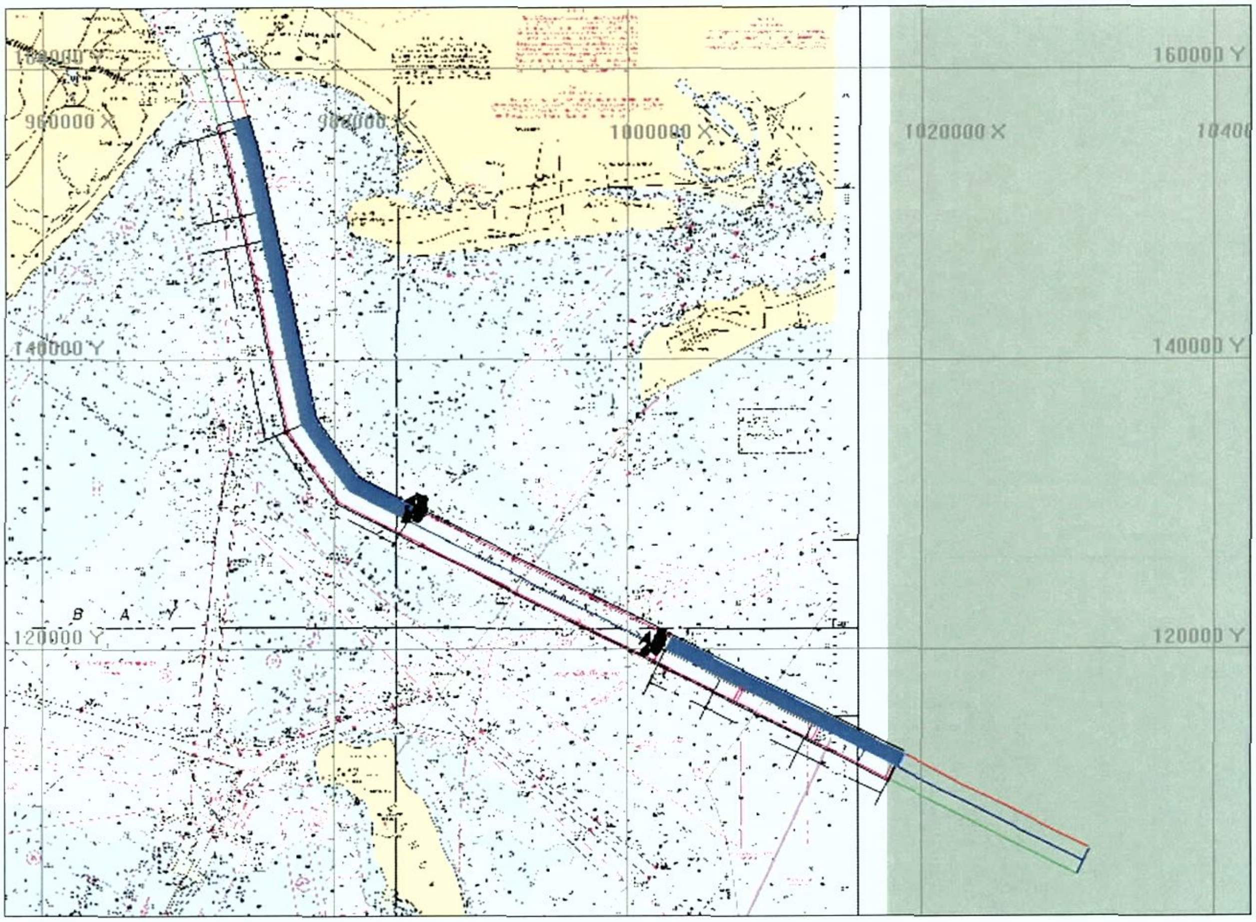


Figure 3-07. Pre-plotted tracklines for current survey area in Hypack® software.

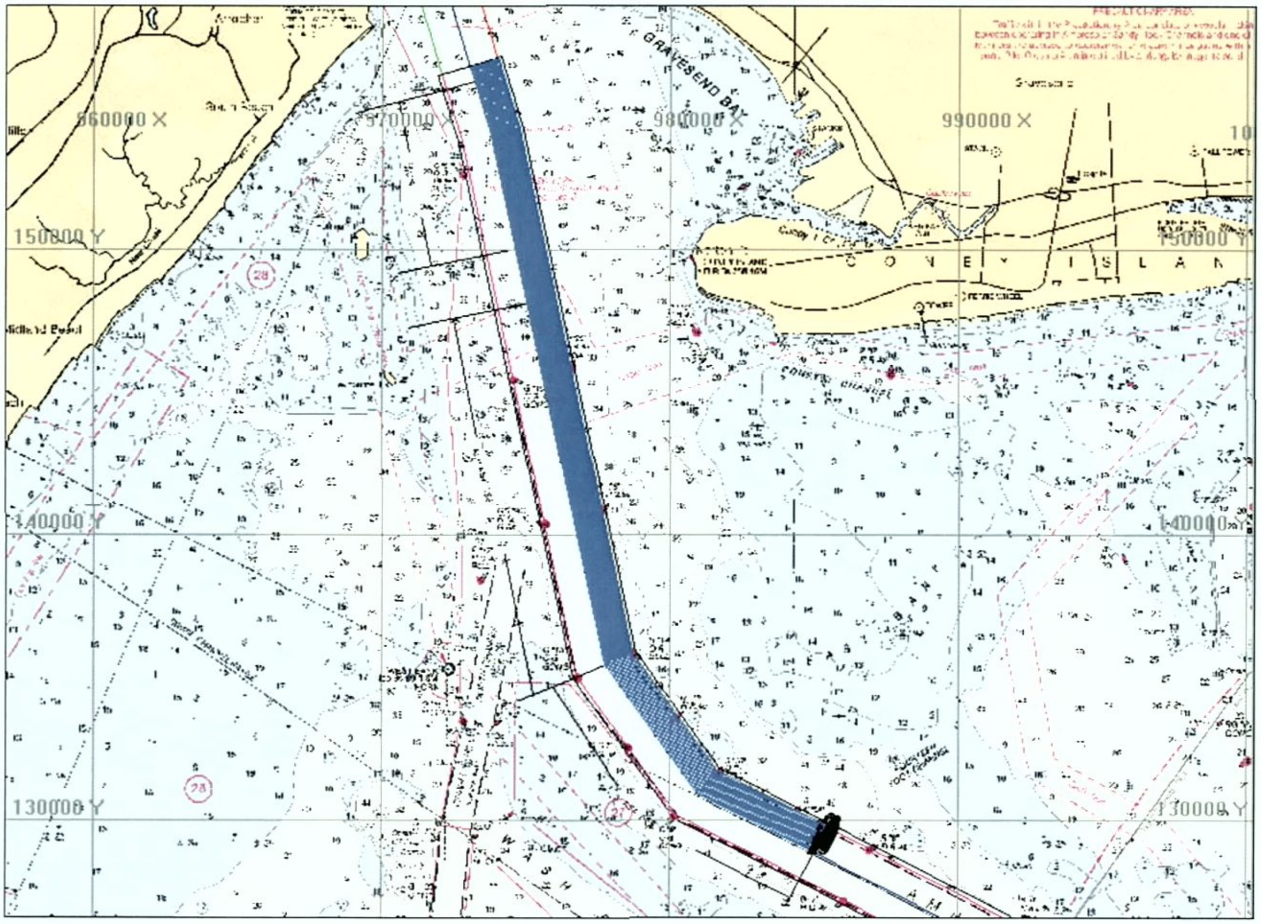


Figure 3-08. Pre-plotted tracklines detail – north area.

Each of the tracklines was run until completed. Any navigation errors, problems with the remote sensing instruments or with the positioning system during the running of a line resulted in the termination of that run. Significant off-line errors in navigation resulted in the immediate repetition of that line. Problems with remote sensing instruments were resolved before repeating the run of an aborted line.

Upon completion of the magnetometer survey, the raw positioning and magnetometer data were edited within the Hypack® computer program. The edited file was input into the system's contouring program to produce magnetic contour maps. The maps, field notes, and magnetometer digital strip charts were then analyzed to create a list of magnetic anomalies that were indicative of potentially significant cultural resources. Afterwards, the sidescan sonar data was reviewed for any evidence of submerged cultural resources. The sidescan sonar target locations were then overlaid on the magnetometer contour map to determine the correlation of the magnetic anomalies with the sidescan sonar targets.

It should be stated that prior to contour map production, a review of each survey trackline was conducted in Hypack®. Magnetic anomalies present on each survey trackline are labeled at this time, and locational information (Easting, Northing) as well as gamma deviations are taken from the electronic strip-chart data and tabulated, the data table appearing in the report. Once all survey tracklines have been analyzed and all anomalies along each line have been labeled and tabulated, the contour map is then produced.

In regard to analysis of anomalies relative to potential significance, if an anomaly represents a single-source object (a localized deviation), it is generally identified as non-significant, especially in an area with the type of industrial and commercial activity as the project area.

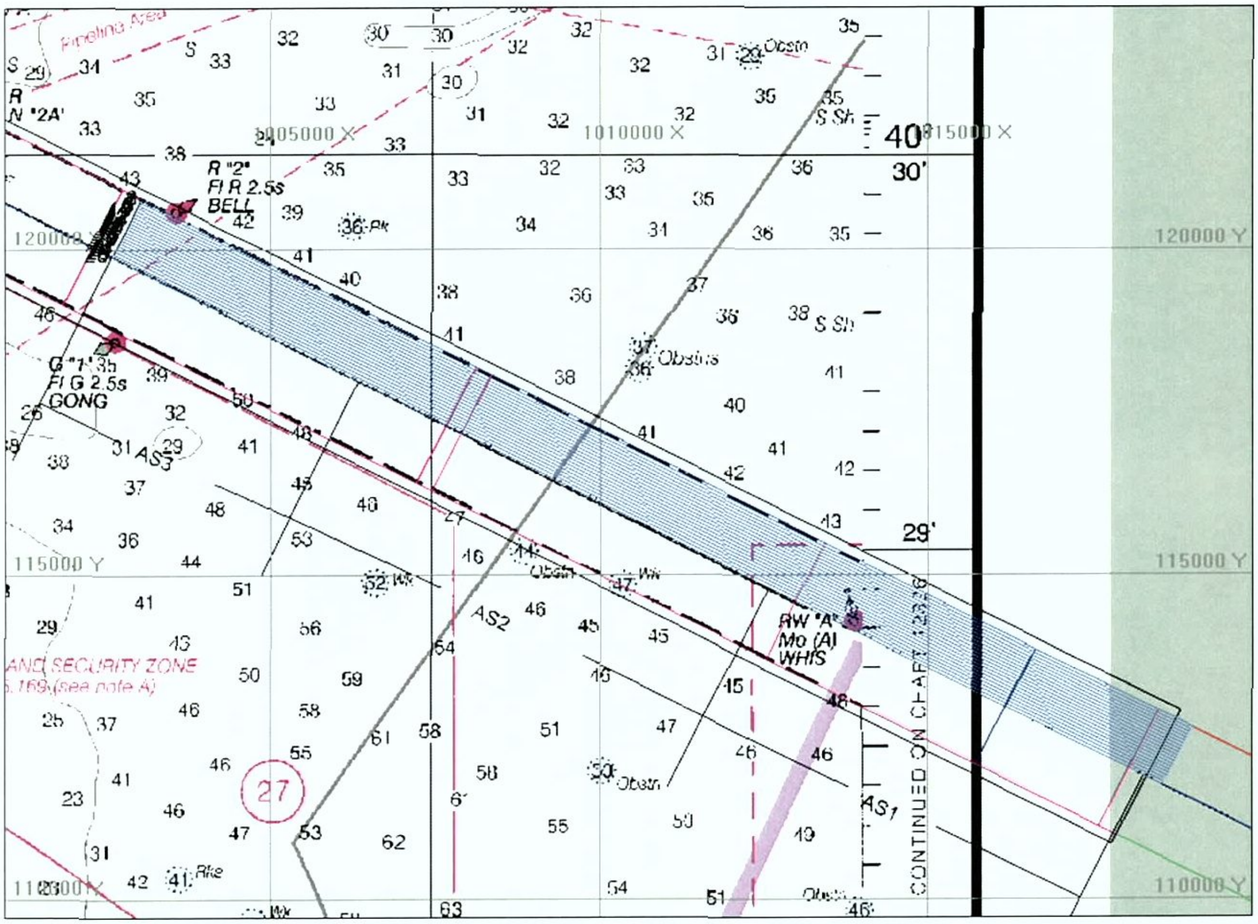


Figure 3-09. Pre-plotted tracklines detail – south area.

DATA ANALYSIS PROCEDURES

Upon completion of the remote sensing survey, the data was reviewed. This task essentially entailed the archaeologist and remote sensing specialist analyzing the previously acquired and processed data. Sidescan and subbottom features and magnetic anomalies were tabulated and prioritized as to possible significance by employing signal characteristics (e.g., spatial extent, structural features, etc.). Magnetic data was presented in a magnetic contour map(s) with trackline format. Specific sidescan targets are also located on the map and are illustrated and discussed individually. The magnetic anomalies and/or sidescan targets shown on the map(s) are sequentially numbered and tabulated as to location (Northing and Easting), as well as magnetic deviation. The contoured/labeled targets are then compared with strip chart records and attendant sidescan data. Each magnetic anomaly or sidescan target, described with the proper terminology and locational and positional information, is included. If any of the remote sensing targets correlated with any documentary evidence, it was noted.

The evaluation of the potential cultural significance of targets was then conducted, which was dependent on a variety of factors. These include the detected characteristics of the individual targets (e.g., magnetic anomaly strength and duration, and sidescan image configuration), association with other sidescan or magnetic targets on the same or adjacent lines, relationships to observable target sources such as channel buoys or pipeline crossings, as well as correlation to the historic record. Magnetic anomalies were evaluated and prioritized based on amplitude or deflection intensity in concert with duration or spatial extent. Targets such as isolated sections of pipe can normally be immediately discarded as non-significant. Targets that were likely to represent potential historical shipwrecks or other potentially historic submerged resources were identified, and recommendations were made for subsequent avoidance or assessment by archaeological divers.

MAGNETOMETER ANALYSIS

Interpretation of data collected by the magnetometer is perhaps the most problematic to analyze. Magnetic anomalies are evaluated and prioritized based on magnetic amplitude or deflection of gamma intensity in concert with duration or spatial extent; they are also correlated with sidescan targets. The problems of differentiating between modern debris and shipwrecks based on remote sensing data have been discussed by a number of authors. This difficulty is particularly true in the case of magnetic data, and therefore it has received the most attention in the current body of literature dealing with the subject. Pearson and Saltus state, "even though a considerable body of magnetic signature data for shipwrecks is now available, it is impossible to positively associate any specific signature with a shipwreck or any other feature" (1990:32). There is no doubt that the only positive way to verify a magnetic source object is through physical examination. With that said, however, the size and complexity of a magnetic signature does provide a usable key for distinguishing between modern debris and shipwreck remains (see Garrison et al. 1989; Irion et al. 1995; Pearson et al. 1993). Specifically, the magnetic signatures of most shipwrecks tend to be large in area and tend to display multiple magnetic peaks of differing amplitude.

The state of technology of iron-hulled or steam vessels may also be considered a factor in their potential for being detected by modern remote sensing techniques. The magnetometer detects ferrous objects that create deviations in the Earth's natural magnetic field. The greater the weight of iron in the remains of a shipwreck, the greater the likelihood the remains will be observed, at least theoretically. The mass of metal on iron-hulled or steam vessels is made up of the hull and/or boilers, pipes, valves, steam engines, hogging trusses and straps, deck gear, auxiliary engines, pumps, hoists, winches, and other pieces of equipment. As the state of steam technology advanced, boilers and engines got larger, and/or more were used for larger vessels. Larger locomotion systems contained more iron and therefore are more likely to have a detectable magnetic signature.

In a study of magnetic anomalies in the northern Gulf of Mexico, Garrison et al. (1989) indicate that a shipwreck signature will cover an area between 10,000 and 50,000 m^2. Applicable to the Gulf Coast and based on large vessel types, the study's findings are not completely relevant to wooden sailing vessels in the pre-steam era. However, criteria from the Garrison et al. (1989) study and others developed to identify the signatures of larger vessel types are applicable. Using the Garrison et al. (1989) study, as well as years of "practical experience," in an effort to assess potential significance of remote sensing targets, Pearson et al. (1991) developed general characteristics of magnetometer signatures most likely to represent shipwrecks. The report states, "the amplitude of magnetic anomalies associated with shipwrecks vary [*sic*] considerably, but, in general, the signature of large watercraft, or portions of watercraft, range from moderate to high intensity (>50 gamma) when the sensor is at distances of 20 ft. or so" (1991:70). Using a table of magnetic data from various sources as a base, the report goes on to state, "data suggest that at a distance of 20 ft. or less watercraft of moderate size are likely to produce a magnetic anomaly (this would be a complex signature, i.e., a cluster of dipoles and/or monopoles) greater than 80 or 90 ft. across the smallest dimension…" (Pearson et al. 1991:70).

While establishing baseline amounts of amplitude and duration reflective of the magnetic characteristics for a shipwreck site, the authors recognize, "that a considerable amount of variability does occur" (1991:70). Generated in an effort to test the 50-gamma/80-foot criteria and determine amount of variability, Table 3-01 lists numerous shipwrecks as well as single- and multiple-source objects located by magnetic survey and verified by divers. All shipwrecks meet and surpass the 50-gamma/80-foot criteria, while all single-source object readings, with the exception of the pipeline, fall below the criteria. However, the signature of the pipeline should show up as a linear feature on a magnetic contour map and not be confused with a single-source object. While the shipwrecks and single-source objects adhere to the 50-gamma/80-foot criteria, the multiple-source objects do not. If all targets listed on the table had to be prioritized as to potential significance based on the 50-gamma/80-foot criteria, the two multiple-source object targets would have to be classified as potentially significant.

Table 3-01. Magnetic data from shipwrecks and non-significant sources.

Vessel (object)	Type & Size	Magnetic deviation	Duration (feet)	Reference
Shipwrecks				
Tug	wooden tug with machinery	-30257	176	Tuttle and Mitchell 1998
Mexico	288 ton wooden bark	1260	454	Tuttle and Mitchell 1998
J.D. Hinde	129-ft. wooden sternwheeler	573	110	Gearhart and Hoyt 1990
Utina	267-ft., 238-ton wooden freighter	690	150	James and Pearson 1991; Pearson and Simmons 1995
King Phillip	182-ft., 1,194-ton clipper	300	200	Gearhart 1991
Reporter	141-ft., 350-ton schooner	165	160	Gearhart 1991
Mary Somers	967-ton iron-hulled sidewheeler	5000	400	Pearson et al. 1993
Gen. C.B. Comstock	177-ft. wooden hopper dredge	200	200	James et al. 1991
Mary	234-ft. iron sidewheeler	1180	200	Hoyt 1990
Columbus	138-ft., 416-ton wooden-hulled Chesapeake sidewheeler	366	300+	Morrison et al. 1992
El Nuevo Constante	126-ft. wooden collier	65	250	Pearson et al. 1991
James Stockton	55-ft. wooden schooner	80	130	Pearson et al. 1991
Homer	148-ft. wooden sidewheeler	810	200	Pearson and Saltus 1993
Modern shrimp boat	27 × 5 ft. segment	350	90	Pearson et al. 1991
Confederate obstructions	various wooden vessels w/ machinery removed, filled w/ construction rubble	110	long duration	Irion and Bond 1984
Single-source Objects				
pipeline	18-in. diameter	1570	200	Duff 1996
anchor	6-ft. shaft	30	270	Pearson et al. 1991
iron anvil	150 lbs.	598	26	Pearson et al. 1991
engine block	modern gasoline	357	60	Rogers et al. 1990
steel drum	55 gallon	191	35	Rogers et al. 1990
pipe	8 ft. long × 3 in. diameter	121	40	Rogers et al. 1990
railroad rail segment	4-ft. section	216	40	Rogers et al. 1990
Multiple-source Objects				
anchor/wire rope	8-ft. modern stockless/large coil	910	140	Rogers et al. 1990
cable and chain	5 ft.	30	50	Pearson et al. 1991
scattered ferrous metal	14 × ft.	100	110	Pearson et al. 1991

(After Pearson et al. 1991)

Although data indicate the validity of employing the 50-gamma/80-foot criteria when assessing magnetic anomalies, other factors must also be taken into account. Pearson and Hudson (1990) have argued that the past and recent use of a water body must be an important consideration in the interpretation of remote sensing data; in many cases, it is the most important criterion. Unless the remote sensing data, historical record, or specific environment (e.g., harbor entrance channel) provide compelling and overriding evidence to the contrary, it is believed that the history of use should be a primary consideration in interpretation. What constitutes "compelling evidence" is to some extent left to the discretion of the researcher; however, in settings where modern commercial traffic and historic use are intensive, the presence of a large quantity of modern debris must be anticipated. In harbor, bay, or riverine situations with heavy traffic, this debris will be scattered along the channel right-of-way, although it may be concentrated at areas where traffic would slow or halt; it will appear on remote sensing surveys as small discrete objects.

Sidescan Analysis

By contrast, sidescan analysis is less problematic than magnetometer analysis. The chief factors considered in analyzing sidescan data included linearity, height off bottom, size, associated magnetics, and environmental context. Since historic resources in the form of shipwrecks usually contain large amounts of ferrous compounds, sidescan targets with associated magnetic anomalies are of top importance. Targets with no associated magnetics usually turn out to be items such as rocks, trees, and other non-historic debris of no interest to the archaeologist. In addition, since historic shipwrecks tend to be larger, smaller targets tend to be of less importance during data evaluation. In addition, the area in which the target is located can have a strong bearing on whether or not the target is selected for further work. If a target is found in an area with other known wreck sites, or an area determined to be high probability for the location of historic resources, it may be given more consideration than it would have otherwise. However, every situation and every target located is different, and all sidescan targets are evaluated on a case-by-case basis.

Subbottom Profiler Analysis

Subbottom profilers generate low frequency acoustic waves that are capable of penetrating the seabed and then reflecting off any boundaries or objects within the subsurface. These returns are received by hydrophone or hydrophone array operated in close proximity to the source. The resulting data are then processed and reproduced as a cross section that is scaled in two-way travel time (the time taken for the pulse to travel from the source to the reflector and back to the receiver). This travel time can subsequently be interpolated to depth in the sediment column by reference to the travel time of the sound down (averaging 1,500 m/s) and forward (speed of the vessel). These seismic cross sections can be studied visually, and the shapes and extent of reflectors can be used to identify both bottom and subbottom profile characteristics.

Seismic stratigraphy is a form of stratigraphic correlation. The reflection characteristics (e.g., as amplitude, continuity, wipeout [erosion] and bedform geometry) of regional unconformities and strata surfaces are used to estimate rock or sediment properties, facies relationships and some stratigraphic details to infer structural evolution and paleo-environmental histories (Mitchem et al. 1977, Vail et al. 1977).

There are five types of spurious signals that may cause confusion in the two dimensional records: direct arrivals from the sound source, water surface reflection, side echoes, reflection multiples, and point source reflections. Judicious analysis is required to suspect them. This is particularly true when the bottom or subbottom being traversed has considerable deformation or point source anomalies.

Subbottom in the Identification of Shipwreck Sites

Previous research (Quinn et al. 1997, 1998) has demonstrated that wooden wreckage can be recognized, dependent on the type of wood (hard woods are easier to identify), the size of the remains, and the context (e.g., sand or silt, etc.). The strategy for identifying historic shipwrecks was to identify any seismic features within the strata that might be coincident with magnetometer fluctuations, and therefore indicate buried wreckage. In addition, the subbottom profiler record includes information on the precise depth to the bottom, and thus can be used to reconstruct bathymetry.

This output record provides a visual representation of density differences within the geologic bed and the sound wave velocity of the device. In general, high and low amplitude reflectors (light and dark returns) distinguish between stratigraphic beds; parabolic and "spot" returns are indications of point-source objects that are of a sufficient size to be sensed by the wavelength and frequency of the power source. It is possible to identify erosional or non-depositional contacts according to discontinuities in extent, slope angle, and shape of the reflector returns. This latter fact is important when identifying drowned channels systems as well as other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, upland areas around drainage features), but it is not necessarily of significant value with respect to the identification of shipwreck remains.

Wood objects of sufficient density and size can be sensed with Chirp systems (Figure 3-10), but the image is dependent on "*the orientation of the incident compression wave relative to the axis of the woods elastic symmetry cellular structure*" (Quinn et al. 1997:27). In other words, the ability of the sensor to detect buried shipwreck remains is dependent on which angle the wood is approached with the sound waves, the character of the burial sediment, and the size of the remains (ibid:33).

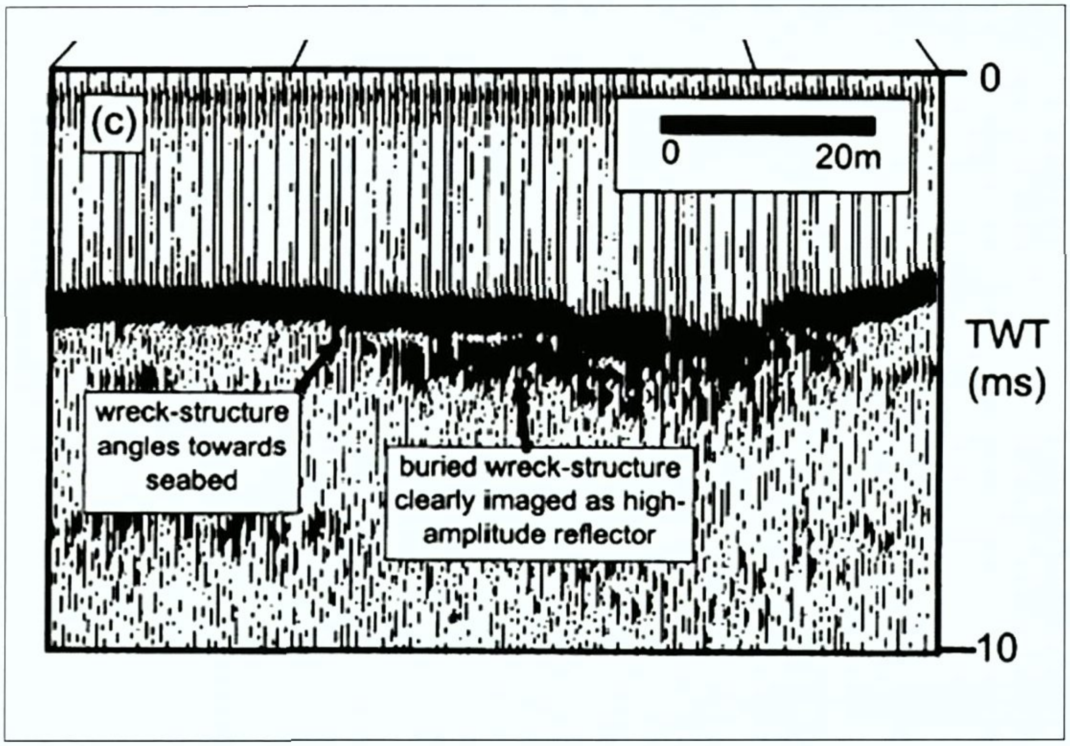


Figure 3-10. Example of subbottom profiler images of known eighteenth-century oak vessel HMS *Invincible* (Quinn et al. 1997). Enlarged band-pass filtered section of the exposed starboard side (left to right in the above diagram). The buried oak wreck structure is clearly imaged as high amplitude reflector in section.

Figure 3-10 above illustrates an example of a large area of wreck that has been remote sensed with subbottom profiler operating at a 2 to 8 kHz swept frequency band. This wreck, the HMS *Invincible*, is oak and partially buried by unconsolidated (sand) sediments—an environment similar to the current project area. Note that there is nothing inherent in the image that indicates wreckage except that it is known that wreckage exists where the dark areas occur, indicating a wide area low amplitude reflector. Additional data, such as that obtained from a magnetometer, might help differentiate actual wreck sites from other objects presenting similar reflective characteristics.

The strategy for the current project was to cover the survey area in a large systematic pattern (lines 1 through 6), and subsequently to assess the association of magnetometer anomalies and indications of shallow reflectors in the record. While the records indicate a fluctuating bottom, the seas were relatively calm when running the tracklines, so the undulations are, for the most part, real.

Target Relocation and Refinement Methods

The second part of the project involved a remote sensing refinement of targets identified during the survey, along with collection and evaluation of remote sensing data for five additional target locations specified by the Corps. A total of 16 targets received refinement survey. These included 11 targets from the remote sensing survey data, the 3 obstructions in the Sandy Hook Pilot Area, and Shoals C and D in the northern part of the survey area. The remote sensing equipment used during the refinement aspect of the investigation included the previously discussed equipment including DGPS, sidescan sonar, magnetometer, and subbottom profiler.

The coordinates of the five targets prior to field investigations and entered into Panamerican's navigation system. Coordinates for targets located during the remote sensing survey were tagged from the remote sensing data. The survey vessel then approached each target area and, when the proper coordinates were reached, a reference buoy deposited within close proximity of the target area.

For each target, a minimum of four refinement tracklines were run past the target location in a parallel pattern in order to relocate and refine the target. Tracklines were run on an orientation parallel to the channel. This pattern allowed for complete coverage of the reported target location and helped to establish the exact location of the anomaly. Each refinement trackline was a minimum of 800 feet in length, extending at least 400 feet to either side of the target/anomaly location. Lines were run out from the target location until the sensors registered background for one entire line. Trackline spacing was 50 feet (Figure 3-11).

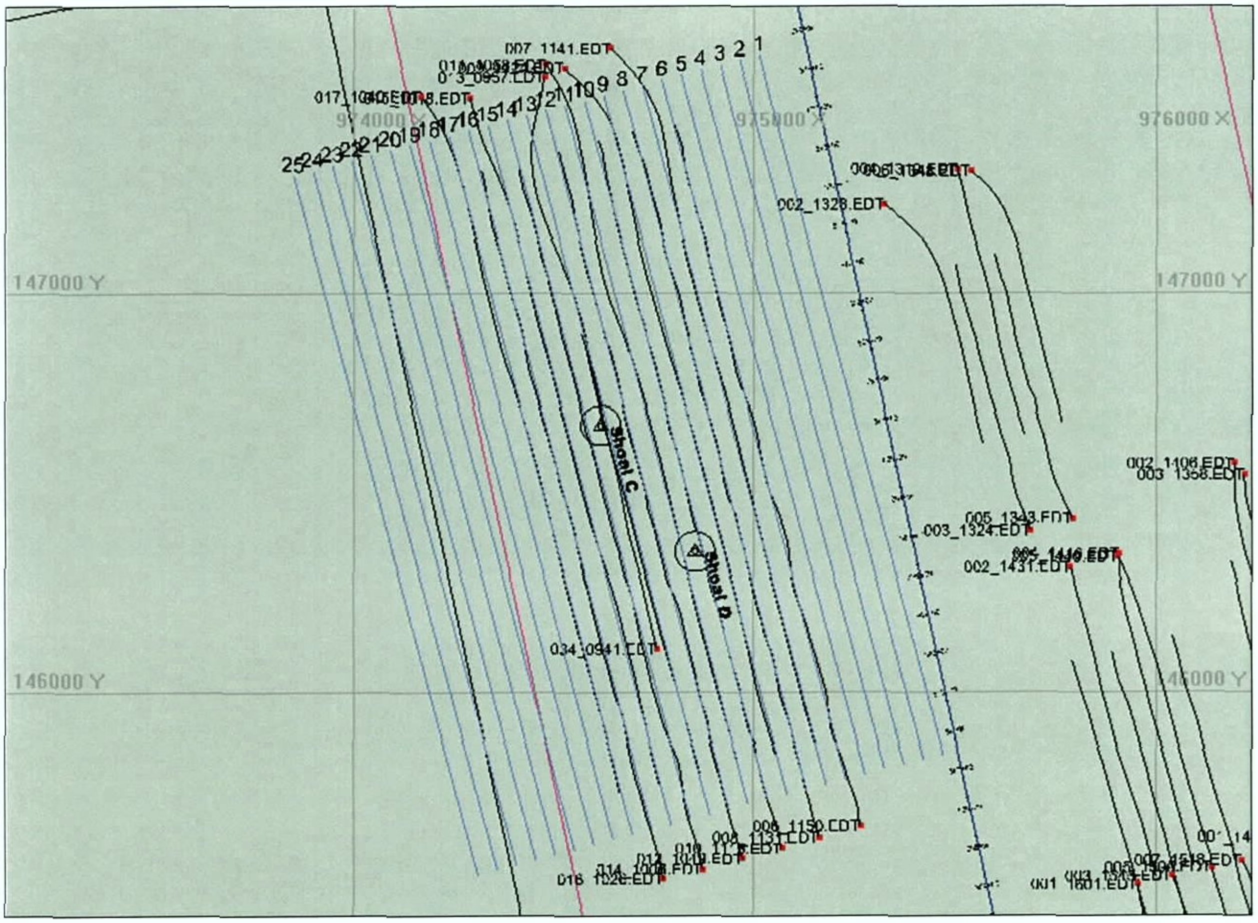


Figure 3-11. Example of the refinement pattern including planned and completed tracklines. This refinement survey was conducted over Shoals C and D, two of the five targets specified by the Corps.

4. RESULTS

Remote Sensing Survey

Results of the remote sensing survey of the stipulated northern and southern areas of the channel identified a total of 16 magnetic anomalies and 51 sidescan sonar targets (many of which are associated with the anomalies). All anomalies were examined individually against the established criteria detailed previously in Chapter 3. Numerous passing vessels, such as large cargo ships and freighters, did affect the data from time to time. These instances were recorded in the field notes and in the electronic data for reference during analysis. Of the 16 magnetic anomalies, none are considered to represent potentially significant resources. The sidescan data was examined as well, and the sonar record indicates a seafloor of varying composition with sand/gravel areas that have scattered cobbles and boulders (some 3 feet in height), which are adjacent to areas of sand/silt. While the acoustic targets ranged from small linear features to complete shipwrecks, most images were geologic, crab pots, or other isolated debris. Of the 51 acoustic targets recorded, only one, a wooden barge, is considered potentially significant. Located in 90 feet of water and therefore outside of the APE, it is not recommended for further investigation.

All of the targets that were determined through analysis to potentially represent significant submerged cultural resources during the remote sensing survey were further refined via magnetometer, sidescan sonar, and subbottom profiler. The results of these refinement surveys are included with the discussion of the individual magnetic anomalies provided in the following sections.

In addition to the magnetic anomalies and sidescan sonar targets refined in the two survey areas discussed above, seven additional target locations were examined using sidescan sonar, magnetometer, and subbottom profiler to determine their extent and composition, also to further evaluate them for any potential submerged cultural resources. These additional locations included the three obstructions within the Sandy Hook Pilot Area, Shoal C (which was thought to be the location of a potential shipwreck) and Shoal D, as well as two additional shoals located nearby, Shoal A and Shoal B. Of these seven target locations, four are considered to have the potential to represent significant cultural resources, as indicated by their electronic signatures. These four targets (Shoal C, Shoal D, High Spot A [WK52], and High Spot B [OBSTN53], see Table 5-01) are therefore recommended for either avoidance by project activities or additional investigation by a qualified marine archaeologist in order to assess their historical significance and NRHP eligibility status.

Identification of Potentially Significant Historic Sites

Magnetic Data

Analysis of the magnetic data revealed a total of 16 anomalies in the two survey areas. Of these, 14 were located in the northern survey area (Table 4-01, Figures 4-01 through 4-05), and two were located in the southern survey area (Table 4-01, Figures 4-06 through 4-08). Numerous incidental anomalies caused by passing vessels were recorded and noted in the data. An example of such an anomaly, easily distinguished from those anomalies that are the subject of this investigation, is shown in Figure 4-09.

Table 4-01. Magnetic anomalies located during the current remote sensing survey (coordinates in NAD 83 State Plane Long Island U.S. feet).

Anomaly	N	E	Strength (+)	Strength (-)	Duration (ft.)	Type	Associated Sidescan	Depth (ft.)	No. Lines
M001	974188.3	154842.59	107	8	243	dipole	SSS073, SSS060	80	4
M002	975338.36	148216.05	19	33	127	dipole		59	2
M003	975607.42	146865.98	48	41	122	dipole		54	2
M004	976019.34	145820.69	45	0	220	monopole	SSS106	51	1
M005	976376.51	146139.75	19	2	220	dipole		53	1
M006	976307.45	145113.51	20	0	90	monopole	SSS054	51	2
M007	976331.26	144770.63	25	25	143	dipole	SSS054	51	2
M008	976116.97	144518.24	20	0	80	monopole	SSS107	52	1
M009	976466.99	144465.85	50	0	75	monopole	SSS020	51	1
M010	976743.19	143877.73	0	20	100	monopole		51	1
M011	977355.13	139565.6	102	154	168	dipole		50	2
M012	977912.3	139115.57	206	16	116	dipole	SSS078, SSS118	45	2
M013	978231.36	135572.53	14	35	90	dipole		50	1
M014	980888.65	132360.46	20	22	90	dipole	SSS070	60	2
M015	1016662.47	113016.8	40	40	170	dipole		50	3
M016	1017209.55	112564.8	0	55	80	monopole		50	1

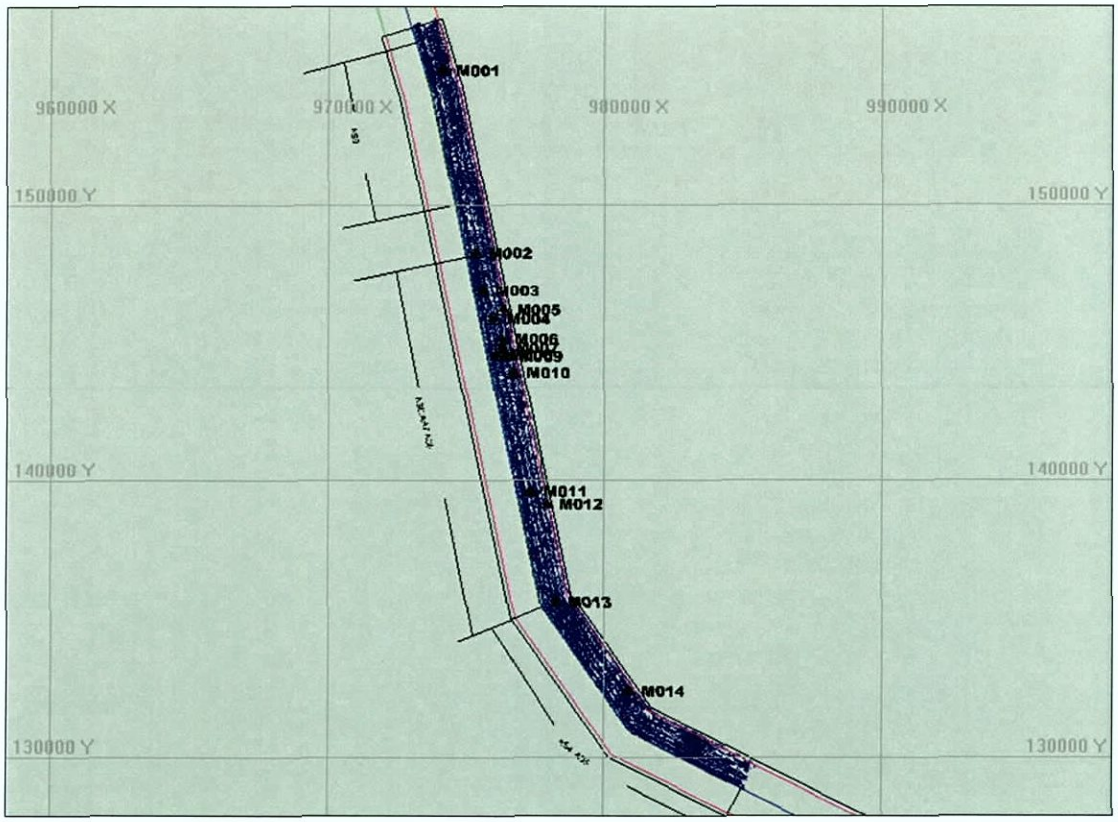


Figure 4-01. Northern survey area overview showing locations of anomalies.

Figure 4-02. Northern survey area close-up.

Figure 4-03. Northern survey area close-up.

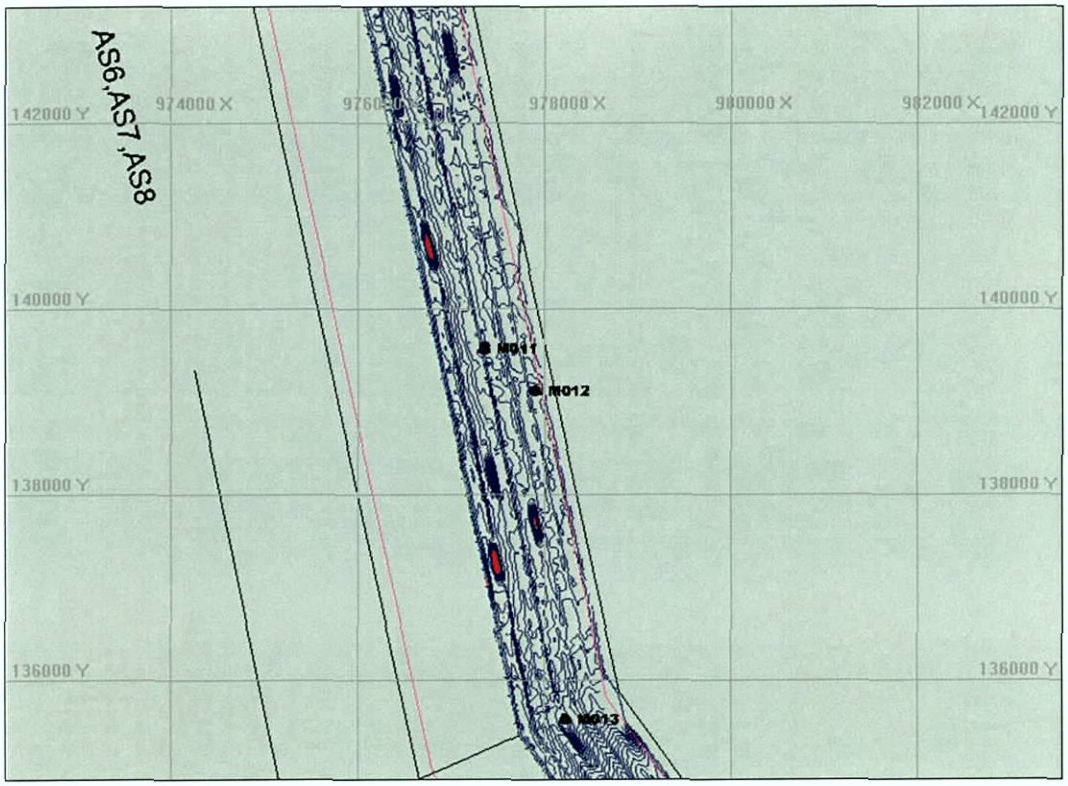


Figure 4-04. Northern survey area close-up.

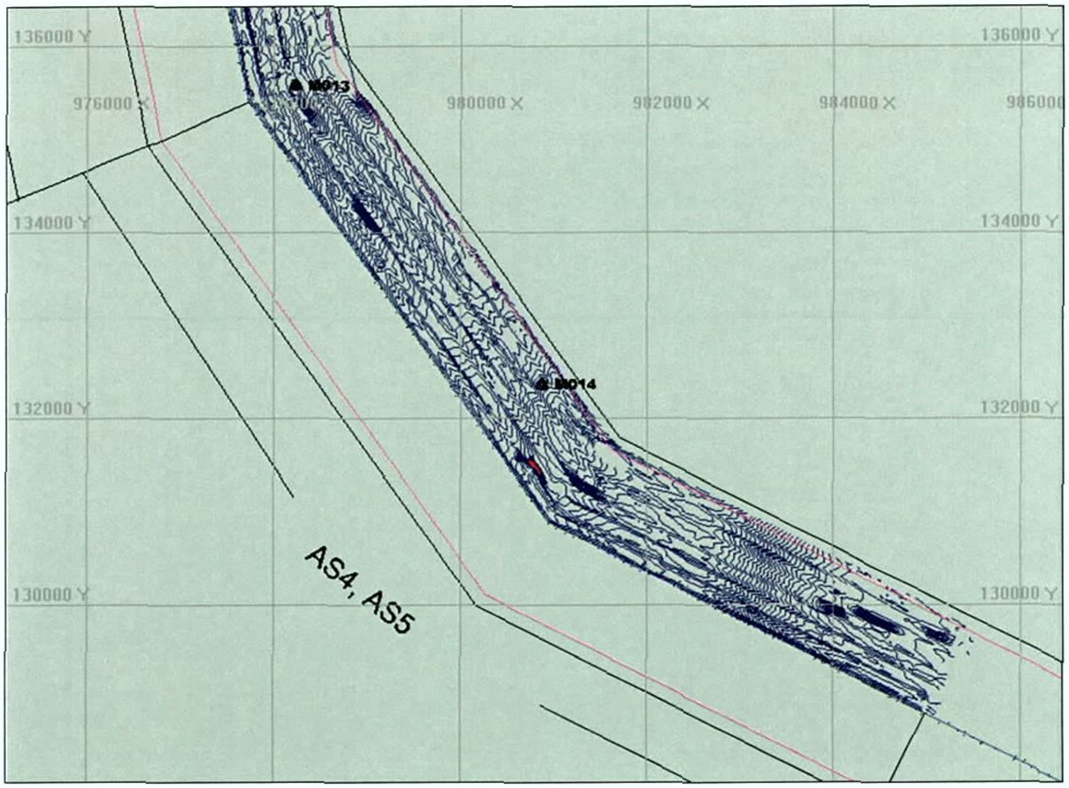


Figure 4-05. Northern survey area close-up.

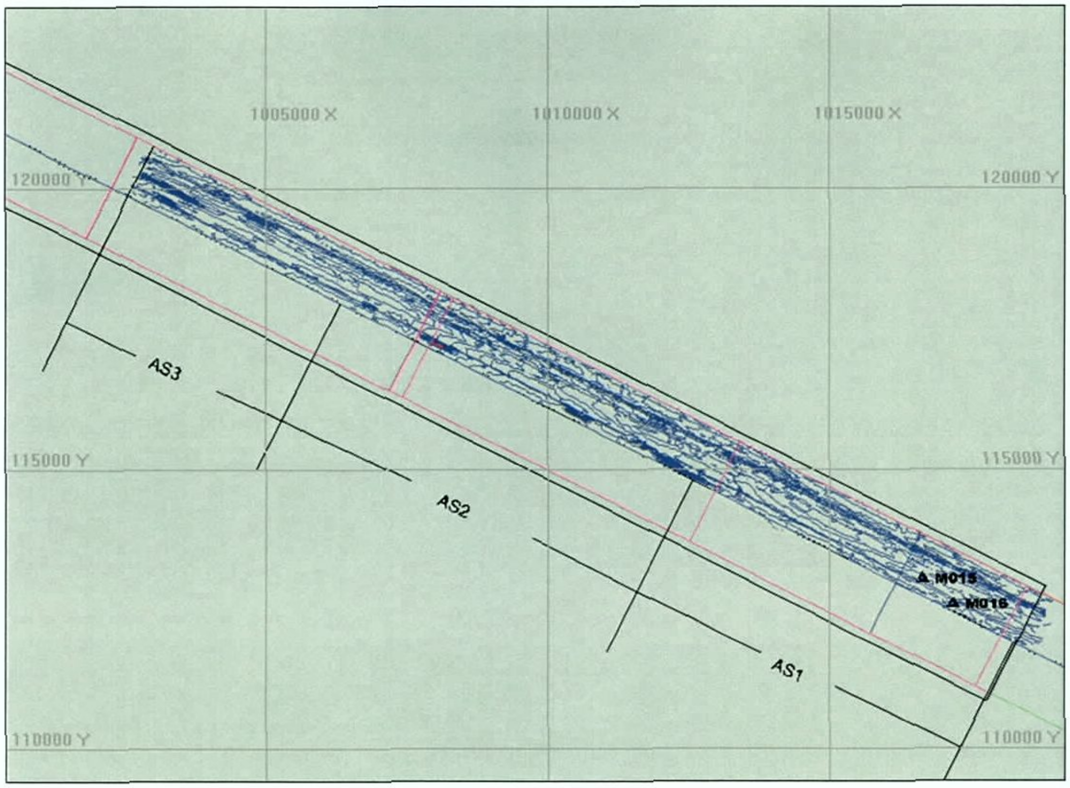


Figure 4-06. Southern survey area overview showing locations of anomalies.

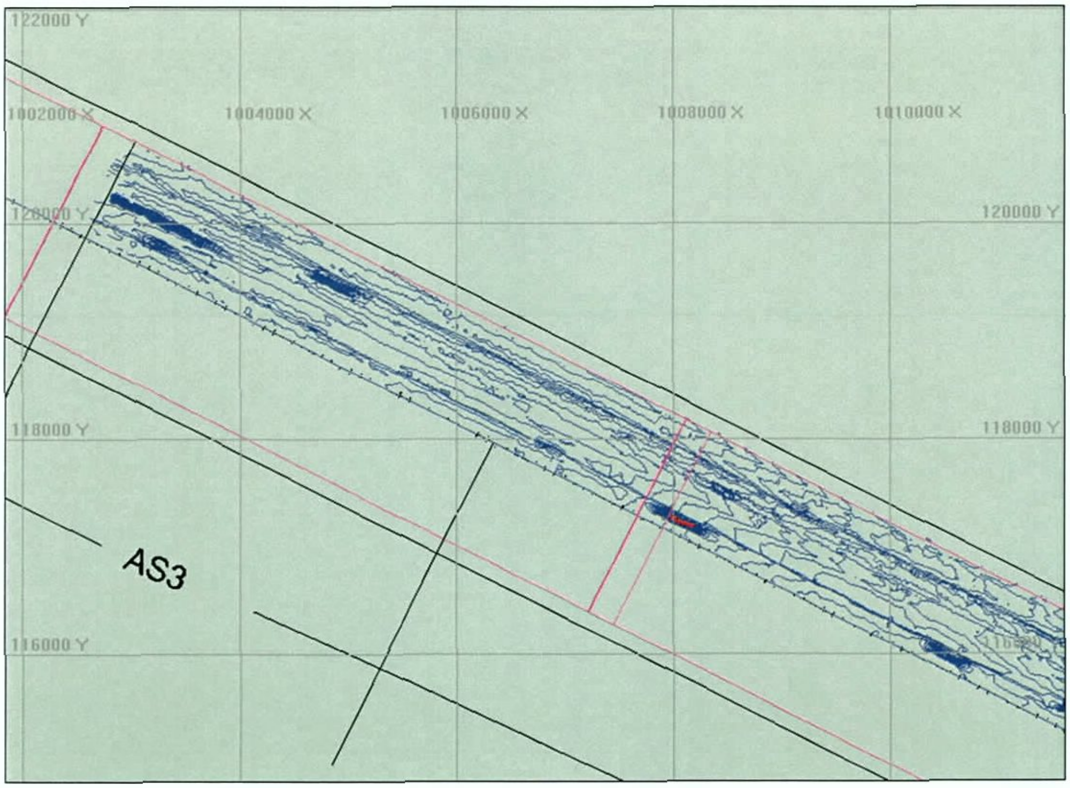


Figure 4-07. Southern survey area close-up.

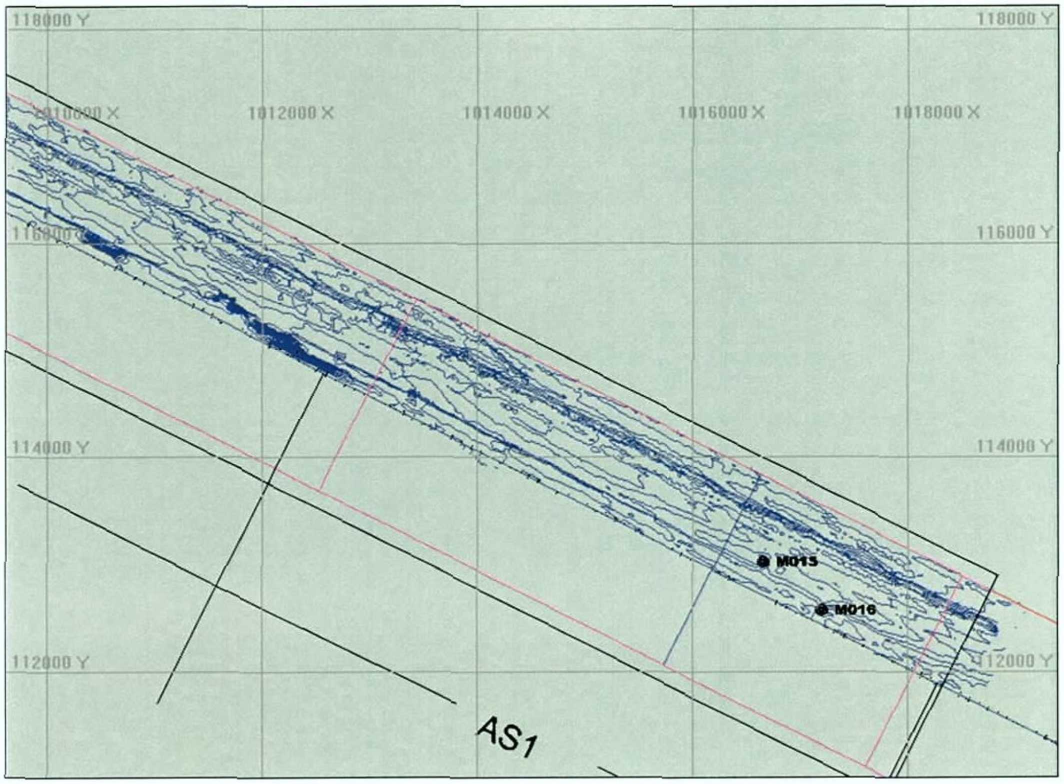


Figure 4-08. Southern survey area close-up.

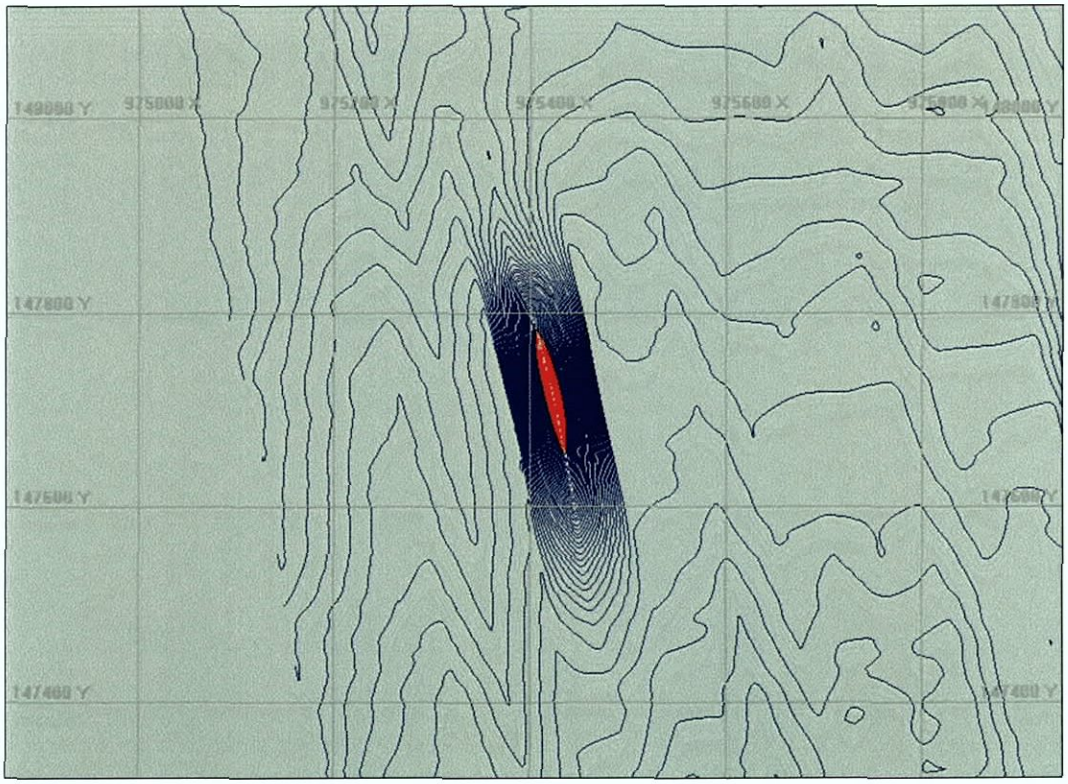


Figure 4-09. Example of incidental anomaly caused by passing cargo vessel.

Anomaly 1

Anomaly 1 (Figure 4-10; see Table 4-01, Figures 4-01 and 4-02), located at 154842 E and 974188 N in 80 feet of water, consists of a 115-gamma dipole with a duration of 243 feet. This anomaly appeared on five lines and is associated with sidescan sonar targets SSS073 and SSS060 (see Table 4-02). This target appears to be the magnetic signature of a wooden scow, which is described below as target SSS073 in the sidescan sonar section. It is associated with AWOIS record 13730 (see Table 2-03), titled as an unknown obstruction, but described as a barge detected during multi-beam survey in 2002. This target is a wooden barge located in 90 feet of water and therefore outside of the APE, and was therefore not refined. Potentially significant but below the APE, it was not recommended for avoidance or further investigation.

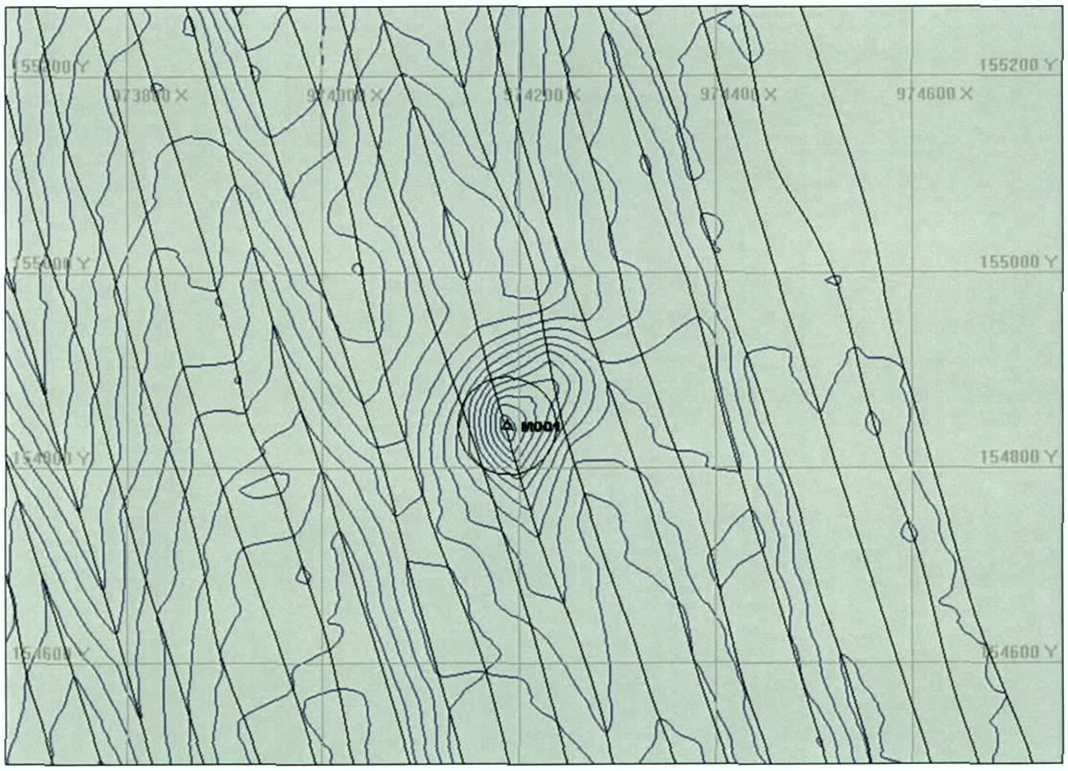


Figure 4-10. Magnetic contour map of Anomaly 1.

Anomaly 2

Anomaly 2 (Figure 4-11; see Table 4-01, Figures 4-01 and 4-03), located at 148216 E and 975338 N, consists of a 52-gamma dipole anomaly with a duration of 127 feet. The anomaly appeared on three lines; it is not associated with a sidescan sonar target. Located in 59 feet of water, this anomaly was not investigated further.

Anomaly 3

Anomaly 3 (Figure 4-12; see Table 4-01, Figures 4-01 and 4-03), located at 146865 E and 975607 N, is an 89-gamma dipole with a duration of 122 feet. The anomaly appeared on two lines and is not associated with a sidescan sonar target from the original survey. The target, located in 54 feet of water, was refined with magnetometer (Figure 4-13), sidescan sonar (Figure 4-14), and subbottom profiler (Figure 4-15). The subsequent sidescan refinement revealed a small spread of debris in the area of the anomaly (see Figure 4-14). No apparent targets were noted during the subbottom refinement. No further work is recommended for this target.

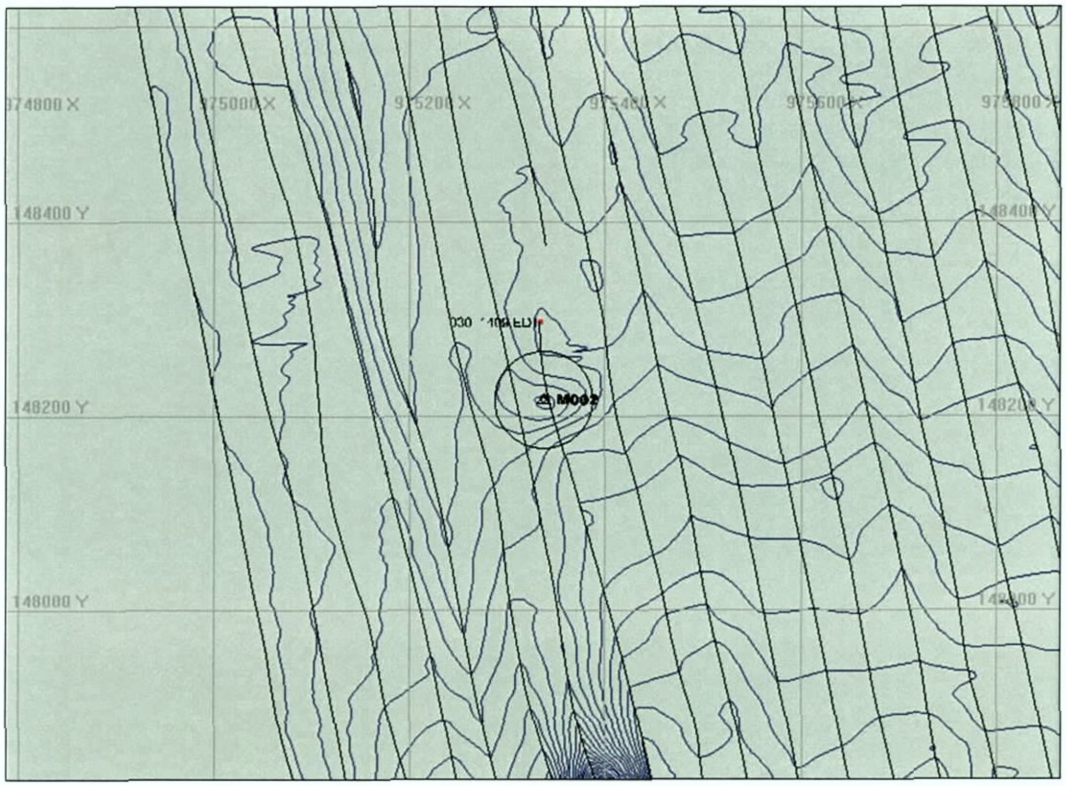


Figure 4-11. Magnetic contour map of Anomaly 2.

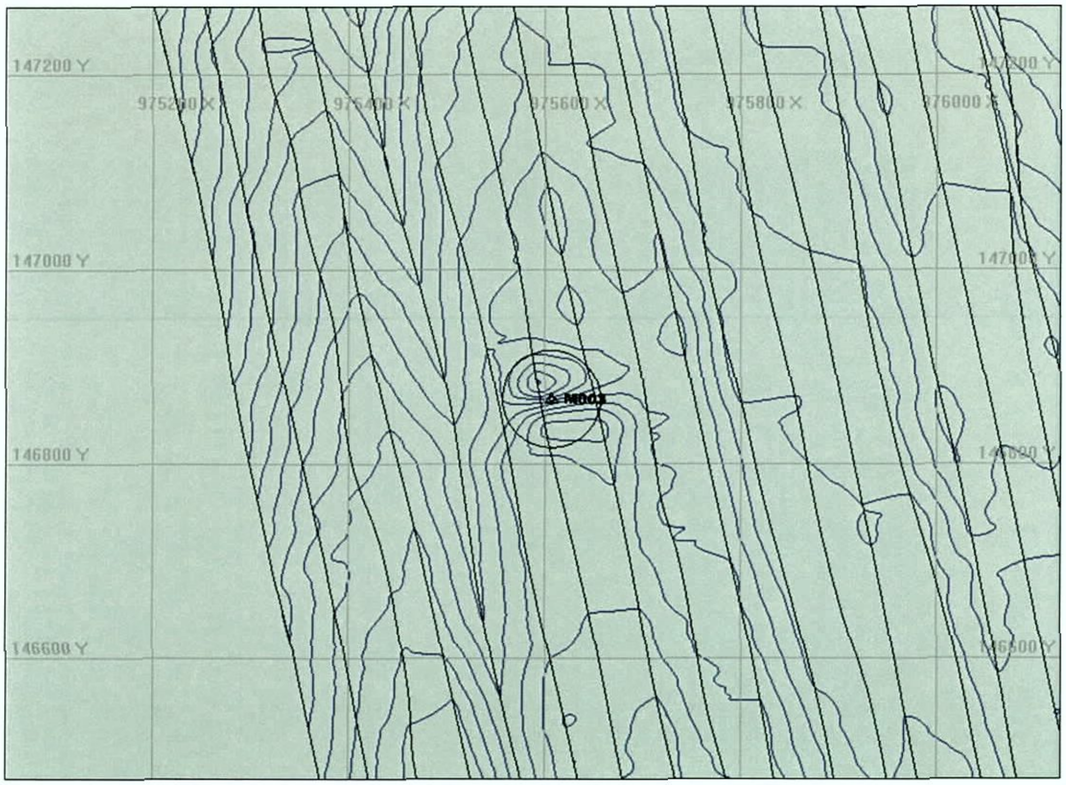


Figure 4-12. Magnetic contour map of Anomaly 3. Contour interval 10 gamma.

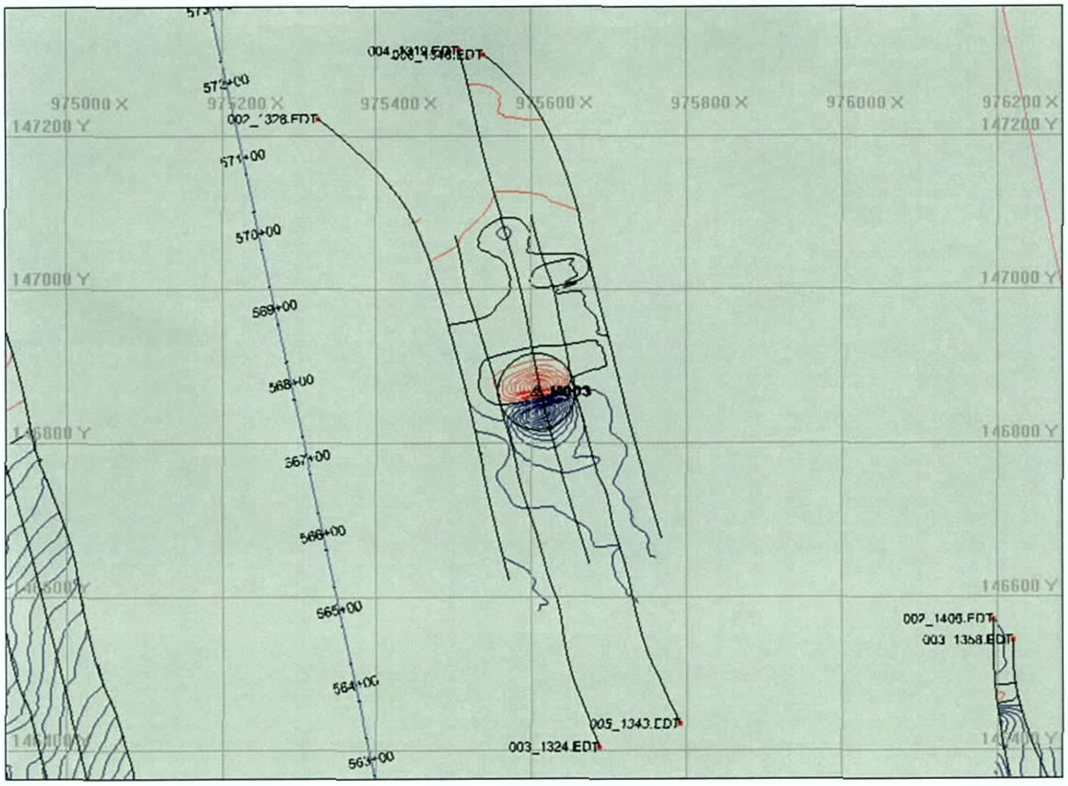


Figure 4-13. Magnetic refinement map of Anomaly 3. Contour interval 5 gamma.

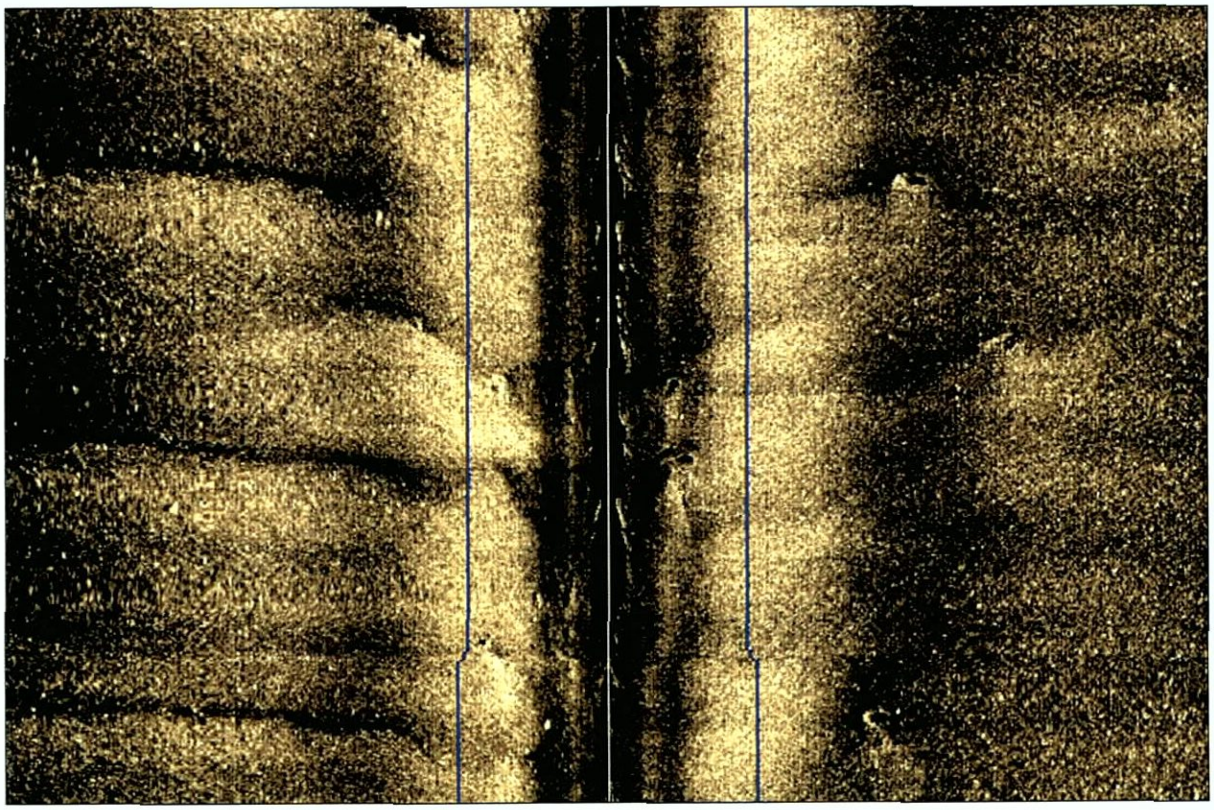


Figure 4-14. Sidescan sonar refinement image of Anomaly 3.

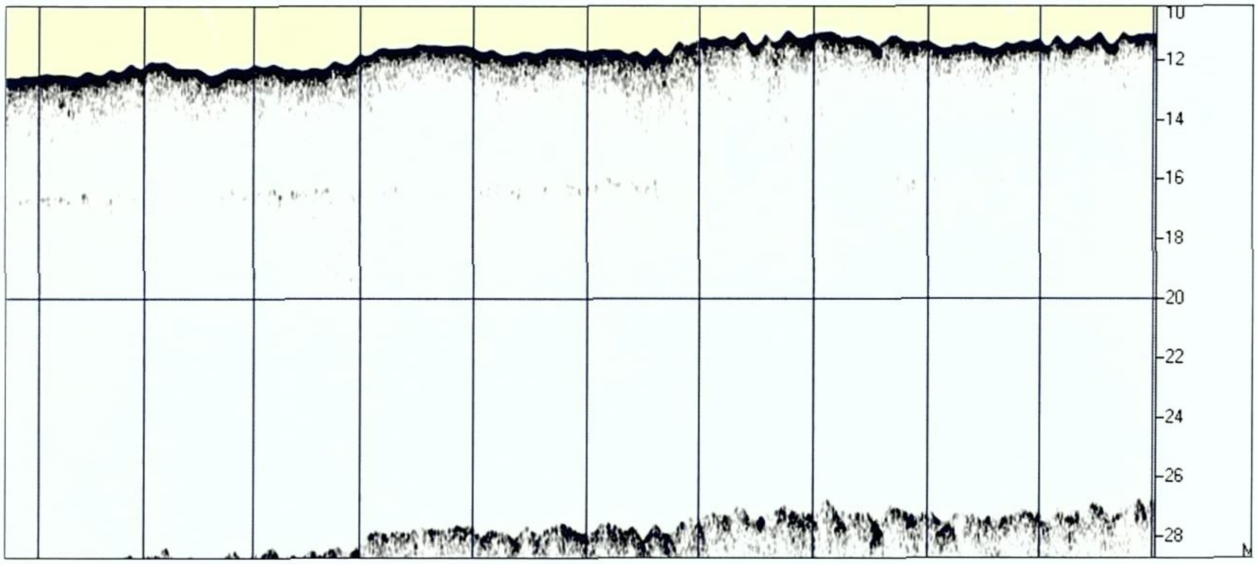


Figure 4-15. Subbottom profiler refinement image of Anomaly 3. Vertical scale in meters, horizontal divisions 31 m (100 ft.) intervals.

Anomaly 4

Anomaly 4 (Figure 4-16; see Table 4-01, Figures 4-01 and 4-03), located at 145820 E and 976019 N, is a 45-gamma monopole with a 220-foot duration. It is associated with sidescan sonar target SSS106 (see Table 4-02). Anomaly 4 appeared on one survey line, and it is located in 51 feet of water. The target was further refined with magnetometer (Figure 4-17), sidescan sonar (Figure 4-18), and subbottom profiler (Figure 4-19). Examination of the sidescan sonar refinement data revealed the presence of several small objects (see Figure 4-18). Analysis of the refinement subbottom data revealed a small target at the surface, whose size appears to be consistent with both the anomaly and the sidescan sonar refinement data. Anomaly 4 appears to be a collection of small pieces of non-historic debris, and no further work is recommended.

Anomaly 5

Anomaly 5, located at 146140 E and 976377 N, is a 21-gamma dipole with a duration of 220 feet (see Table 4-01, Figures 4-01, 4-03, and 4-16). The anomaly, located in 53 feet of water, appeared on one line; it is not associated with a sidescan sonar target. Anomaly 5 was refined with magnetometer (see Figure 4-17), sidescan sonar (Figure 4-20), and subbottom profiler (Figure 4-21). Examination of the sidescan sonar and subbottom profiler refinement data did not reveal any object accounting for the anomaly in the target area. It is likely the source of this anomaly is isolated marine related debris. No further work is recommended for this target.

Anomaly 6

Anomaly 6, located at 145114 E and 976307 N, is a 20-gamma positive monopole with a duration of 90 feet (Figure 4-22; see Table 4-01 and Figures 4-01, 4-03). This anomaly, located in 51 feet of water, appeared on two survey lines. It may be associated with sidescan sonar target SSS054 (Table 4-02), although according to the data the two targets are separated by over 100 feet. Anomaly 5 was refined with magnetometer, sidescan sonar, and subbottom profiler (Figures 4-22 through Figure 4-24). Analysis of the sidescan sonar refinement data revealed a long, thin linear target, likely a fragment of cable or pipeline. Refinement subbottom data showed no indication of any targets. This target is not considered potentially significant and is not recommended for additional investigation.

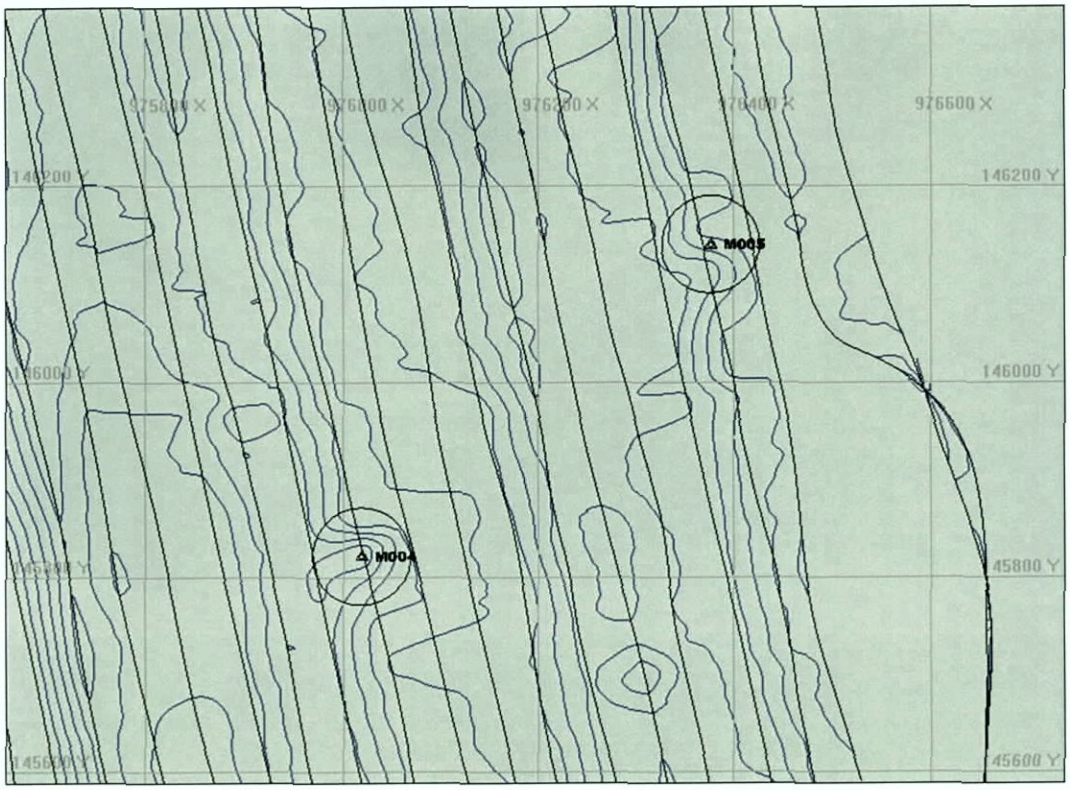


Figure 4-16. Magnetic contour map of Anomaly 4 and Anomaly 5.

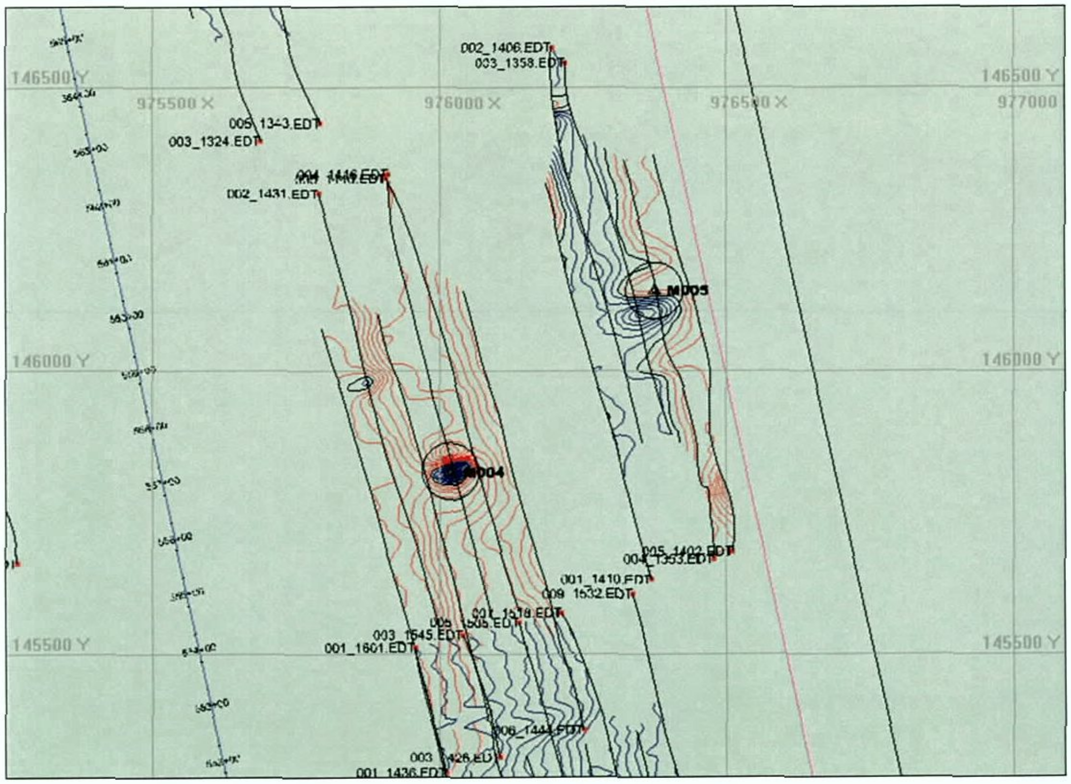


Figure 4-17. Magnetic refinement map of Anomaly 4 and Anomaly 5.

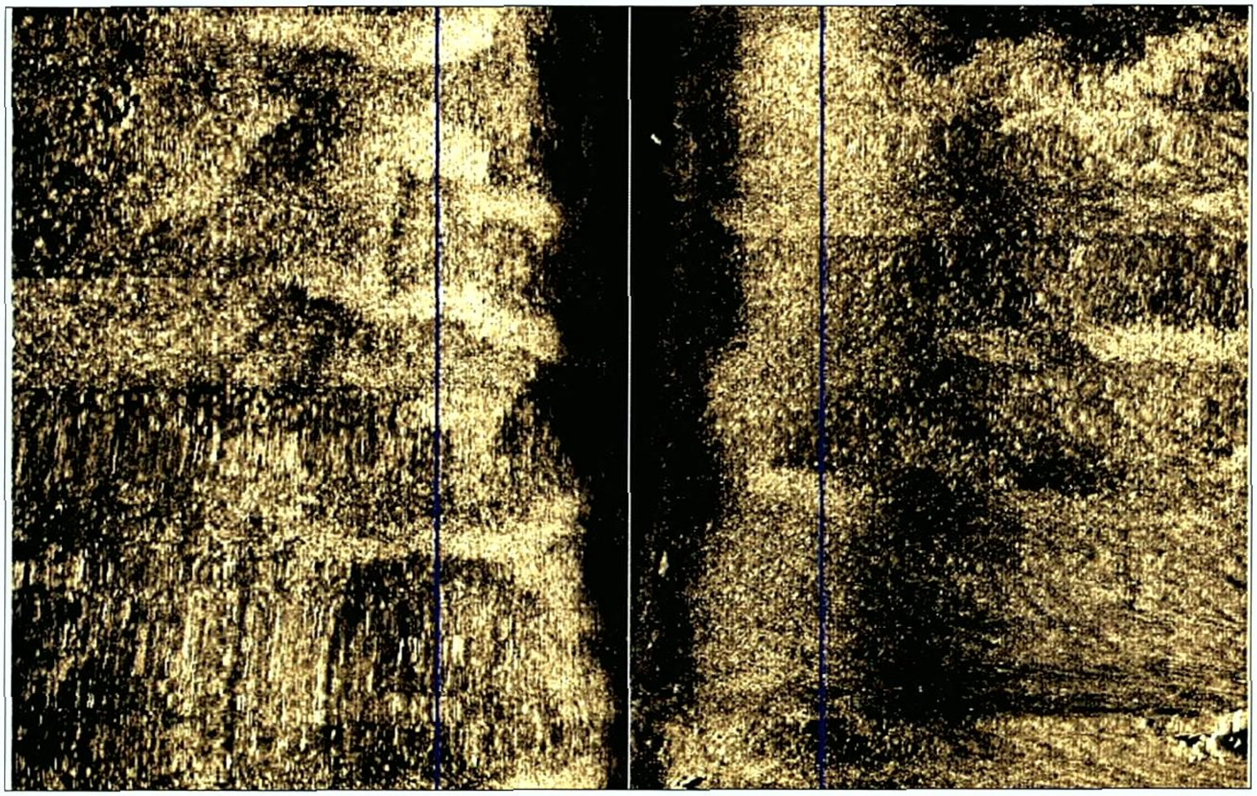


Figure 4-18. Sidescan sonar refinement image of Anomaly 4.

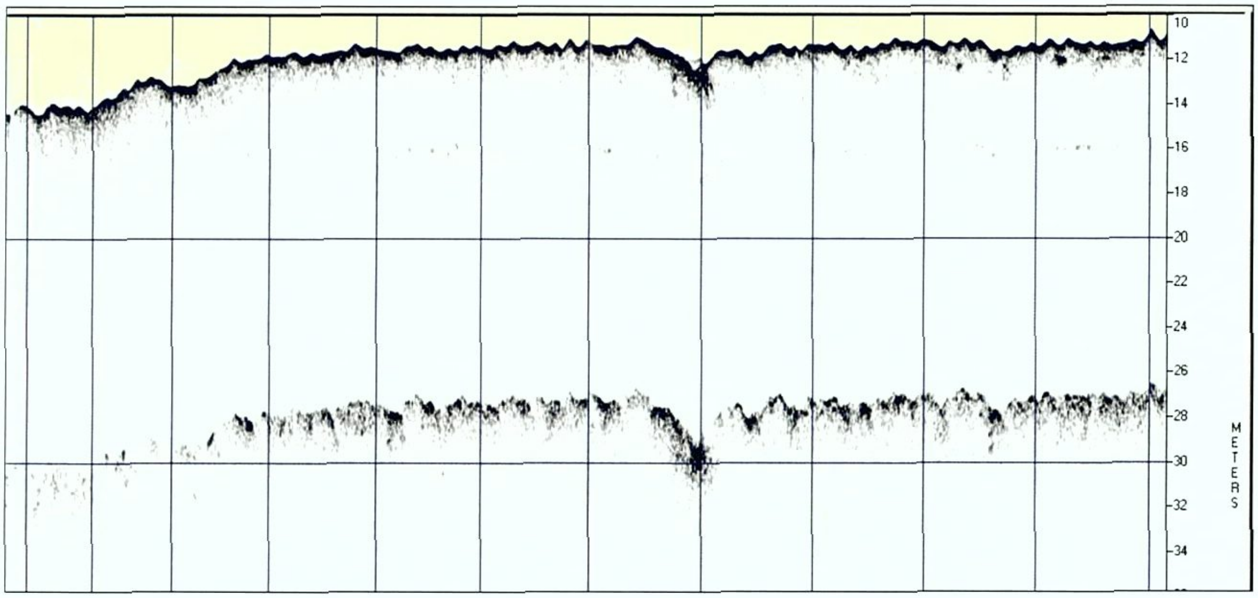


Figure 4-19. Subbottom refinement image of Anomaly 4.

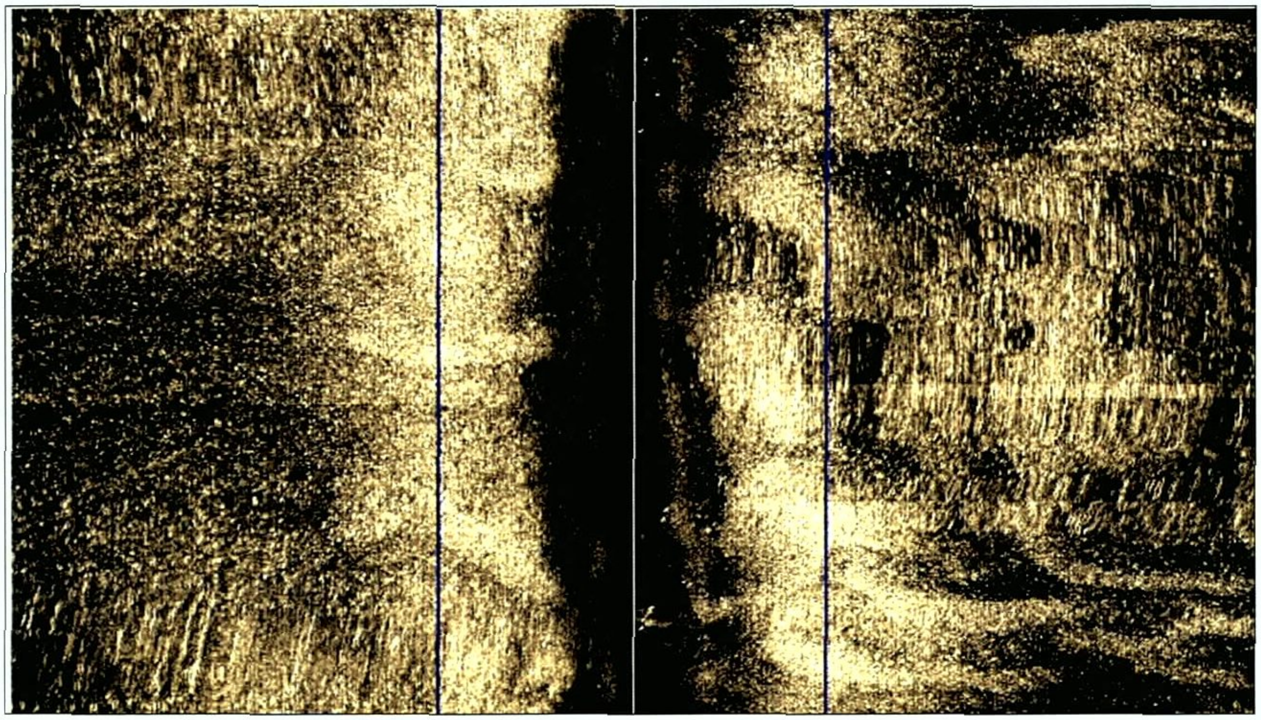


Figure 4-20. Sidescan sonar refinement image of Anomaly 5.

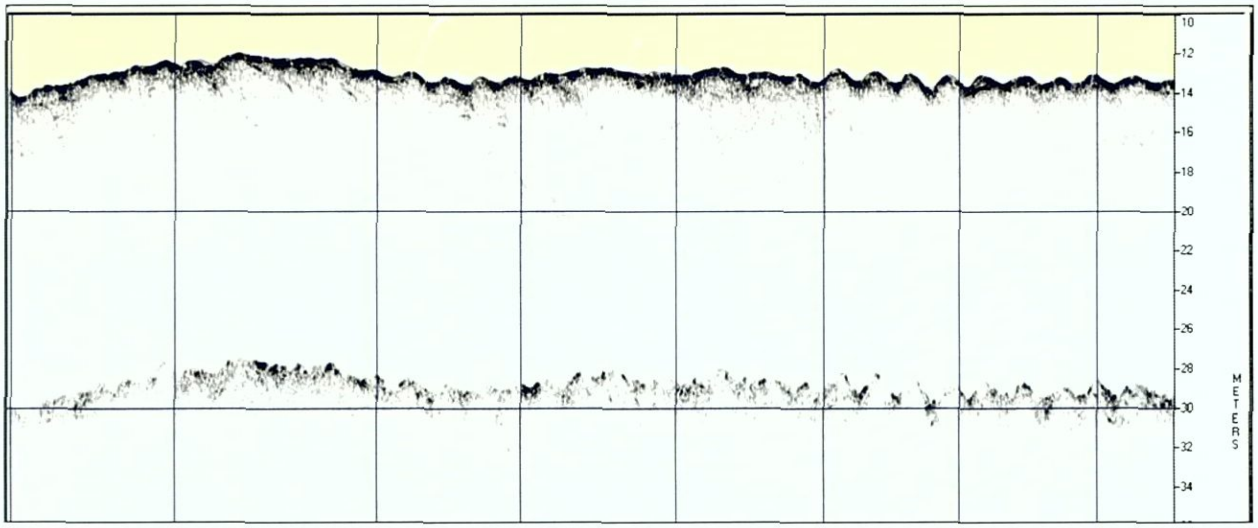


Figure 4-21. Subbottom refinement image of Anomaly 5.

Anomaly 7

Anomaly 7, located at 144771 E and 976331 N, is a 50-gamma dipole with a duration of 143 feet (see Table 4-01, Figures 4-01, 4-03, and 4-22). The anomaly, located in 51 feet of water, appeared on two survey lines. It may be associated with sidescan sonar target SSS054 (see Table 4-02), although the two targets are separated by over 100 feet in the data. This target was refined with magnetometer, sidescan sonar, and subbottom profiler (Figures 4-23, 4-25, and 4-26). Analysis of sidescan refinement data revealed a small object near the anomaly (see Figure 4-26). Subbottom refinement data did not indicate any sizeable objects below the bottom. This target is likely a small piece of isolated debris and is not recommended for further investigation.

Figure 4-22. Magnetic contour map of Anomalies 6, 7, 8, and 9.

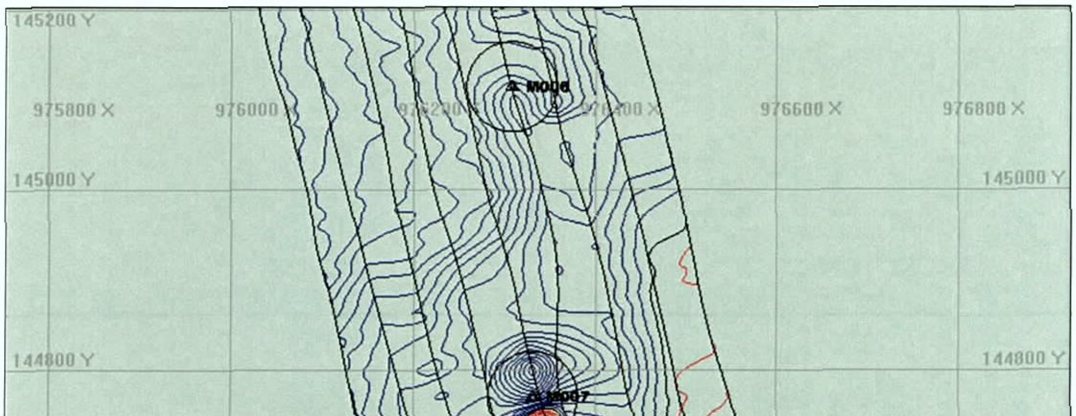


Figure 4-23. Magnetic refinement map of Anomalies 6, 7, and 9.

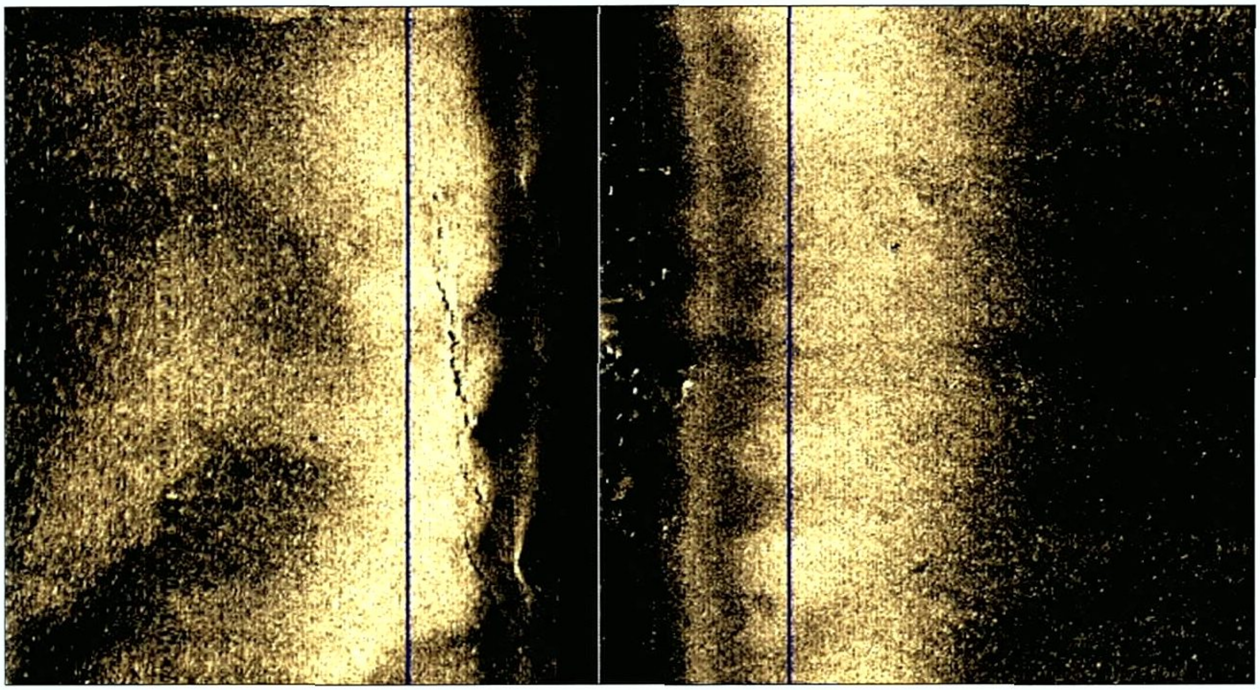


Figure 4-24. Sidescan sonar refinement image of *Anomaly 6*.

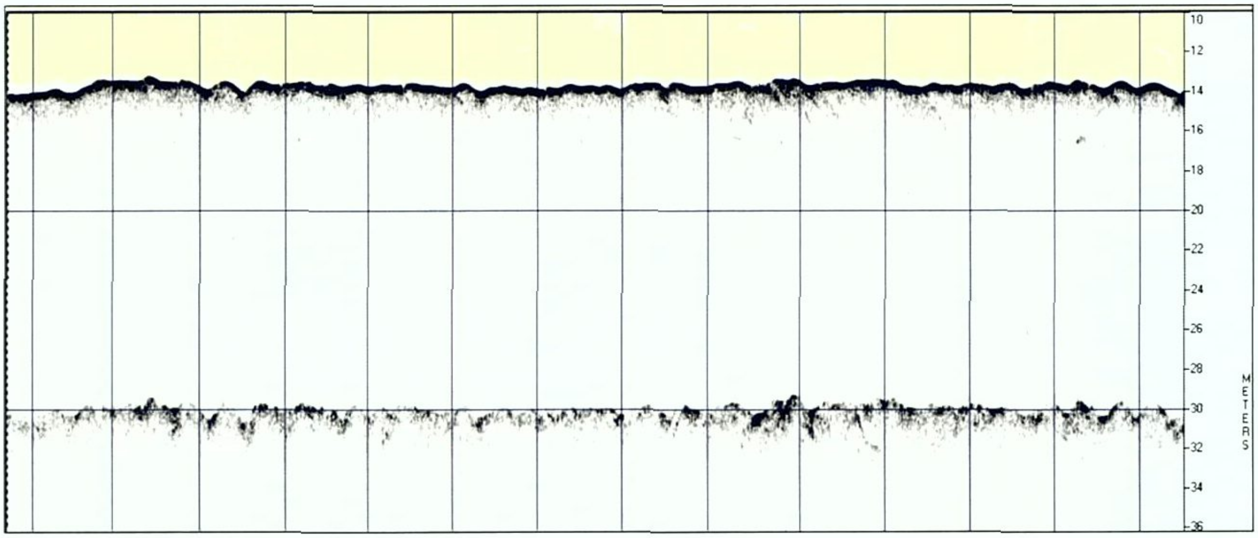


Figure 4-25. Subbottom refinement image of Anomalies 6 and 7.

Anomaly 8

Anomaly 8, located at 144518 E and 976117 N, is a 20-gamma positive monopole with a duration of 80 feet (see Table 4-01, Figures 4-01, 4-03, and 4-22). The anomaly, located in 52 feet of water, appeared on one survey line. It may be associated with sidescan sonar target SSS107 (see Table 4-02) although according to the data, they are separated by a fair distance. Anomaly 8 did not meet criteria for the existence of potentially significant submerged cultural resources and was not refined.

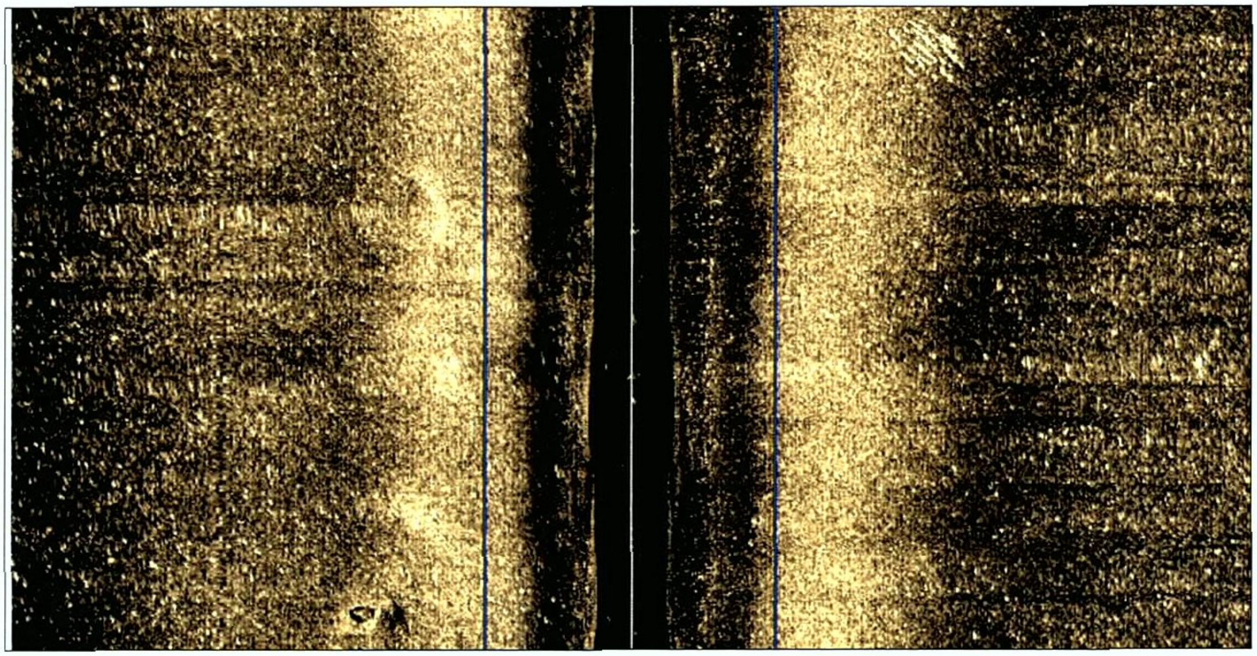


Figure 4-26. Sidescan sonar refinement image of Anomaly 7.

Anomaly 9

Anomaly 9, located at 144466 E and 976467 N, is a 50-gamma positive monopole with a duration of 75 feet (see Table 4-01, Figures 4-01, 4-03, and 4-22). The anomaly, located in 51 feet of water, appeared on one survey line. It may be associated with sidescan sonar target SSS020 (see Table 4-02), although the two targets are separated by a considerable distance in the data. Anomaly 9 was refined with magnetometer (see Figure 4-23), sidescan sonar (Figure 4-27), and subbottom profiler (Figure 4-28). Analysis of the sidescan sonar refinement data revealed the presence of a series of linear objects. Two small subsurface objects were located in the subbottom data. It is likely that this target represents a defunct small pipeline or cable. No further work is recommended.

Anomaly 10

Anomaly 10, located at 143878 E and 976743 N, is a 20-gamma negative monopole with a duration of 100 feet (Figure 4-29; see Table 4-01, Figures 4-01 and 4-03). The anomaly, located in 51 feet of water, appeared on one survey line. It is not associated with a sidescan sonar target. Anomaly 10 did not meet criteria for the existence of potentially significant submerged cultural resources and was not refined.

Anomaly 11

Anomaly 11, located at 139566 E and 977355 N, is a 256-gamma dipole with a duration of 168 feet (Figure 4-30; see Table 4-01, Figures 4-01 and 4-04). The anomaly, located in 50 feet of water, appeared on two survey lines. It is not associated with a sidescan sonar target. Anomaly 11 was refined with magnetometer, sidescan sonar (Figure 4-31), and subbottom profiler (Figure 4-32). Examination of the sidescan sonar refinement data did not indicate any objects on the surface in the target area. Subbottom data did not reveal any subsurface features of note. No further work is recommended.

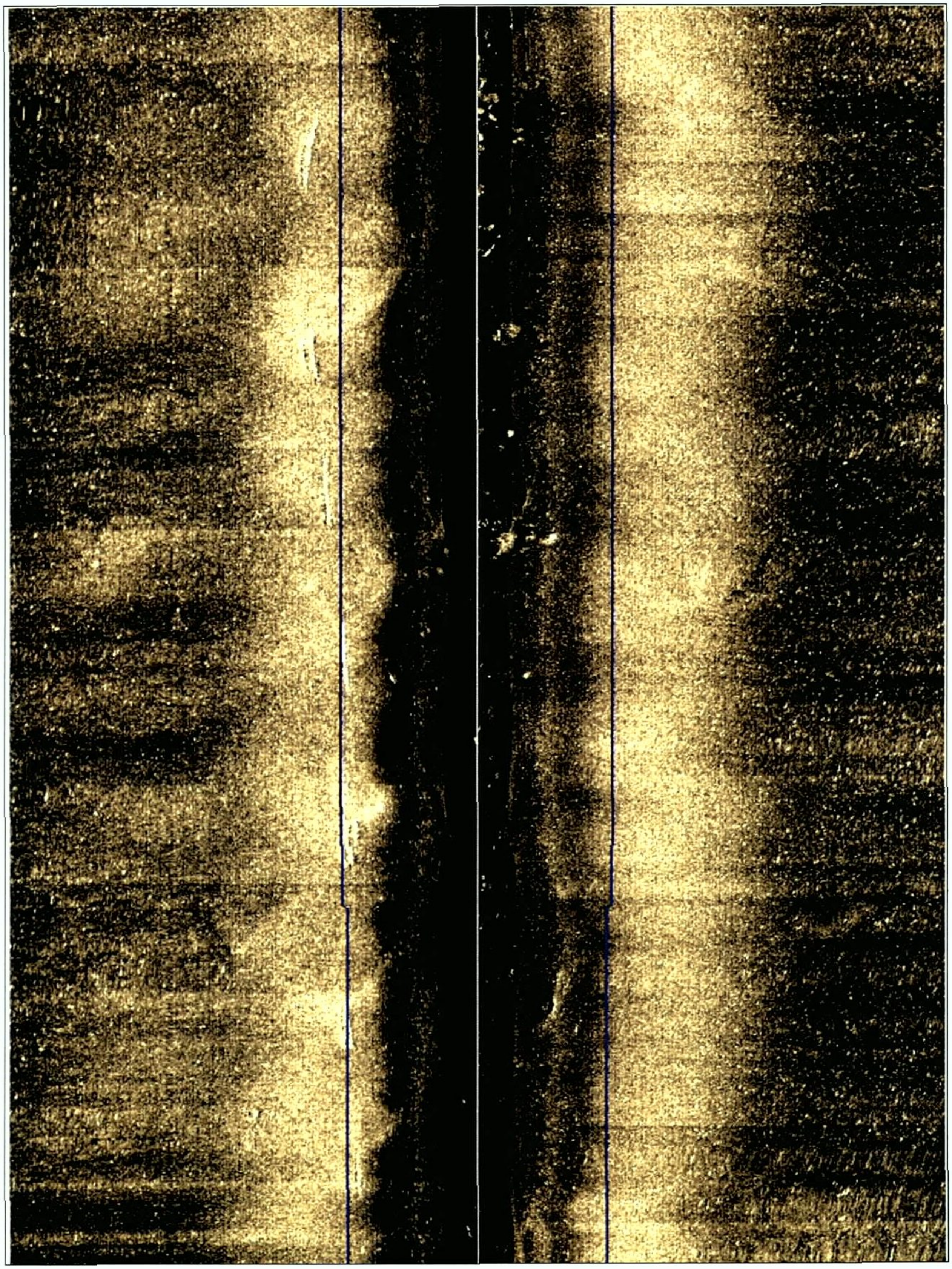


Figure 4-27. Sidescan sonar refinement image of Anomaly 9.

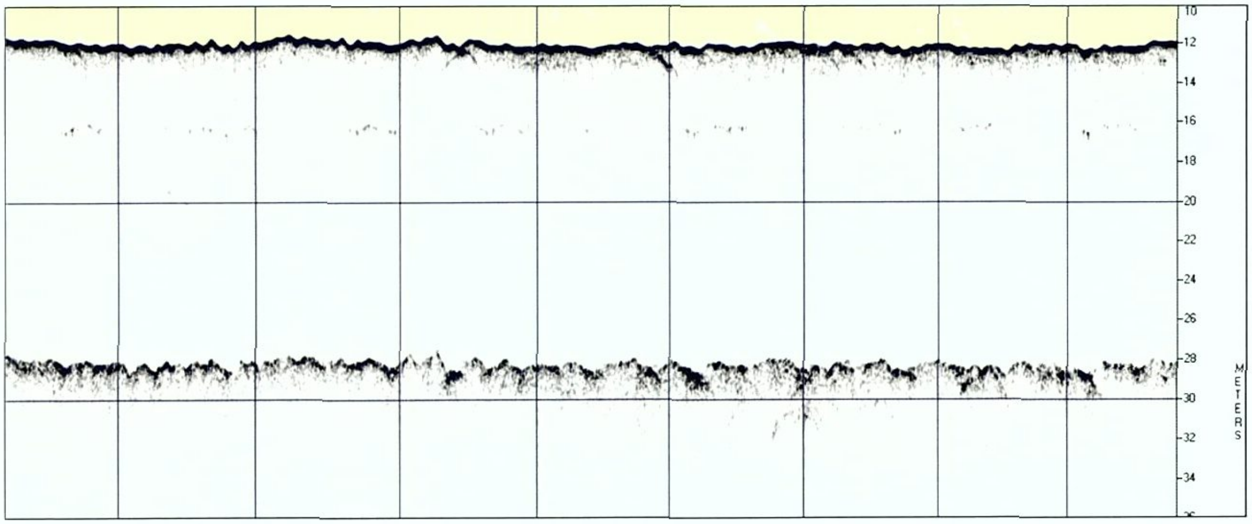


Figure 4-28. Subbottom refinement image of Anomaly 9.

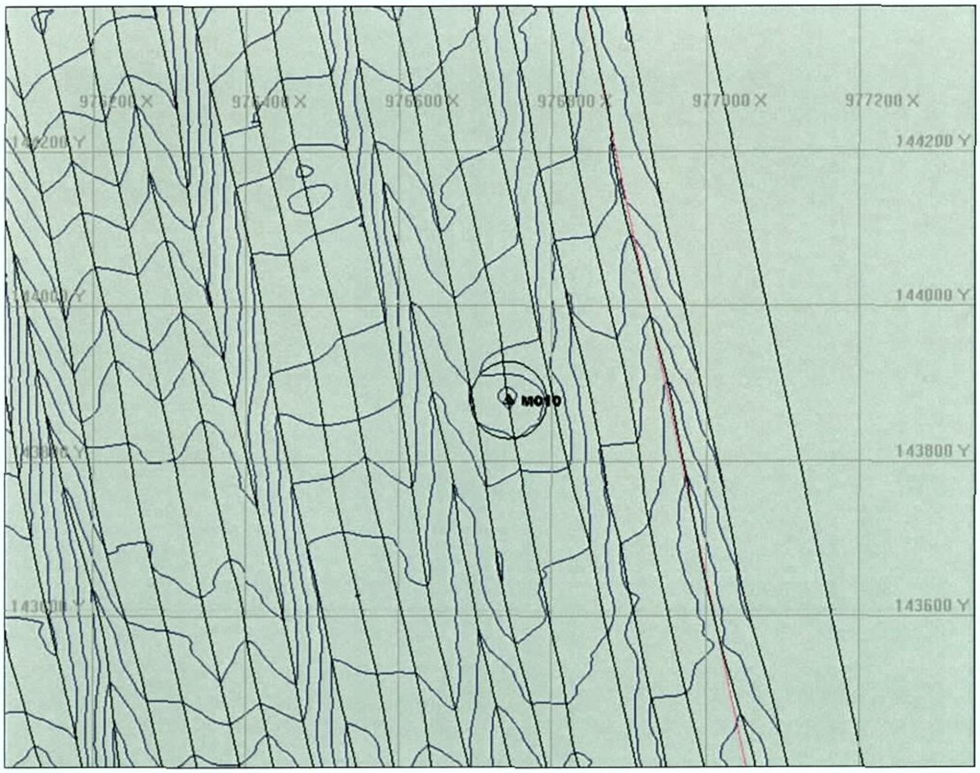


Figure 4-29. Magnetic contour map of Anomaly 10.

Anomaly 12

Anomaly 12, located at 139116 E and 977912 N, is a 222-gamma dipole with a duration of 116 feet (see Table 4-01 and Figures 4-01, 4-04, and 4-31). The anomaly, located in 45 feet of water, appeared on two survey lines. It is associated with sidescan sonar targets SSS078 and SSS118 (see Table 4-02), and is a sunken navigation buoy. The information obtained from the data is sufficient to determine the origin of the target, thus Anomaly 12 was not refined, and no further work is recommended.

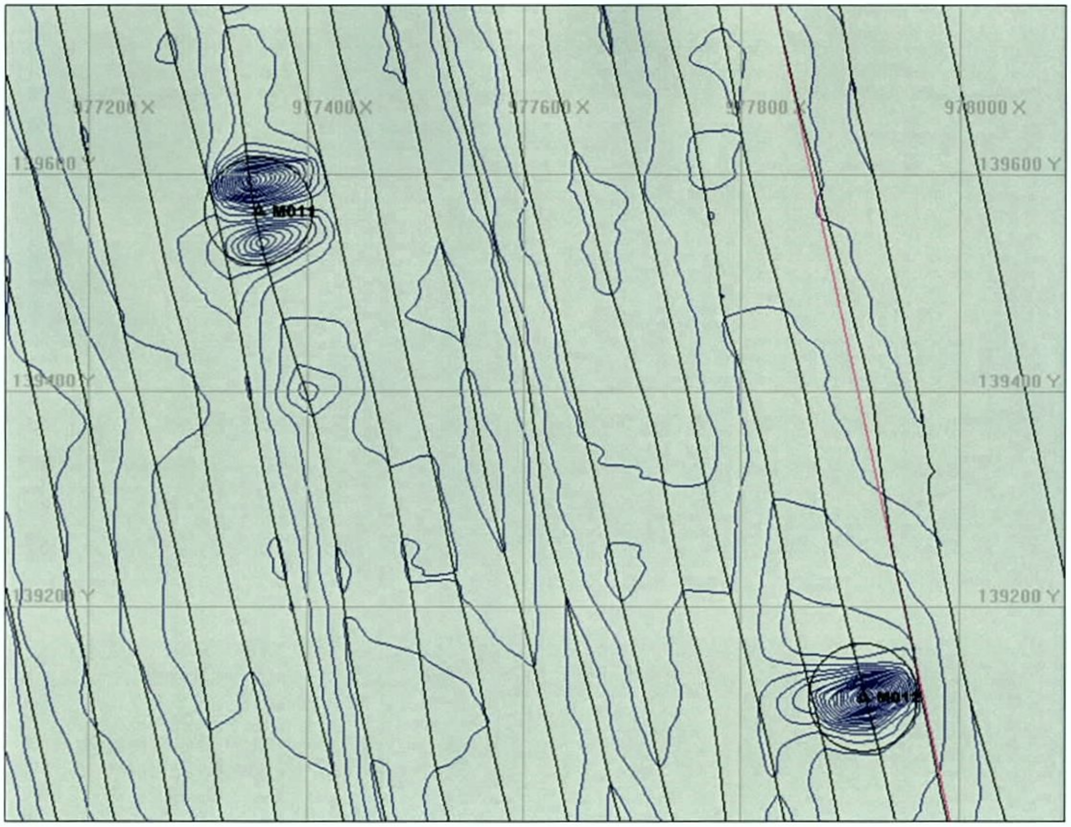


Figure 4-30. Magnetic contour map of Anomalies 11 and 12.

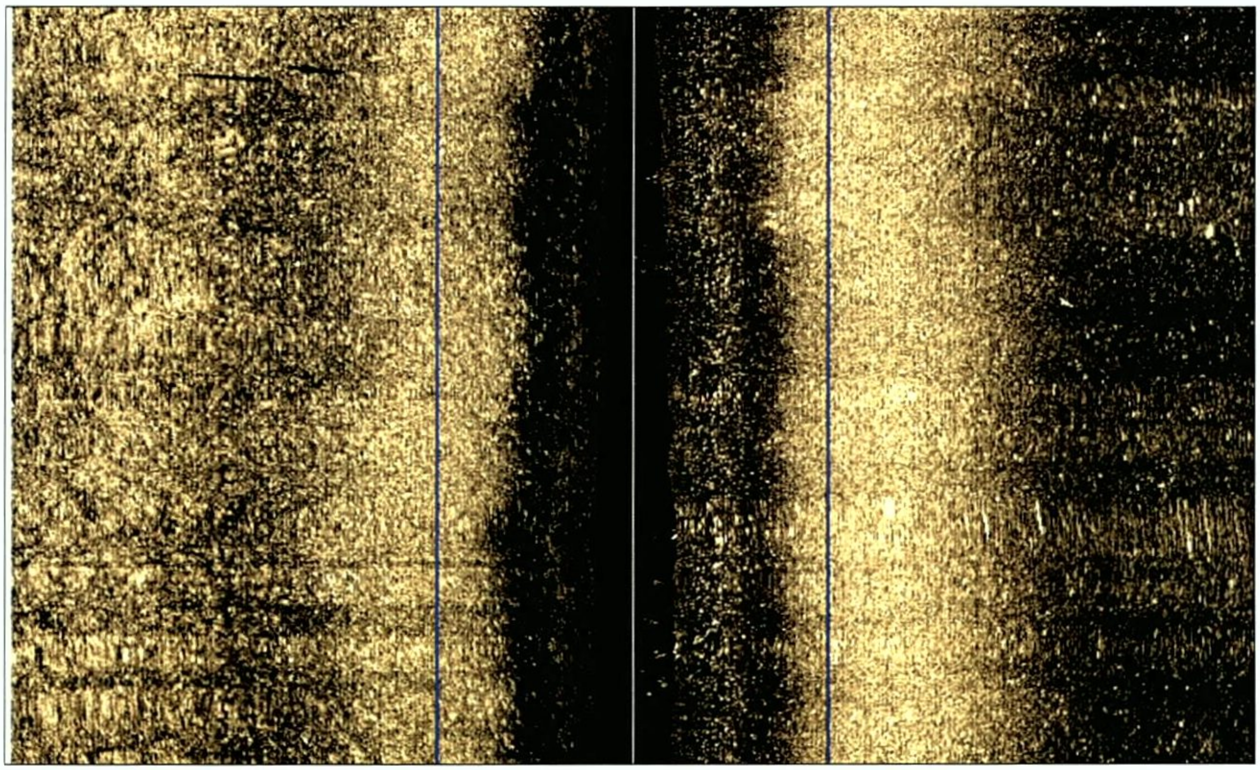


Figure 4-31. Sidescan sonar refinement image of Anomaly 11.

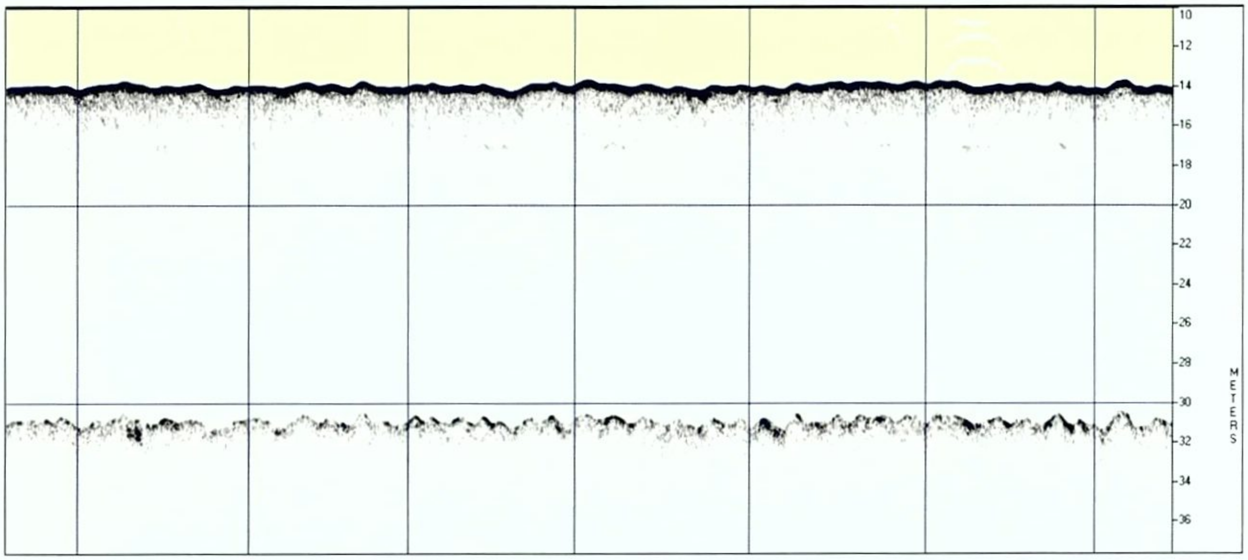


Figure 4-32. Subbottom refinement image of Anomaly 11.

Anomaly 13

Anomaly 13, located at 135573 E and 978231 N, is a 49-gamma dipole with a duration of 90 feet (Figure 4-33; see Table 4-01, Figures 4-01, 4-04, and 4-05). The anomaly, located in 50 feet of water, appeared on one survey line. It is not associated with a sidescan sonar target. Anomaly 13 did not meet the criteria established in the research design, and therefore this target was not refined.

Anomaly 14

Anomaly 14, located at 132360 E and 980888 N, is a 42-gamma dipole with a duration of 90 feet (Figure 4-34; see Table 4-01, Figures 4-01 and 4-05). The anomaly, located in 60 feet of water, appeared on two survey lines. It is associated with sidescan sonar target SSS070 (see Table 4-02). Sidescan analysis indicated that the target is most likely a small point-source piece of debris. The target was not refined.

Anomaly 15

Anomaly 15, located at 113017 E and 1016662 N, is an 80-gamma dipole with a duration of 170 feet (Figure 4-35; see Table 4-01, Figures 4-06 and 4-08). The anomaly, located in 50 feet of water, appeared on three survey lines. It is not associated with a sidescan sonar target. Although the magnetic anomaly does appear to meet the criteria established in the research design, analysis of the raw magnetic data indicated the anomaly to actually consist of a cluster of two smaller point-source anomalies that are located on adjacent lines. It is most likely that these anomalies represent small, point-source debris of a marine nature, and therefore Anomaly 15 was not refined as part of this investigation.

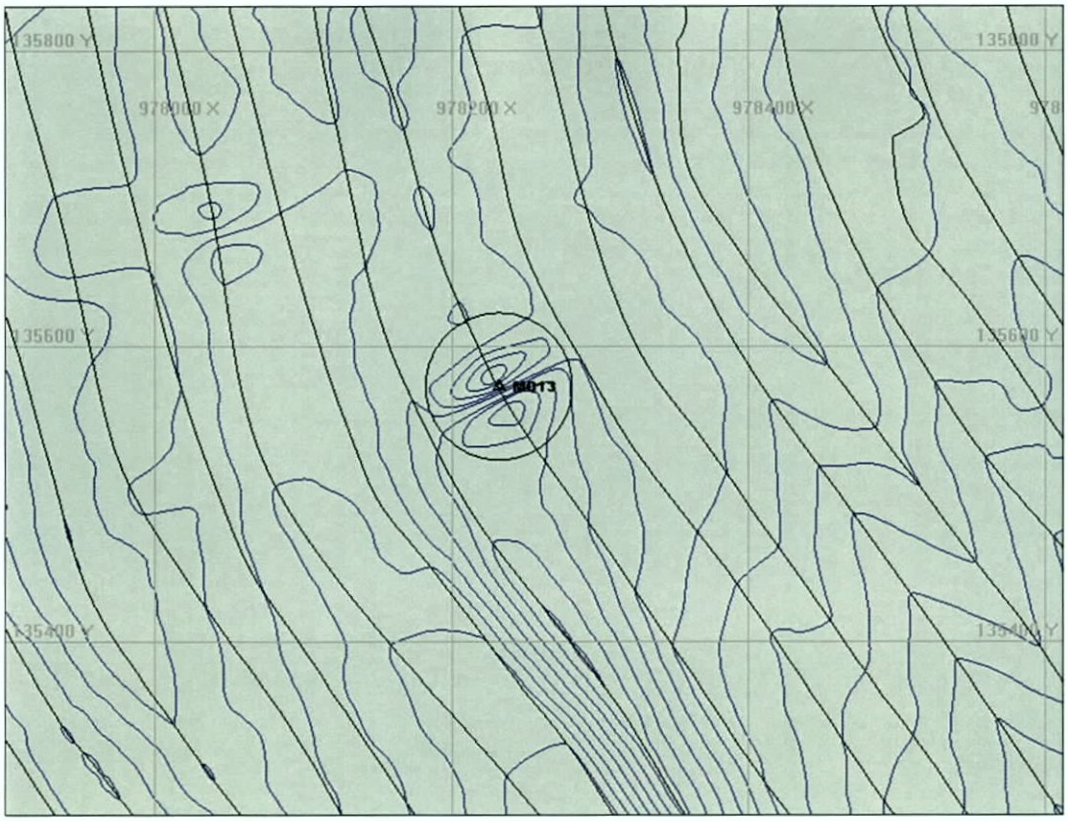


Figure 4-33. Magnetic contour map of Anomaly 13.

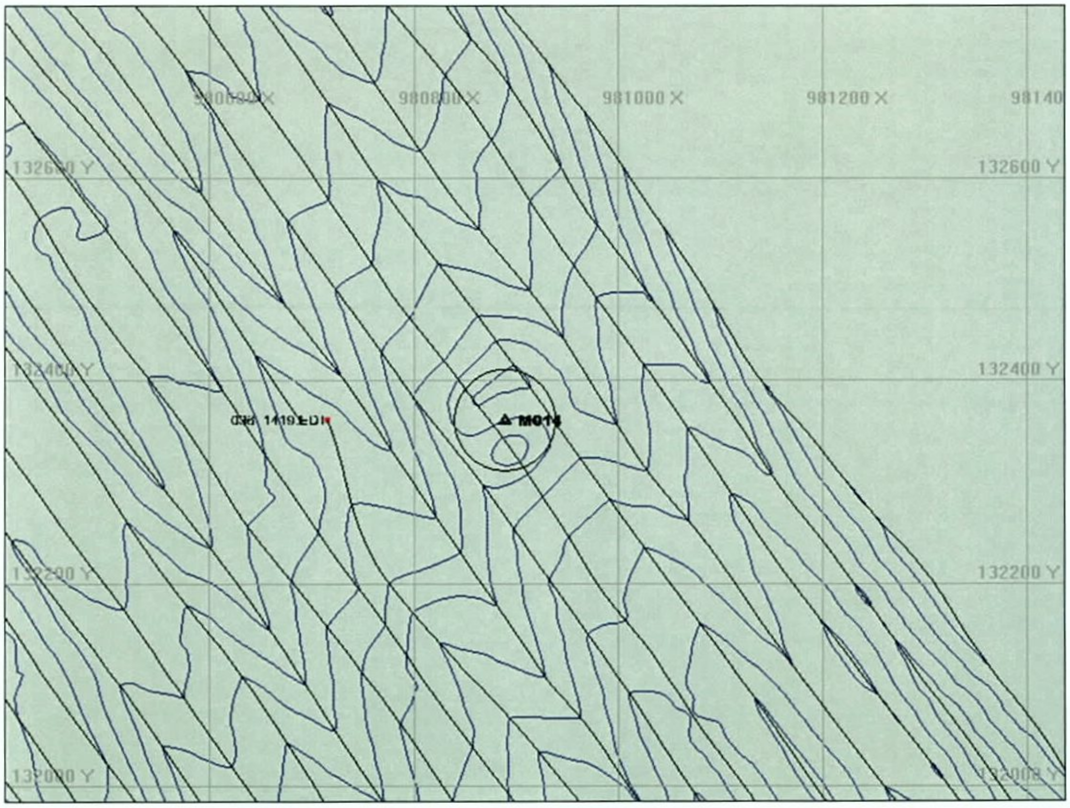


Figure 4-34. Magnetic contour map of Anomaly 14.

Anomaly 16

Anomaly 16, located at 112565 E and 1917210 N, is a 34-gamma negative monopole with a duration of 80 feet (see Table 4-01 and Figures 4-06, 4-08, and 4-35). The anomaly, located in 50 feet of water, appeared on one survey line. It is not associated with a sidescan sonar target. The target was not refined, as it did not meet the criteria established in the research design.

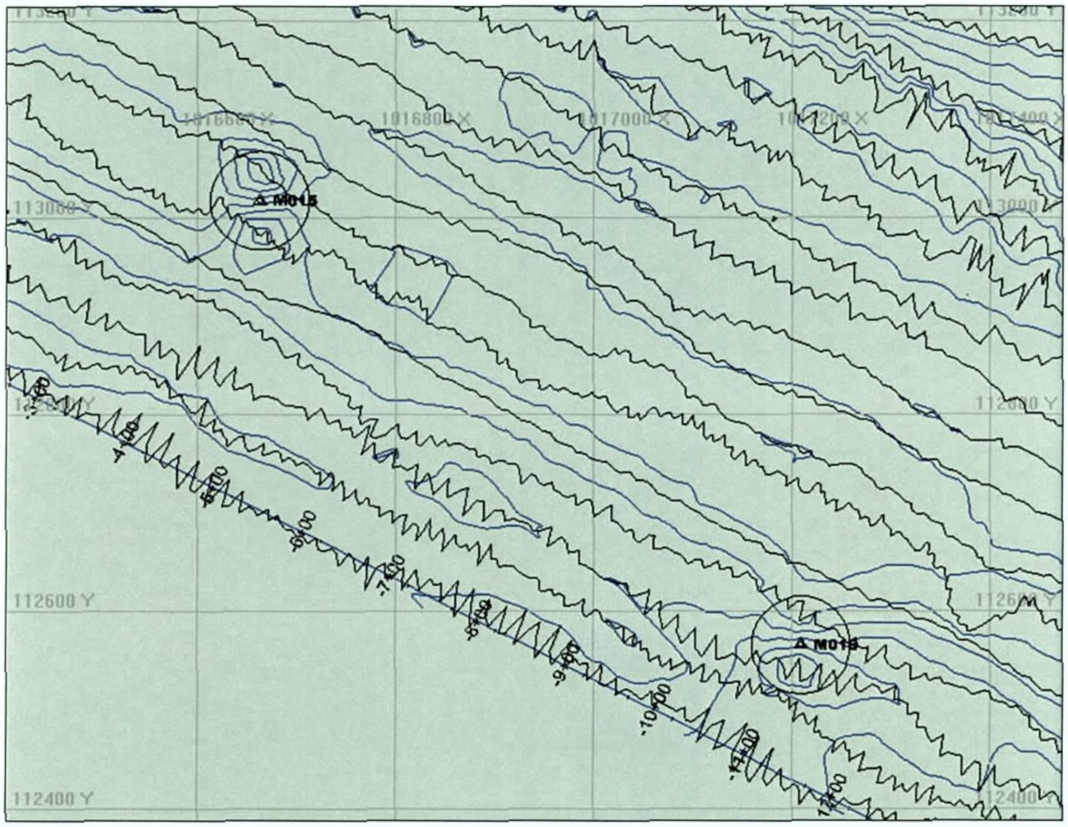


Figure 4-35. Magnetic contour map of Anomalies 15 and 16.

SIDESCAN SONAR TARGETS

Fifty-one sidescan sonar targets were revealed during examination of the current survey data (Table 4-02, Figures 4-36 through 4-41). Of these 51 targets, one appears to be a barge wreck. However, this apparent barge wreck is located deeper than the maximum dredge depth of 55 feet and is therefore outside of the project's APE and will not be affected. Another of the sidescan sonar targets appears to be a sunken navigation buoy, and the remaining 49 targets consist of navigation buoy weights, possible pipelines or cables, or various pieces of non-historic marine debris.

Of the 51 sidescan sonar targets examined during the investigation, none are recommended for further investigation.

Figure 4-36. Sidescan sonar targets.

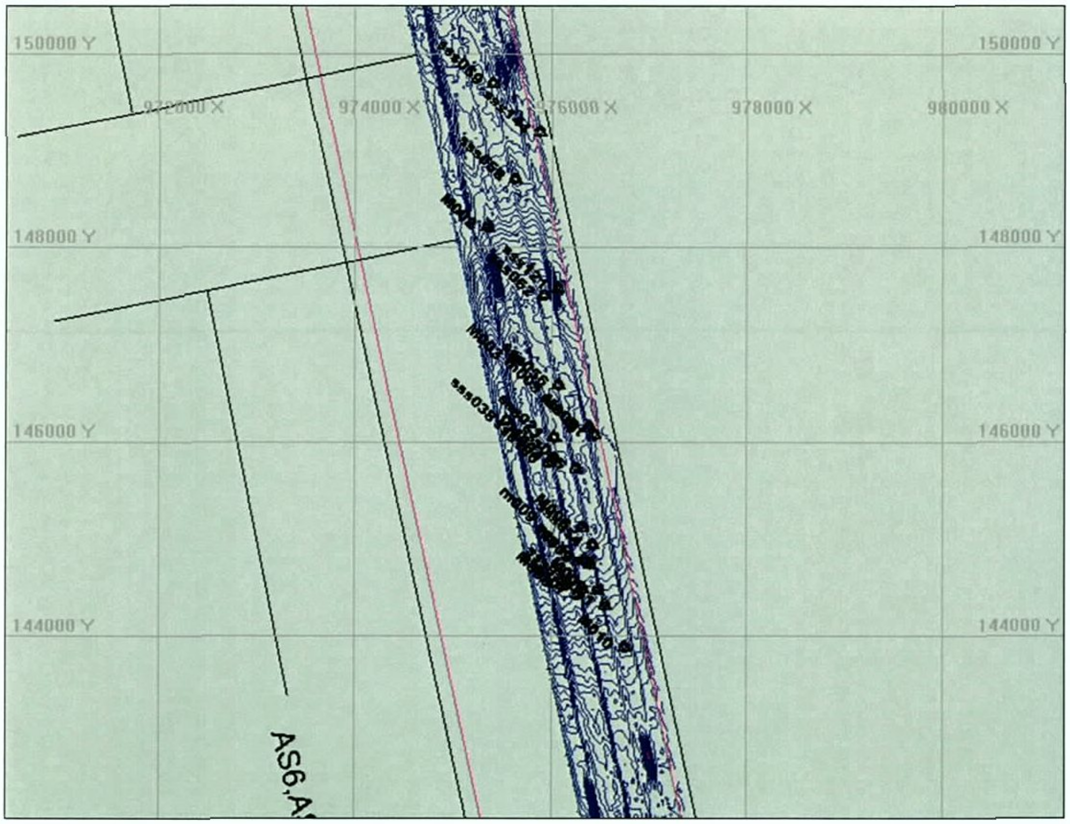


Figure 4-37. Sidescan sonar targets.

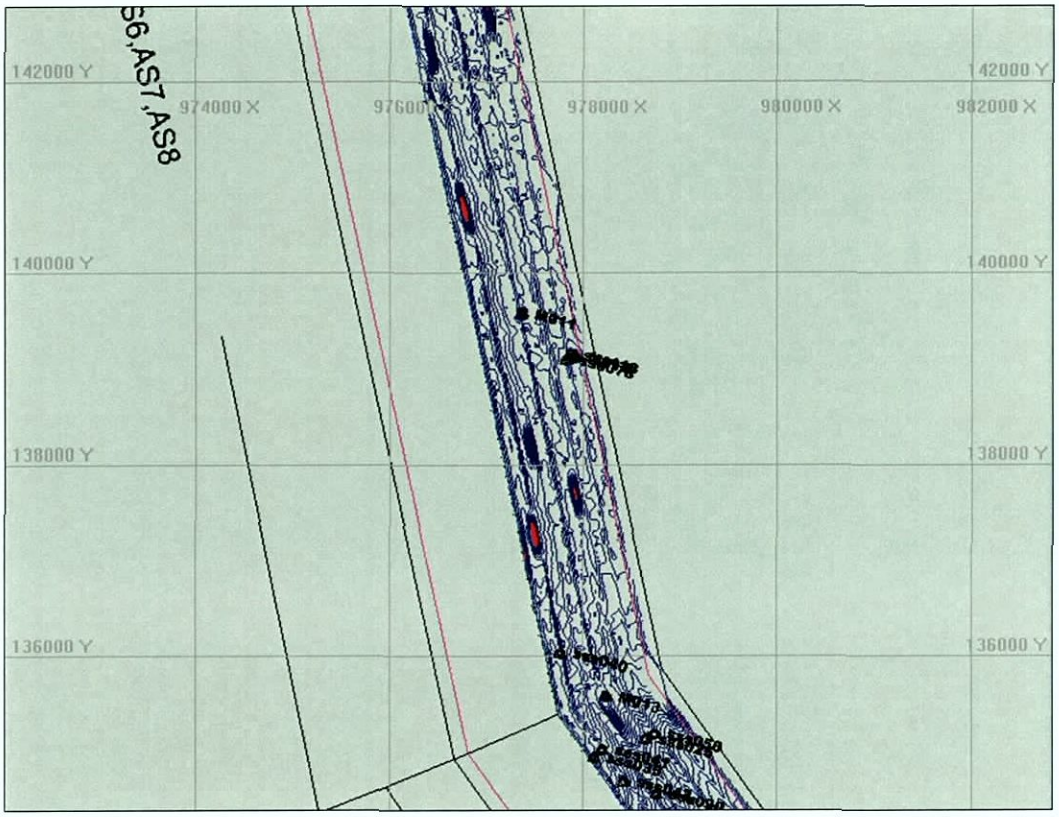


Figure 4-38. Sidescan sonar targets.

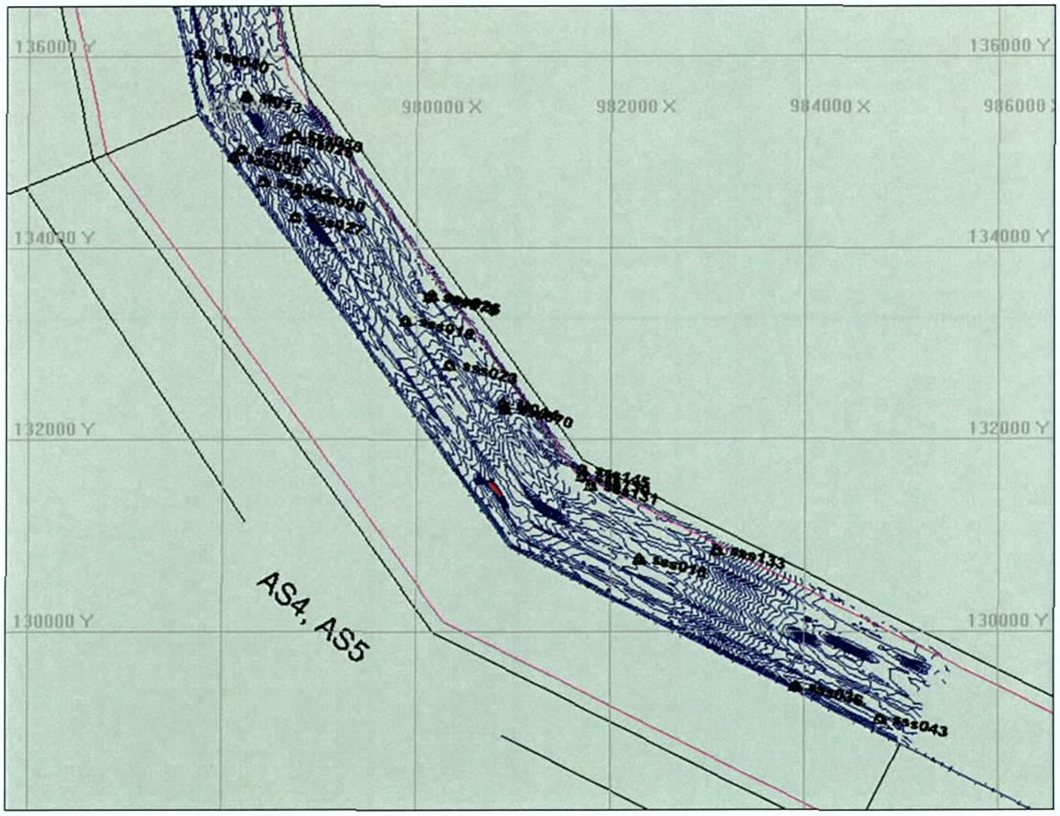


Figure 4-39. Sidescan sonar targets.

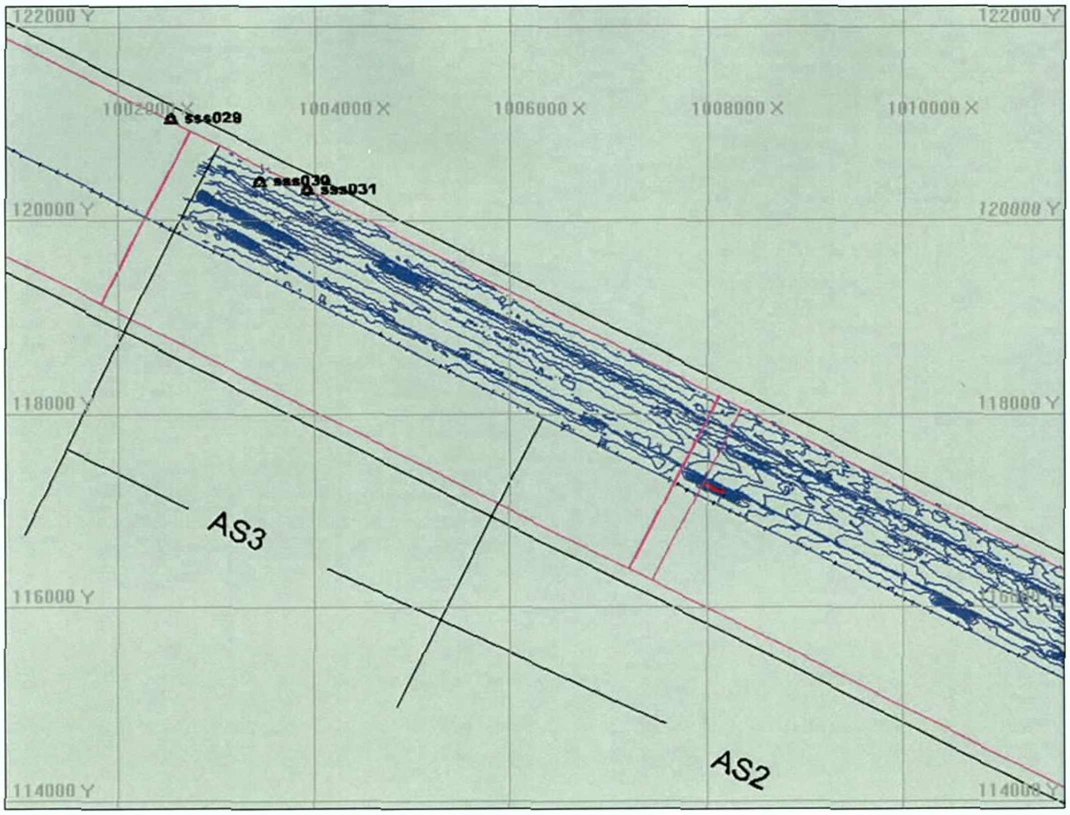


Figure 4-40. Sidescan sonar targets.

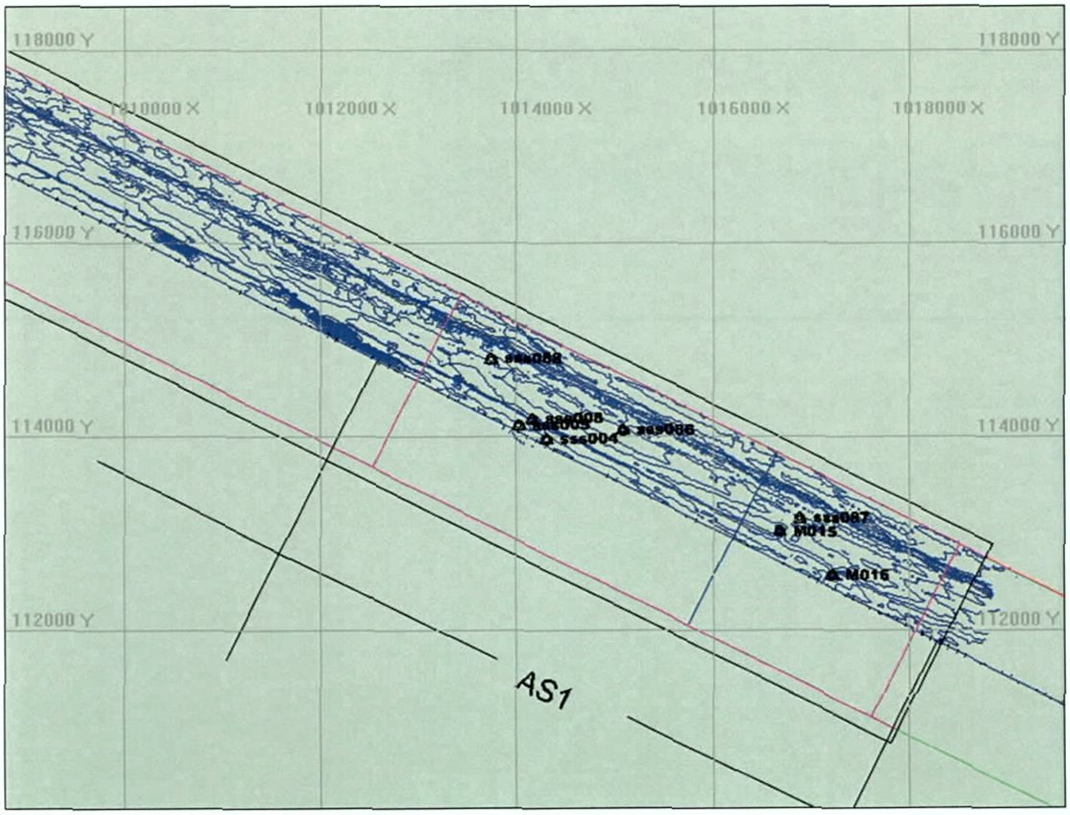
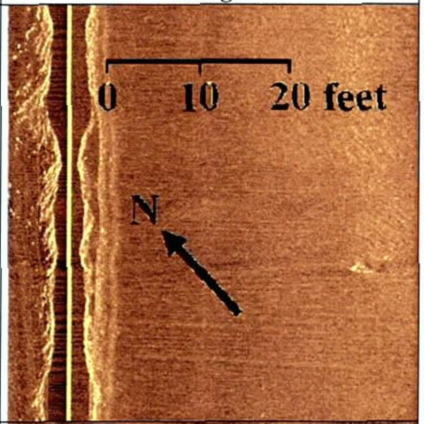
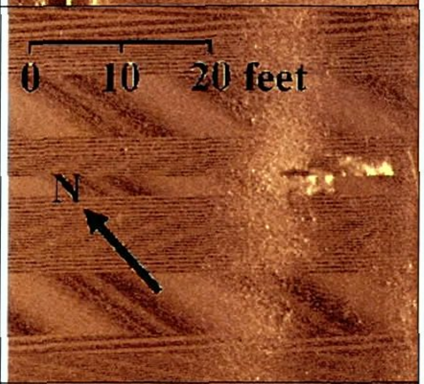
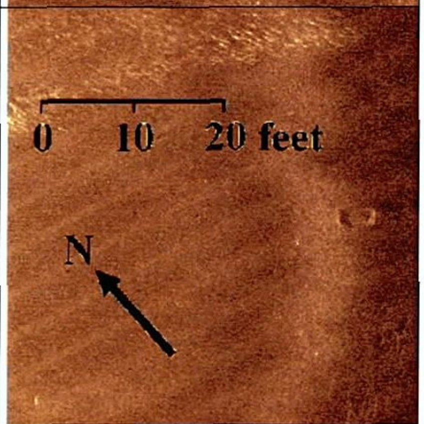
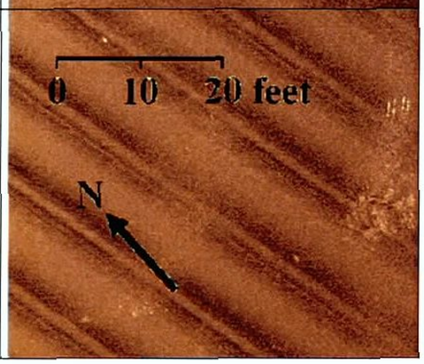
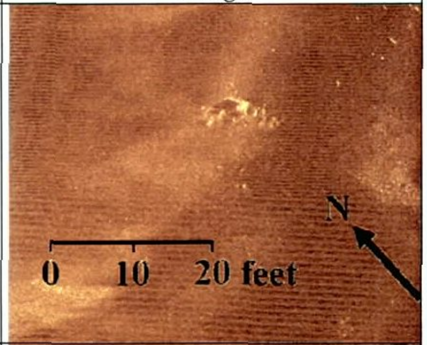
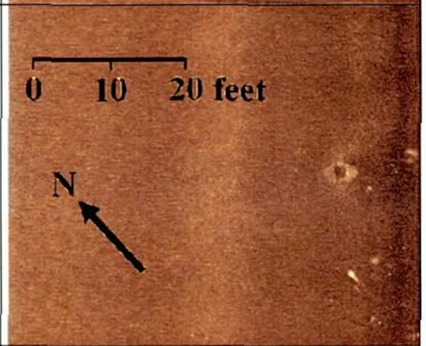
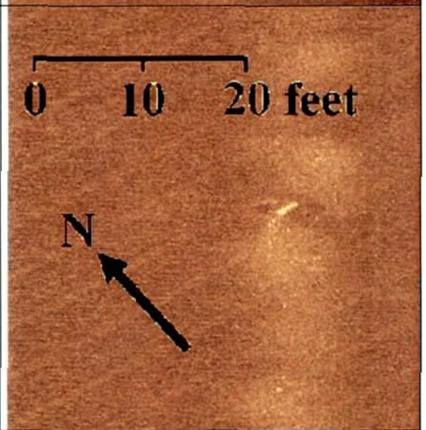
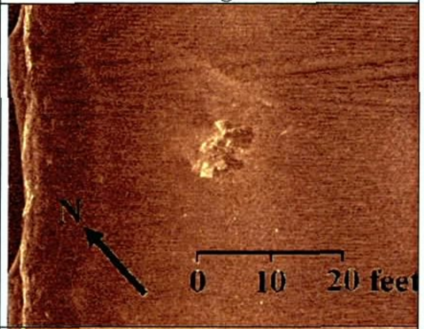
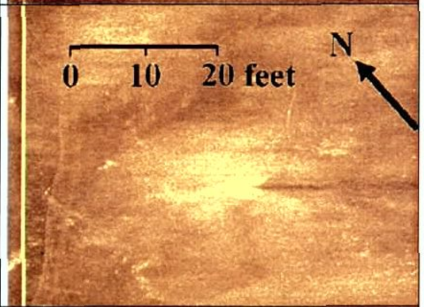
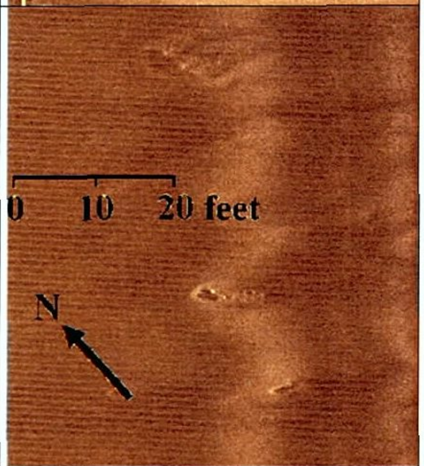
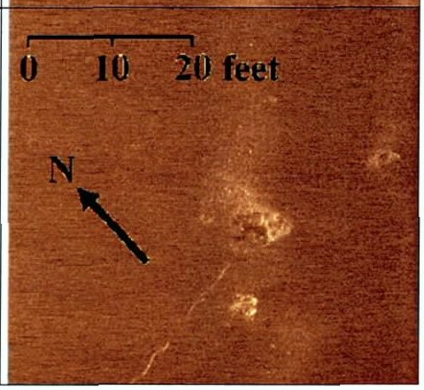


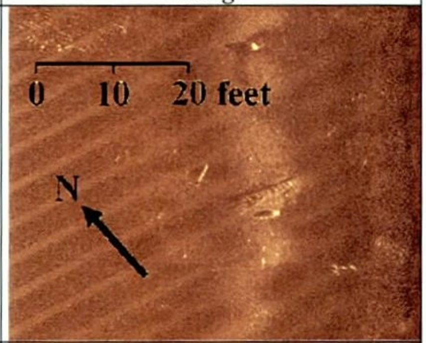
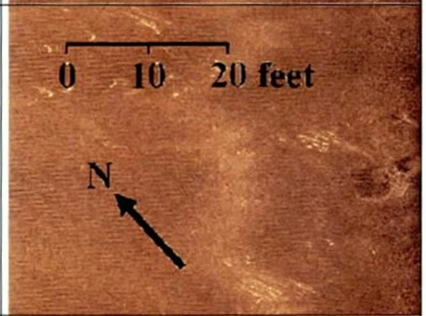
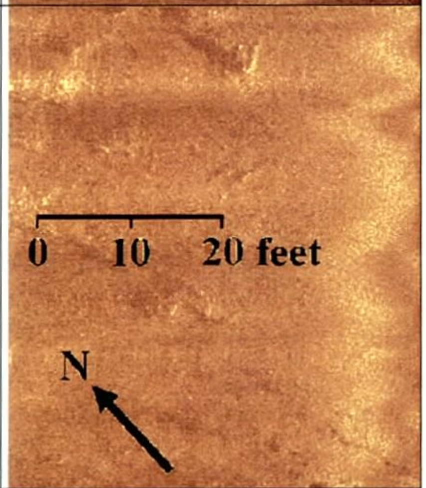
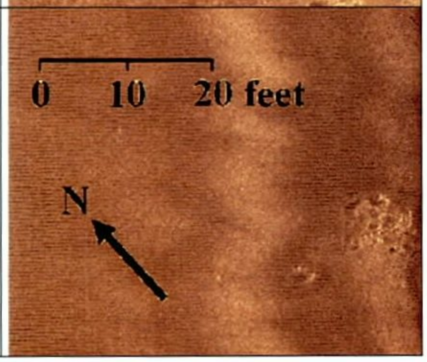
Figure 4-41. Sidescan sonar targets.

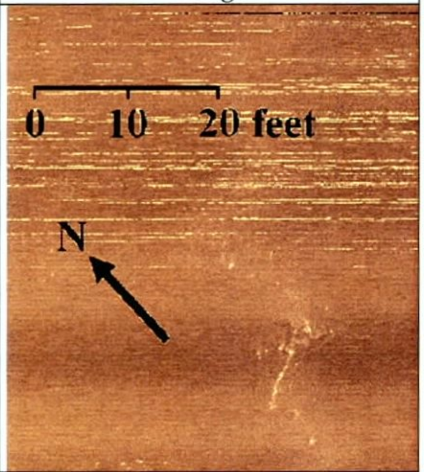
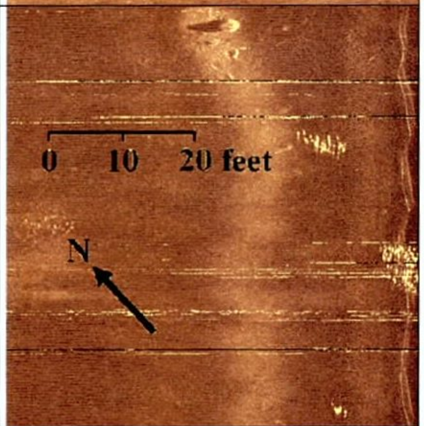
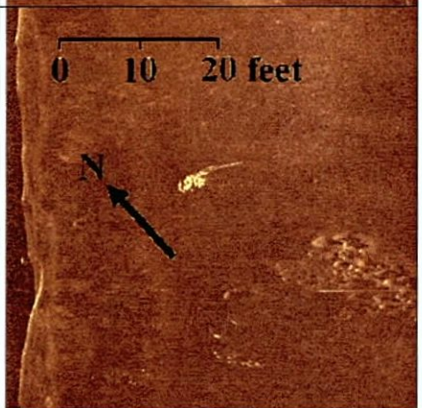
Table 4-02. Sidescan sonar targets.

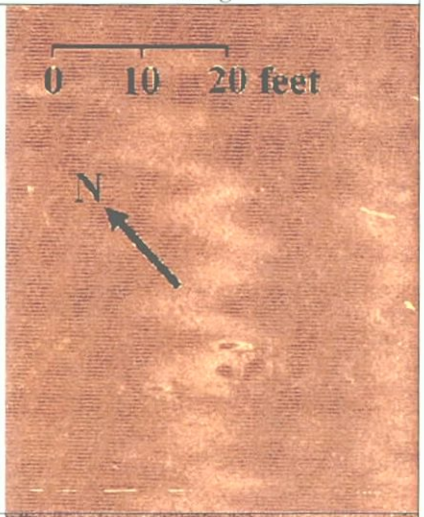
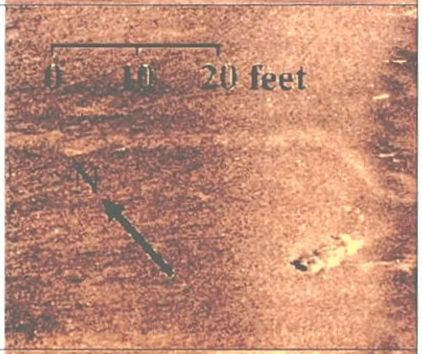
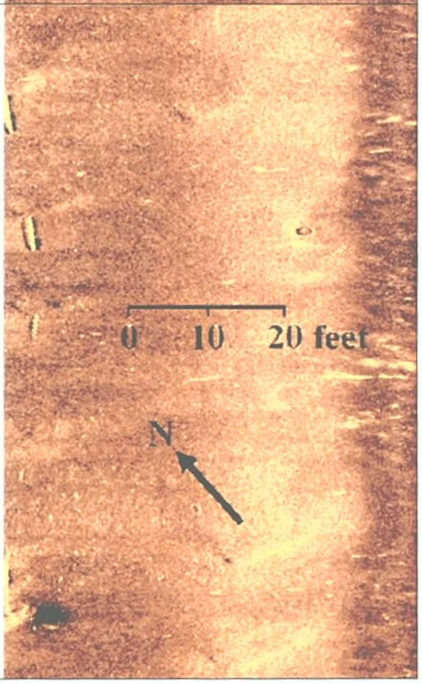
Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS004	1014311	113965	buoy weight	1 × 1 × .5		
SSS005	1014028	114108	irregular target	4 × 3 × 1		
SSS008	1014163	114176	rock-like oval	1 × 1 × .5		
SSS016	982295	130746	irregular target	10 × 3 × .2		

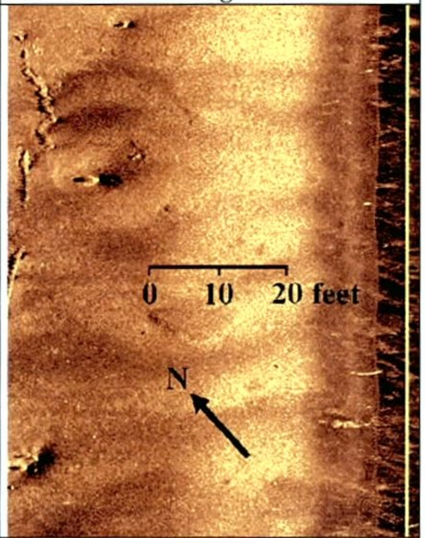
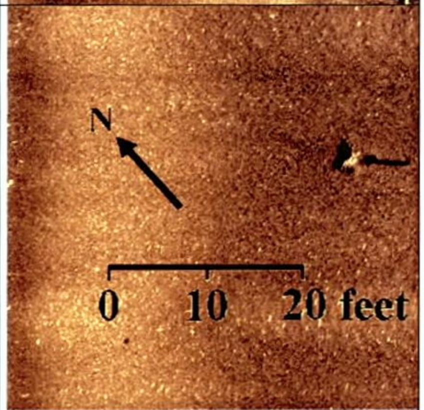
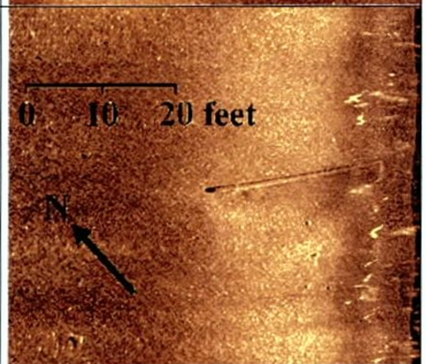
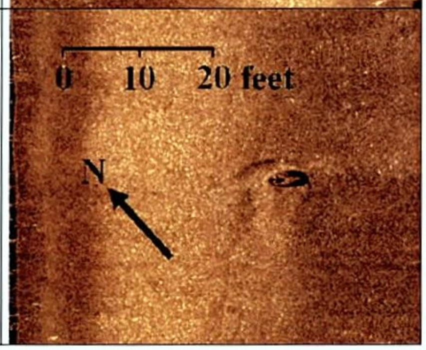
Target	Easting	Northing	Description	L×W×H (m)	Assoc. Anom.	Image
SSS018	979879	133230	irregular debris	2.5 × 2.5 × .2		
SSS020	976309	144478	round	2 × 1 × .2	possibly M0009	
SSS021	976020	146039	irregular small	1 × 1 × .2		
SSS023	980329	132769	debris	20 × 7 × .3		

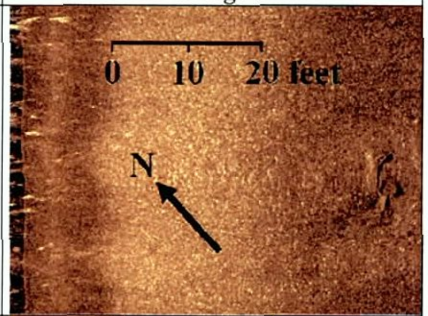
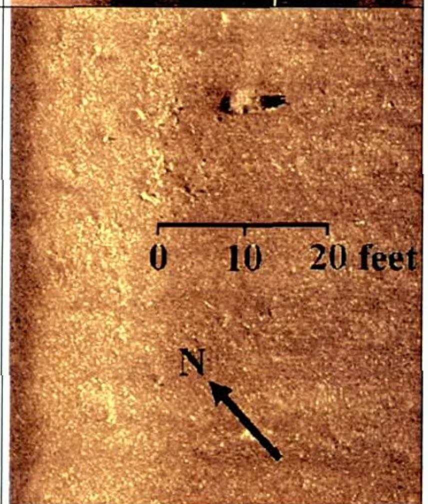
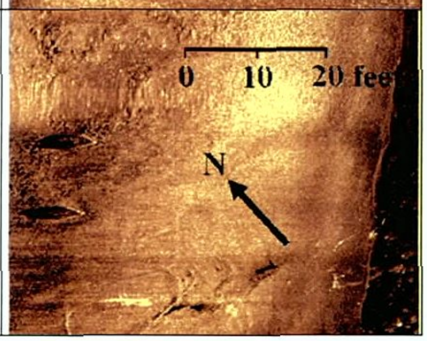
Target	Easting	Northing	Description	L×W×H (m)	Assoc. Anom.	Image
SSS025	978644	135126	debris	5.5 × 2 × .2		
SSS026	980150	133497	buoy weight	1 × 1 × .2		
SSS027	978743	134314	small scattered debris	2 × 1 × .2		
SSS029	1002542	121033	probable buoy weight	2 × 2 × .5		

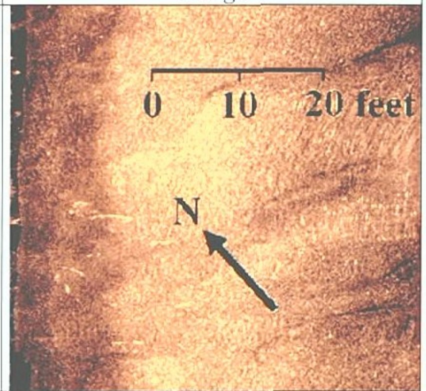
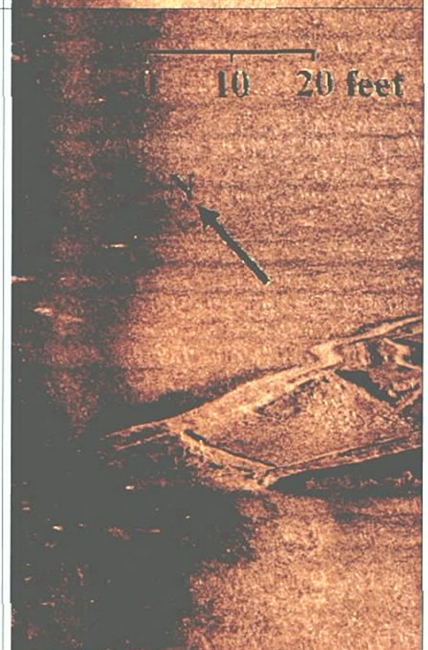
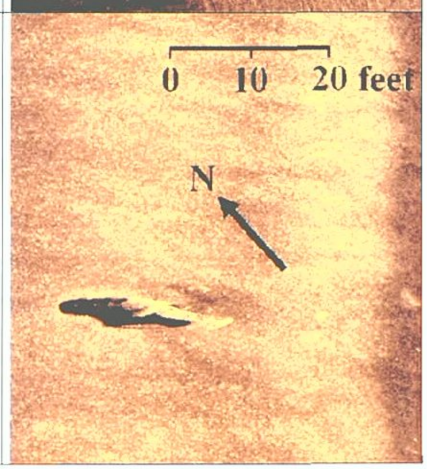
Target	Easting	Northing	Description	L×W×H (m)	Assoc. Anom.	Image
SSS030	1003438	120387	rectangular with segments, misc. debris	5.3 × 1.5 × .5		
SSS031	100392	120297	multiple debris	4 × 2.7 × .5		
SSS032	987327	129514	debris with relief	3 × 1 × .5		
SSS035	978108	134934	debris	8 × 4 × .2		

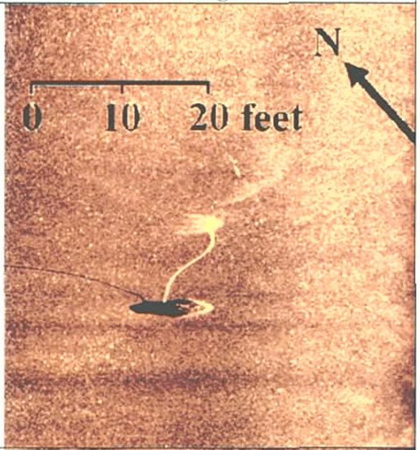
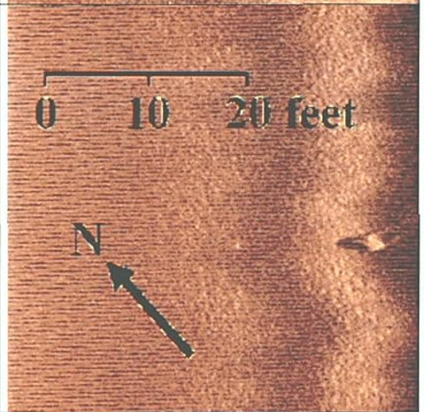
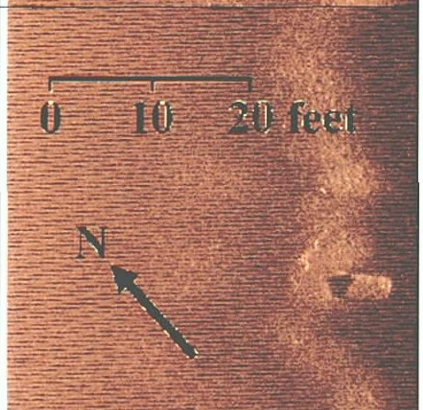
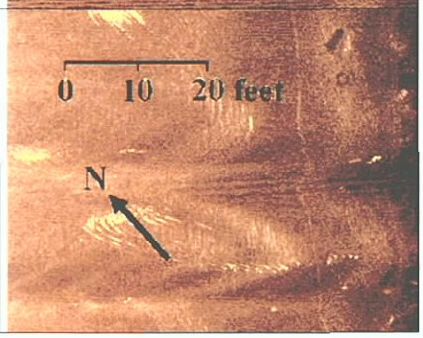
Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS038	975536	146211	debris, possible buoy weight	7 × 1.5 × .1		
SSS040	977758	136020	rocks	1 × 1 × 1		
SSS041	978194	135016	rocks, debris	10 × 4.5 × .2		
SSS042	978418	134686	irregular debris	5 × 2 × .2		

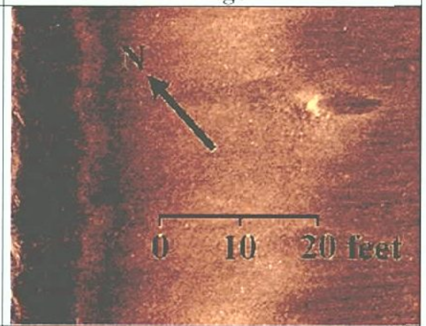
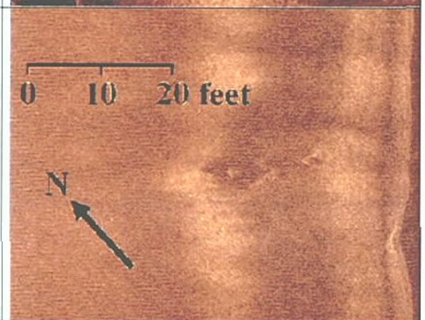
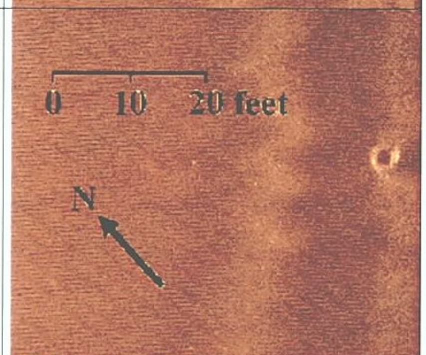
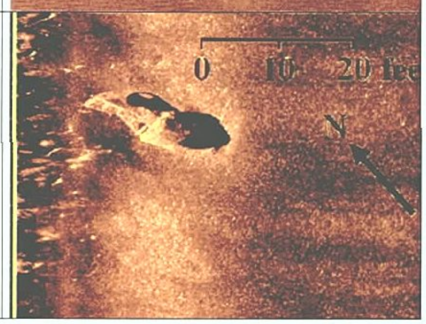
Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS043	984786	129084	small rocks and debris	6 × 3 × .2		
SSS050	978735	135183	debris	3.5 × 1.5 × .2		
SSS051	976543	144312	debris	8 × 2 × .1		

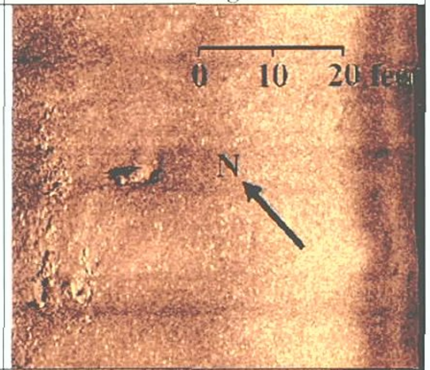
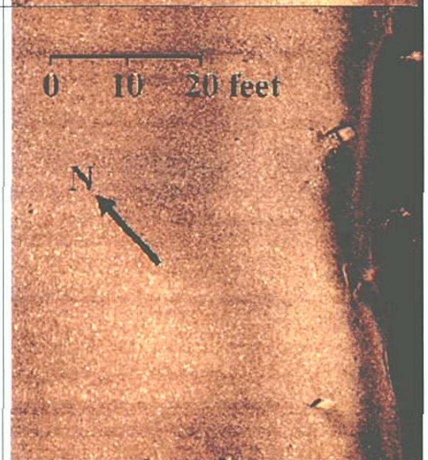
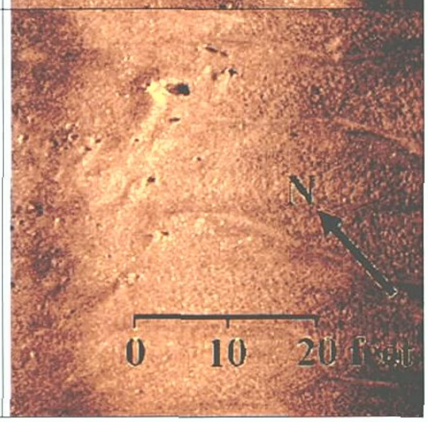
Target	Easting	Northing	Description	L×W×H (m)	Assoc. Anom.	Image
SSS054	976412	144932	debris	27 × 5 × .3	possibly M0006, possibly M0007	
SSS055	976241	145722	debris	2 × 3 × .2		
SSS056	976062	146580	linear-pipe	9 × .3 × .3		
SSS058	975616	148709	circular - tire	2 × 2 × .2		

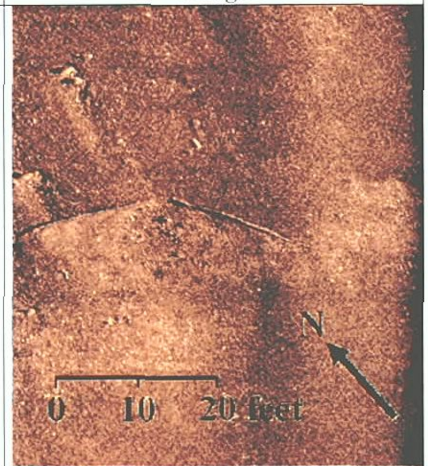
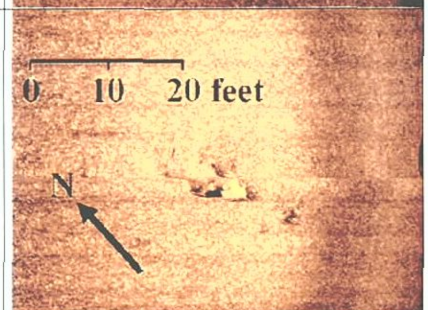
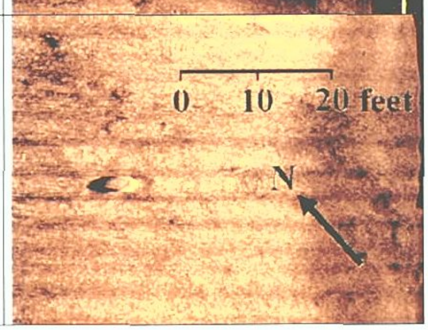
Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS059	975401	149704	debris	6.5 × 2 × .2		
SSS060	974223	154927	wreck - barge	25 × 12 × 2	M0001	
SSS062	975916	147507	debris	2 × 2 × .3		
SSS067	986942	128990	two buoy weights	1 × 1 × .2		

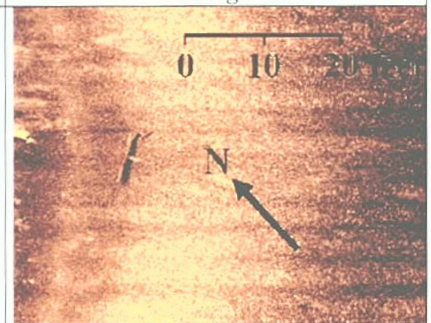
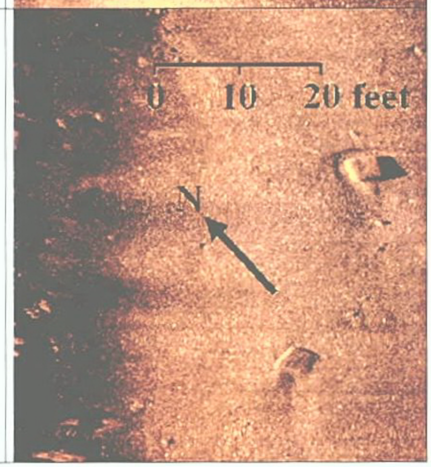
Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS070	980903	132309	rock? concrete? large rectangle	3.5 × 1.5 × .4	M0014	
SSS073	974307	154958	barge wreck	20 × 7 × 1	M0001	
SSS078	977817	139082	sunken navigation buoy	5 × 2 × 2	M0012	

Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS079 bouy	980123	133482	buoy weight	1 × 1 × .5		
SSS086	1015083	114057	rectangular target	1 × 1 × .5		
SSS087	1016868	113149	rectangular target	1.5 × 1.5 × 1		
SSS088	1013739	114797	rectangular and circular	2.3 × 1 × .4		

Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS090	978755	134557	square	2 × 2 × .5		
SSS106	975972	145784	odd irregular target	6 × 3.25 × .2	M0004	
SSS107	976259	144414	round target, large tire?	3 × 1.5 × .3	possibly M0008	
SSS118	977860	139133	sunken navigation buoy	6 × 2.5 × 2.5	M0012	

Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS121	976056	147584	rough area, debris	15 × 4 × .2		
SSS130	981704	131602	navigation buoy weight	1 × 1 × .3		
SSS131	981795	131510	navigation buoy weight	1 × 1 × .5		

Target	Easting	Northing	Description	L× W× H (m)	Assoc. Anom.	Image
SSS133	983102	130837	debris, linear target	11 × 3 × .2		
SSS141	974192	156057	buoy weight	1 × 1 × .3		
SSS142	974150	156370	irregular target	35 × 9 × .3		
SSS143	974237	156079	buoy weight	1.3 × 1.3 × .3		

Target	Easting	Northing	Description	L×W×H (m)	Assoc. Anom.	Image
SSS144	975869	149189	linear target	4.3 × .2 × .2		
SSS145	981704	131682	multiple buoy weights	2 × 1.5 × .3		

Additional Targets

In addition to the survey of the northern and southern areas of the channel and the remote sensing refinement of selected targets, the project also included the examination of seven additional targets (Table 4-03). These included four shoal areas, designated Shoals A, B, C, and D, located within previously dredged areas (Figures 4-42 and 4-43), and three obstructions in the vicinity of the Sandy Hook Pilot Area at the eastern end of Ambrose Channel (Figure 4-44). The three Sandy Hook Pilot Area targets, shown on Figure 4-44 as High Spot A, High Spot B, and High Spot C, are designated WK52, OBSTN53, and OBSTN52, respectively, in this report. Two of the shoals, Shoals A and B, were not included as part of the Scope of Work, but were refined as part of this investigation since they were in close proximity to other targets. Each of the seven additional targets was refined using magnetometer, subbottom profiler, and sidescan sonar. The purpose of the investigation of these areas included two objectives: to determine the potential significance of each target and to determine the extent and volume of material present.

Table 4-03. Additional targets investigated.

Target	E	N
Shoal A	973038	154480
Shoal B	973008	154250
Shoal C	974681	146822
Shoal D	974692	146556
High Spot A (WK52)	1019023	108448
High Spot B (OBSTN53) (center)	1022470	107551
High Spot C (OBSTN52)	1030310	108166

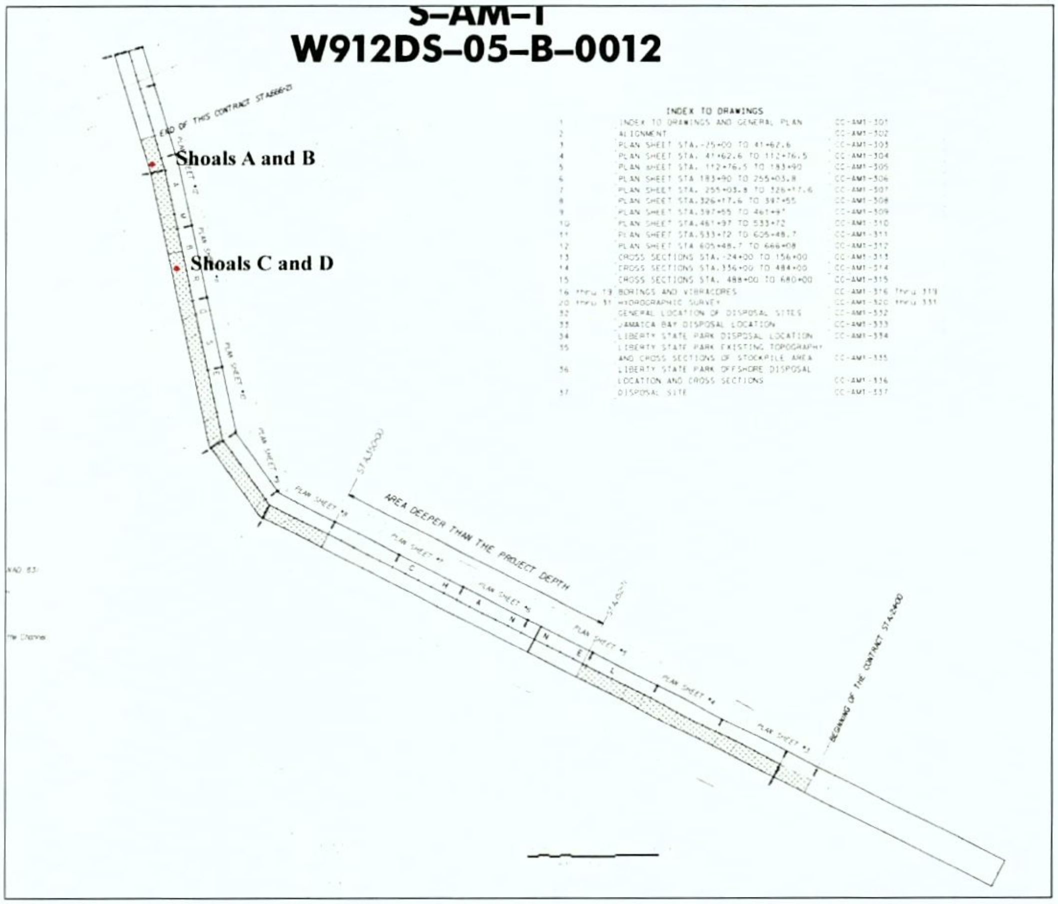


Figure 4-42. Location of Shoals A, B, C, and D (base map courtesy of the U.S. Army Corps of Engineers, New York District).

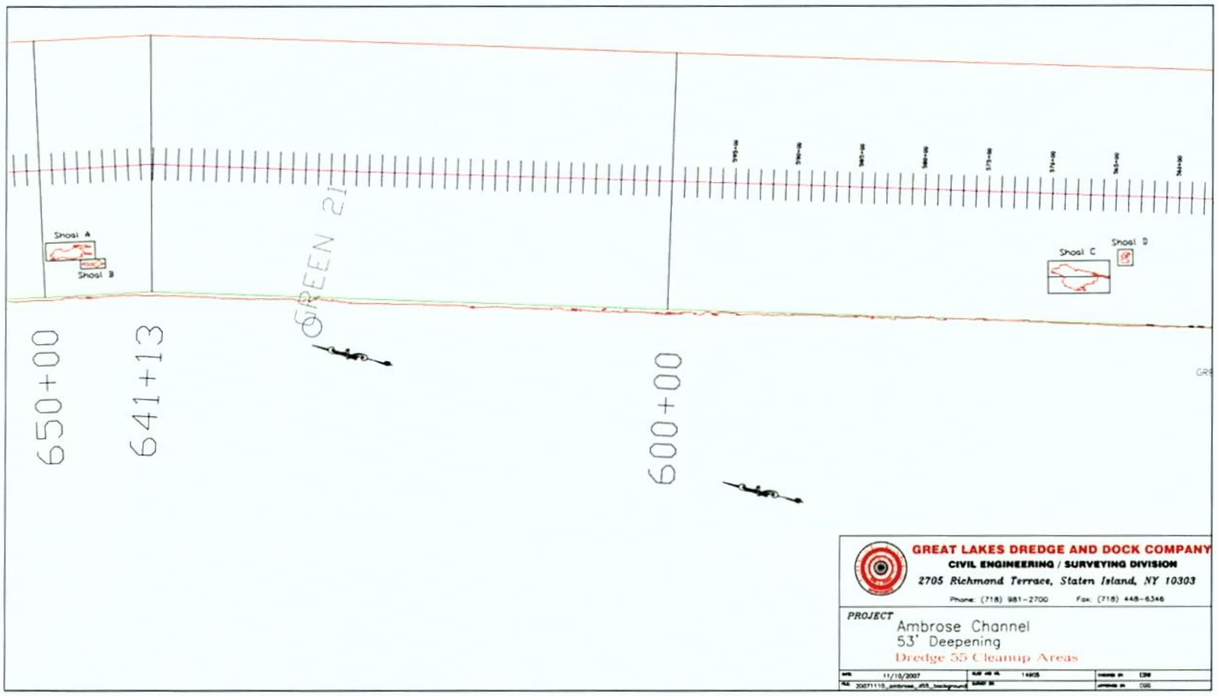


Figure 4-43. Shoal areas A, B, C, and D (courtesy of the U.S. Army Corps of Engineers, New York District).

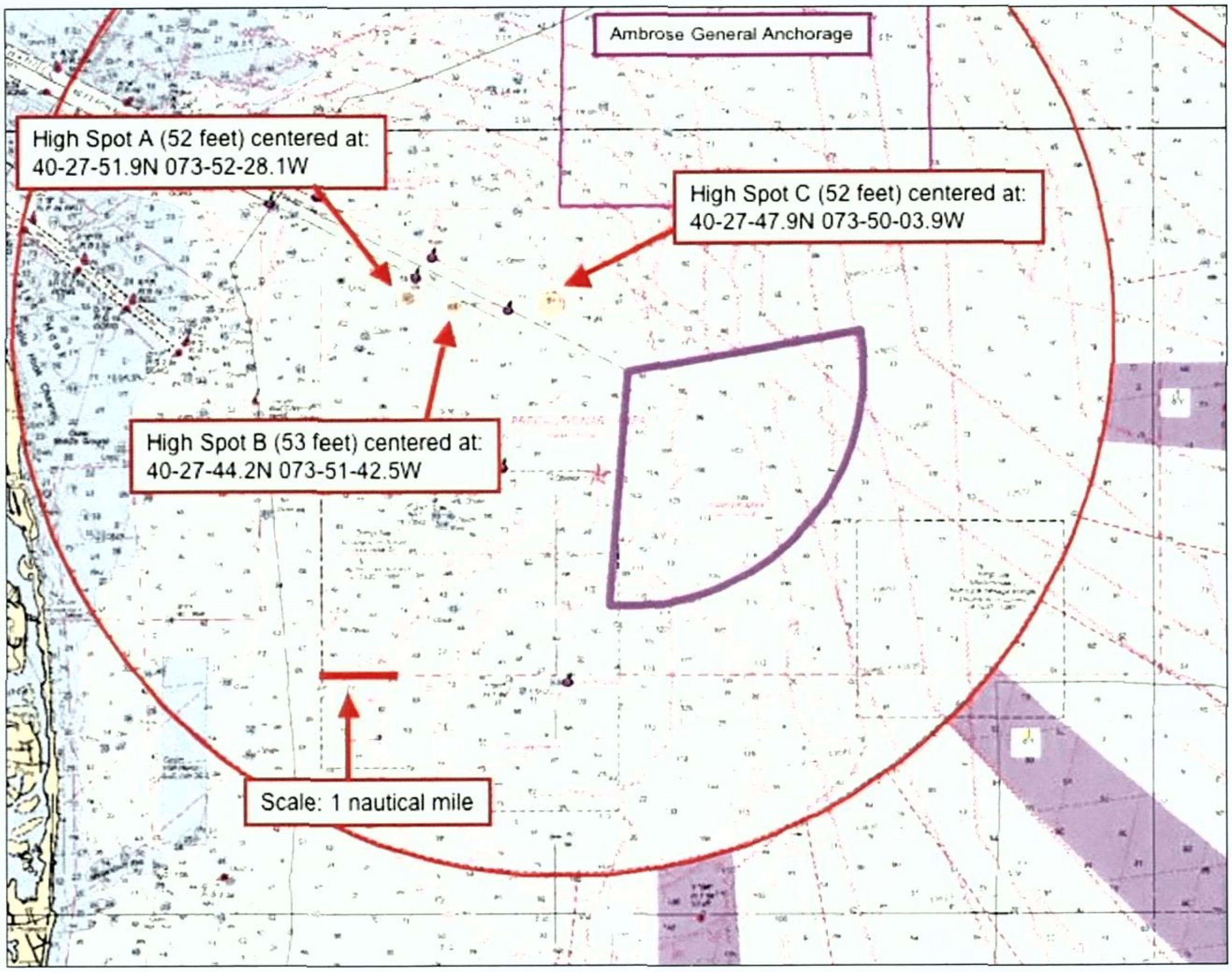


Figure 4-44. Three obstructions investigated in the pilot area at the easternmost end of Ambrose Channel (*map courtesy of* the Sandy Hook Pilot's Association).

Shoals A and B

Shoal A (973038 E and 154480 N) and Shoal B (973008 E and 154250 N) consist of two separate but closely spaced targets that are likely part of the same site or debris field (Figure 4-45). The site was refined with magnetometer, sidescan sonar, and subbottom profiler. The investigation revealed two distinct magnetic anomalies, one at each shoal. The larger anomaly, a dipole of 157-gamma strength and 255-foot duration coincides with Shoal A, while the smaller of the two, a monopole of 90 gamma strength and 58-foot duration, is centered over Shoal B (Figure 4-46). Sidescan sonar data analysis revealed a multiple component debris field (Figures 4-47 and 4-48). Close examination of the debris field did not reveal an articulated hull structure indicative of a wreck site, although a wood-hulled vessel, depending on age, may suffer degradation to the point of the hull no longer being extant. Comparison of the magnetometer and sidescan sonar data (Figure 4-49) revealed that the larger component of the magnetic anomaly is primarily associated with the eastern half of Shoal A, with the smaller component associated with the southernmost area of the site, or Shoal B, indicating that the majority of the ferrous components are located in these areas of the target. In any case, it is apparent that given the relatively large magnetic anomalies associated with the two shoal areas, the sidescan sonar image represents a rather extensive field of ferrous debris.

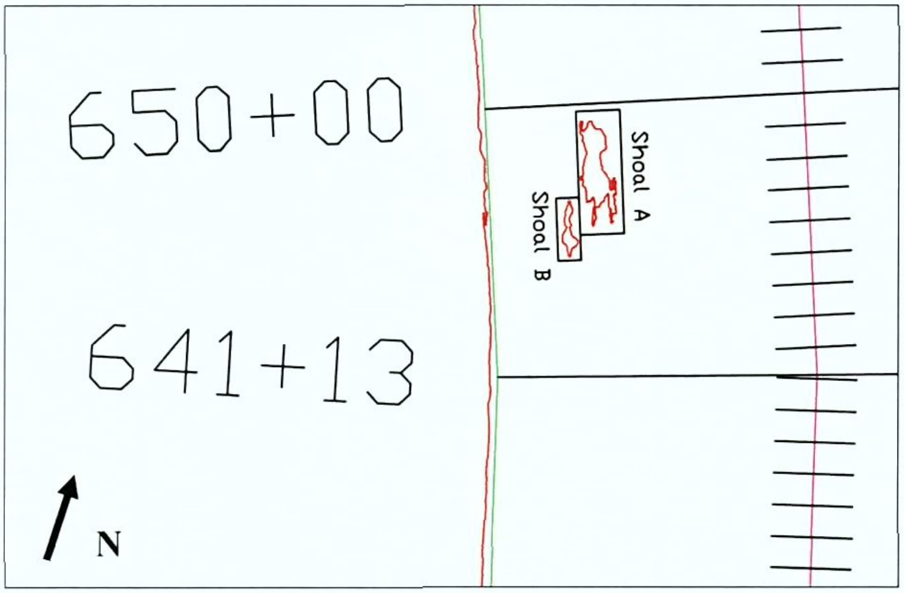


Figure 4-45. Shoals A and B.

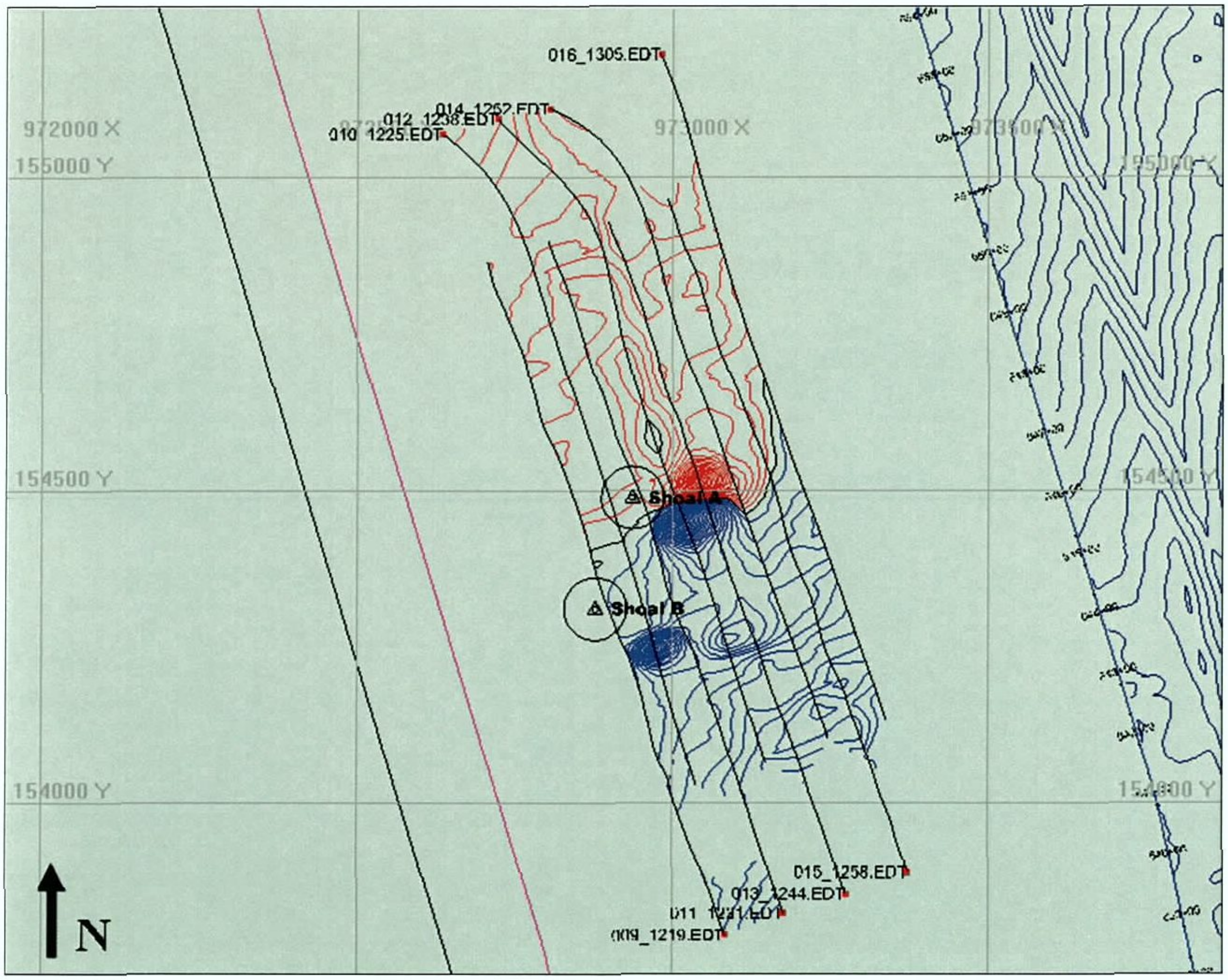


Figure 4-46. Magnetic contour map of Shoals A and B.

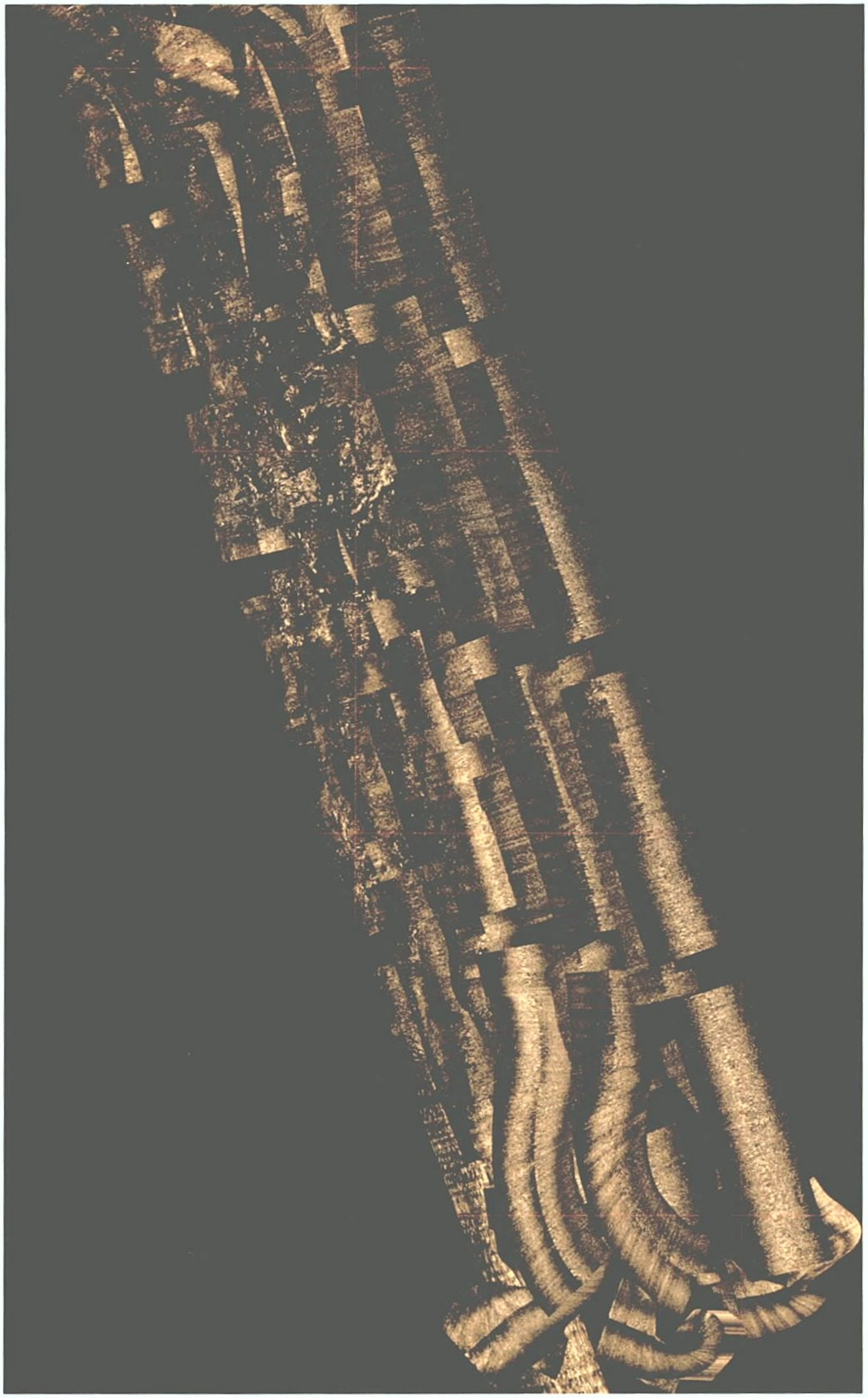


Figure 4-47. Sidescan sonar mosaic of Shoals A and B.

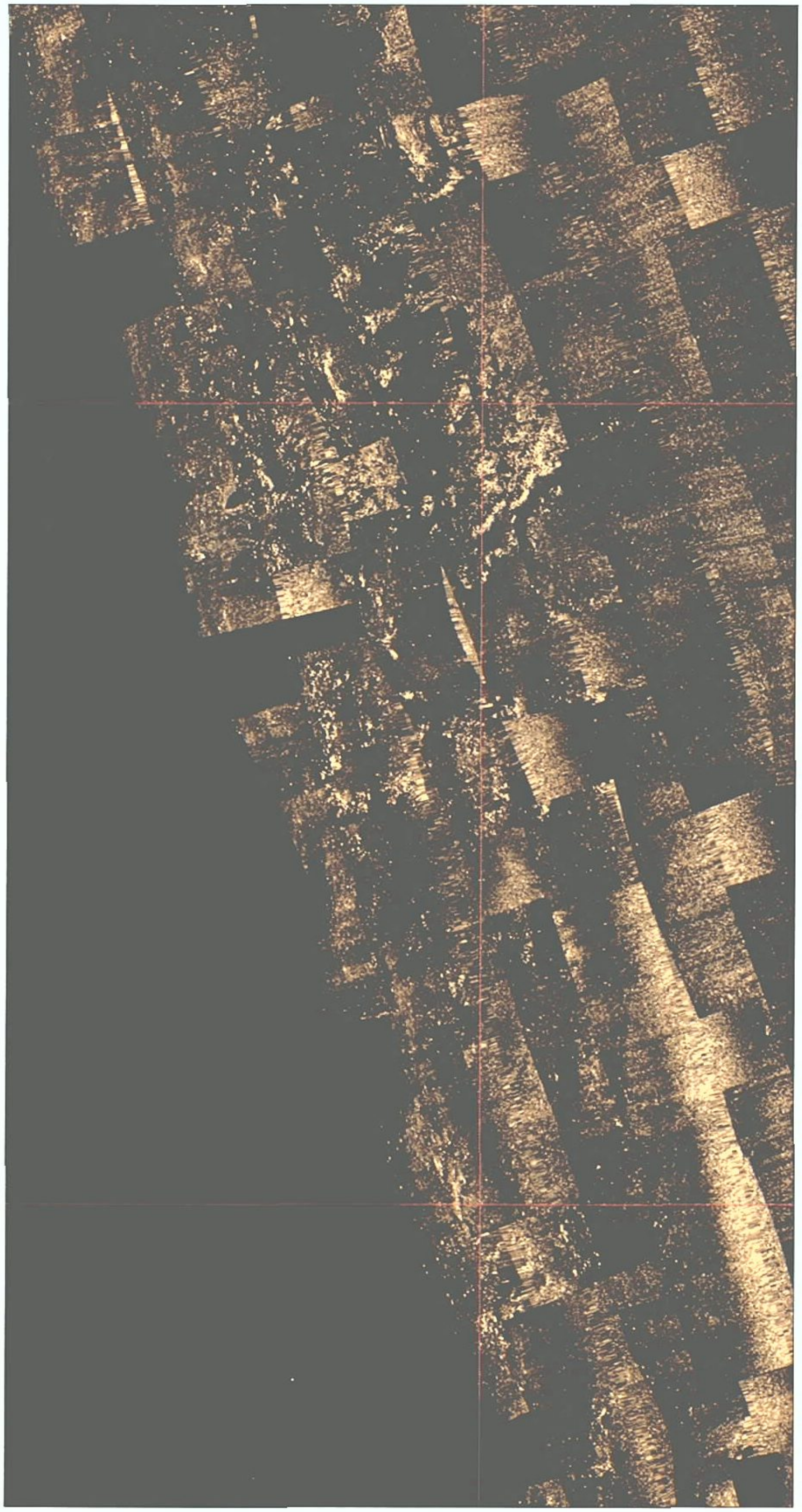


Figure 4-48. Close-up of Shoals A and B.

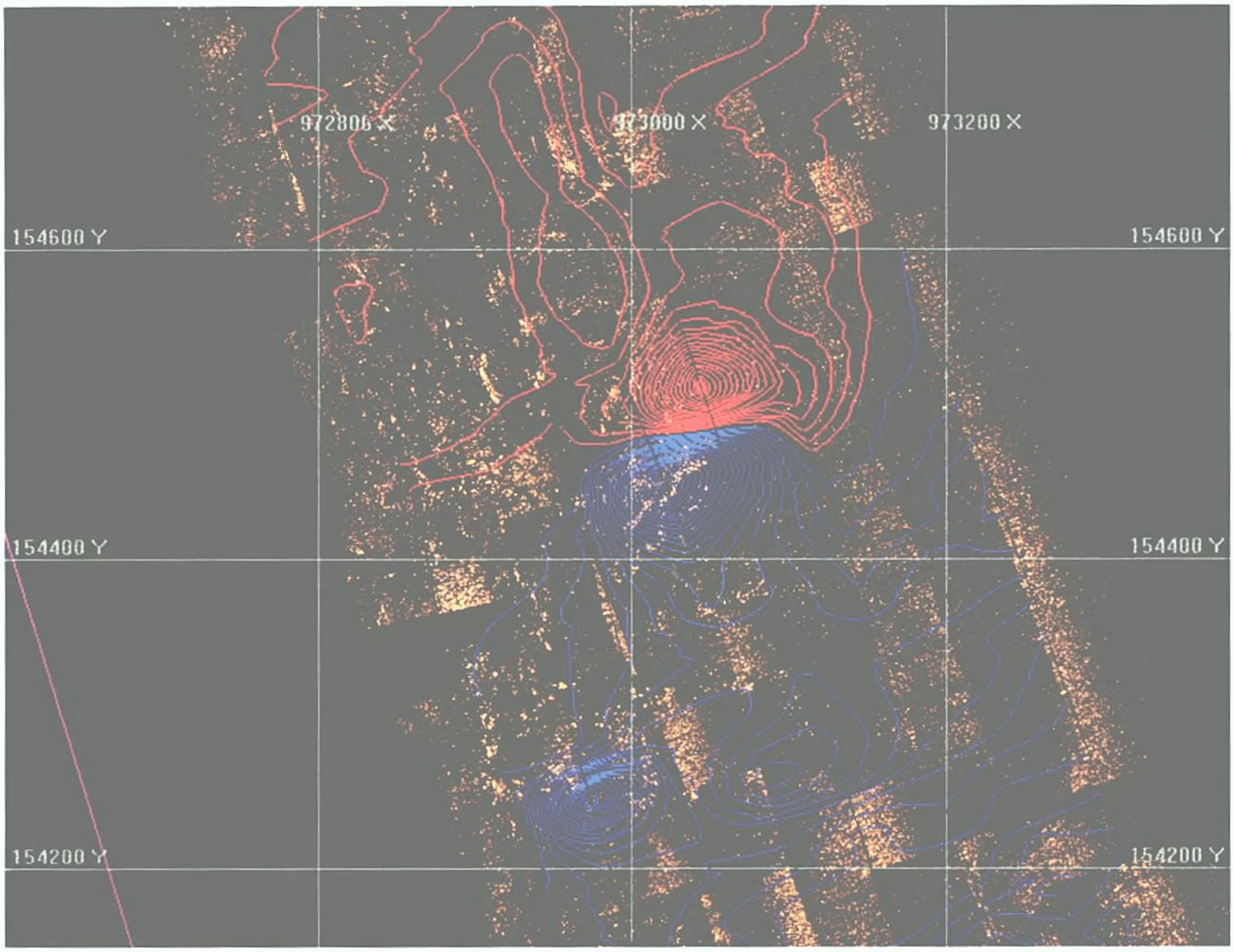


Figure 4-49. Magnetic contour map superimposed over sidescan sonar mosaic.

Analysis of the subbottom data did not indicate a significant large mass of material at either location (Figure 4-50). While the possibility exists that Shoals A and B represent a historic shipwreck site, it is not included in the SOW, is located in a completed construction area, and is not recommended for further investigation.

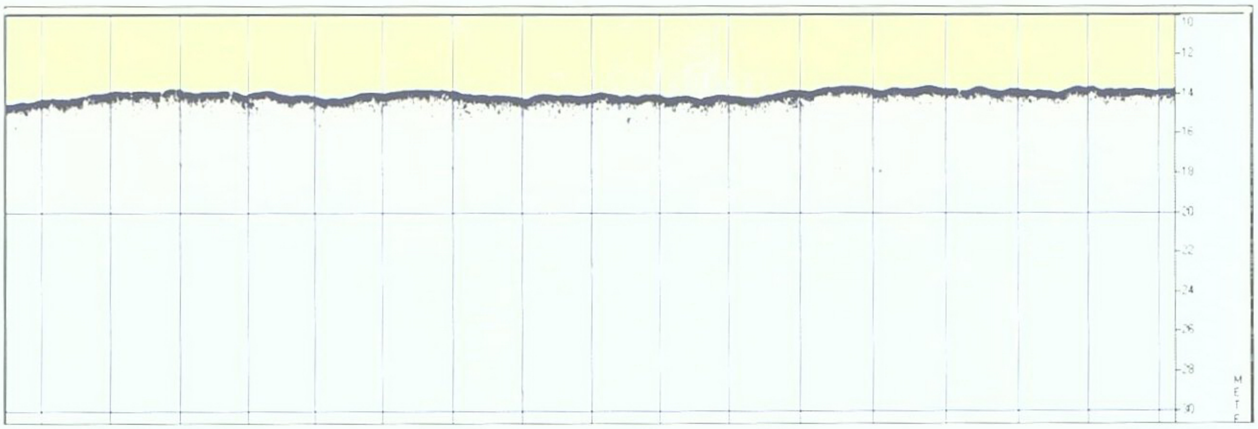


Figure 4-50. Subbottom image of Shoals A and B.

Shoals C and D

Shoals C and D, located at 974681 E and 146822 N, and 974691 E and 146556 N respectively consist of two separate but closely spaced targets that are likely part of the same site or debris field (Figure 4-51). The site was refined with magnetometer, sidescan sonar, and subbottom profiler. Analysis of the magnetic data (Figure 4-52) revealed a large complex dipole anomaly appearing across seven survey lines (350 feet), and measuring 338 gamma in strength and 600 feet in duration. Such an anomaly, particularly one extending over multiple survey lines and associated with a sidescan sonar target, is typically indicative of a shipwreck site. Analysis of sidescan sonar data revealed the existence of two distinct debris fields (Figures 4-53 and 4-54) coinciding with each of the two shoals. Shoal C measured approximately 400 feet square, while Shoal D measured 100 feet N-S and 70 feet E-W. No readily apparent articulated wreck sections were noted in the debris, although the area had been previously dredged and structural elements were recovered in the dredge spoil, indicating the hull structure might be either buried in the sediment or broken up. Analysis of the subbottom profiler data confirmed the presence of a large amount of solid debris over the target area, with a buried mass measuring 40 feet in a north-south direction. This mass extended 1.5 meters below the bottom in the location of Shoal D, and a large surface mass measuring 200 feet in a north-south direction in the vicinity of Shoal C (Figure 4-56).

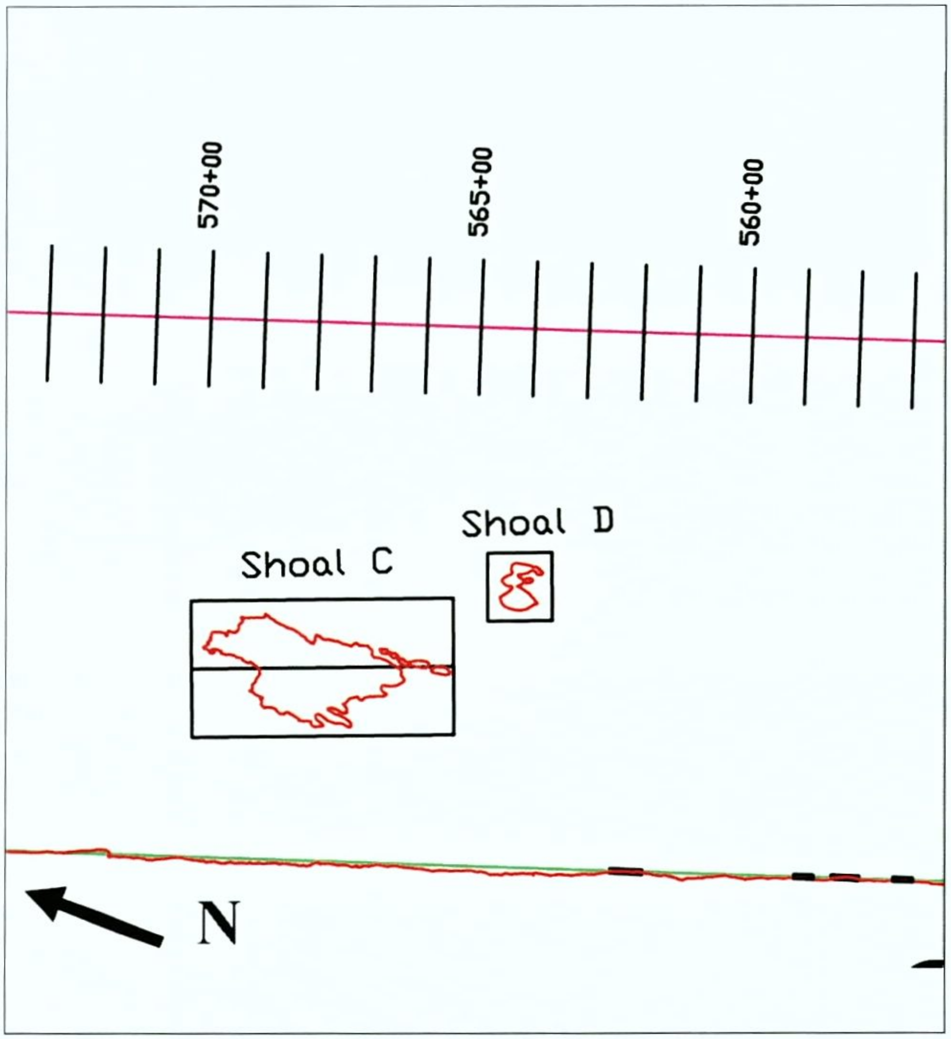


Figure 4-51. Shoal C and Shoal D.

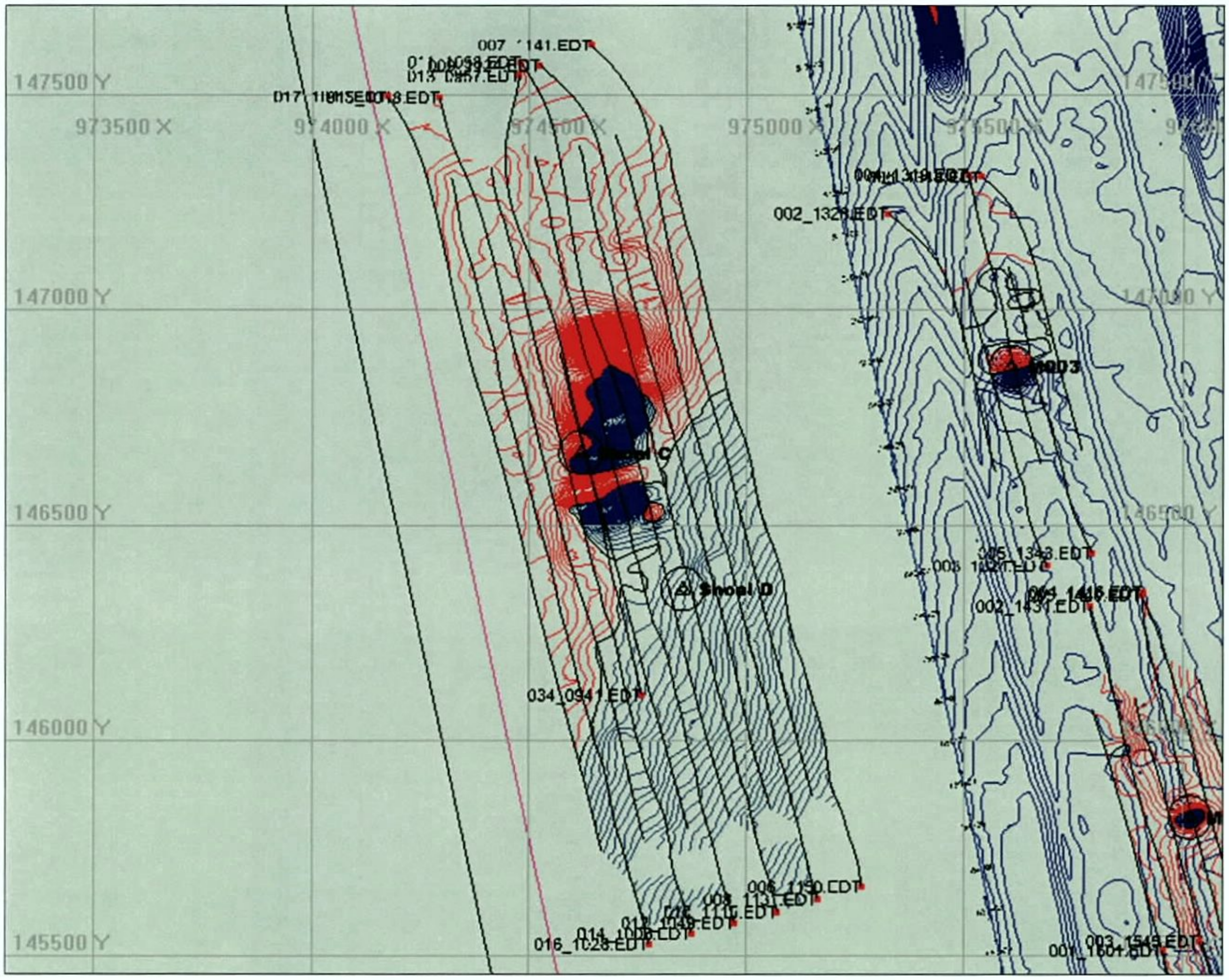


Figure 4-52. Magnetic contour map showing Shoal C and Shoal D.

It is apparent that Shoals C and D represent a debris field of considerable size, and that the site does in fact meet the established electronic signature criteria for the existence of submerged cultural resources. While it is possible that the debris field is the result of dumping, a strong possibility still exists that the site is representative of significant submerged cultural resources, and it is recommended that this site be evaluated by a qualified maritime archaeologist before additional construction activities. Lending credence to this statement, as discussed previously in Table 2-03 above, Shoal C is the location of AWOIS listing 744 that is described as a "wreck, old ship hull, debris piles."

Also investigated as part of this project were three obstructions in the pilot area at the easternmost end of Ambrose Channel (see Figure 4-44). Although these targets have been investigated previously as part of the NOAA AWOIS program, they had not yet been evaluated for historical significance prior to this investigation.

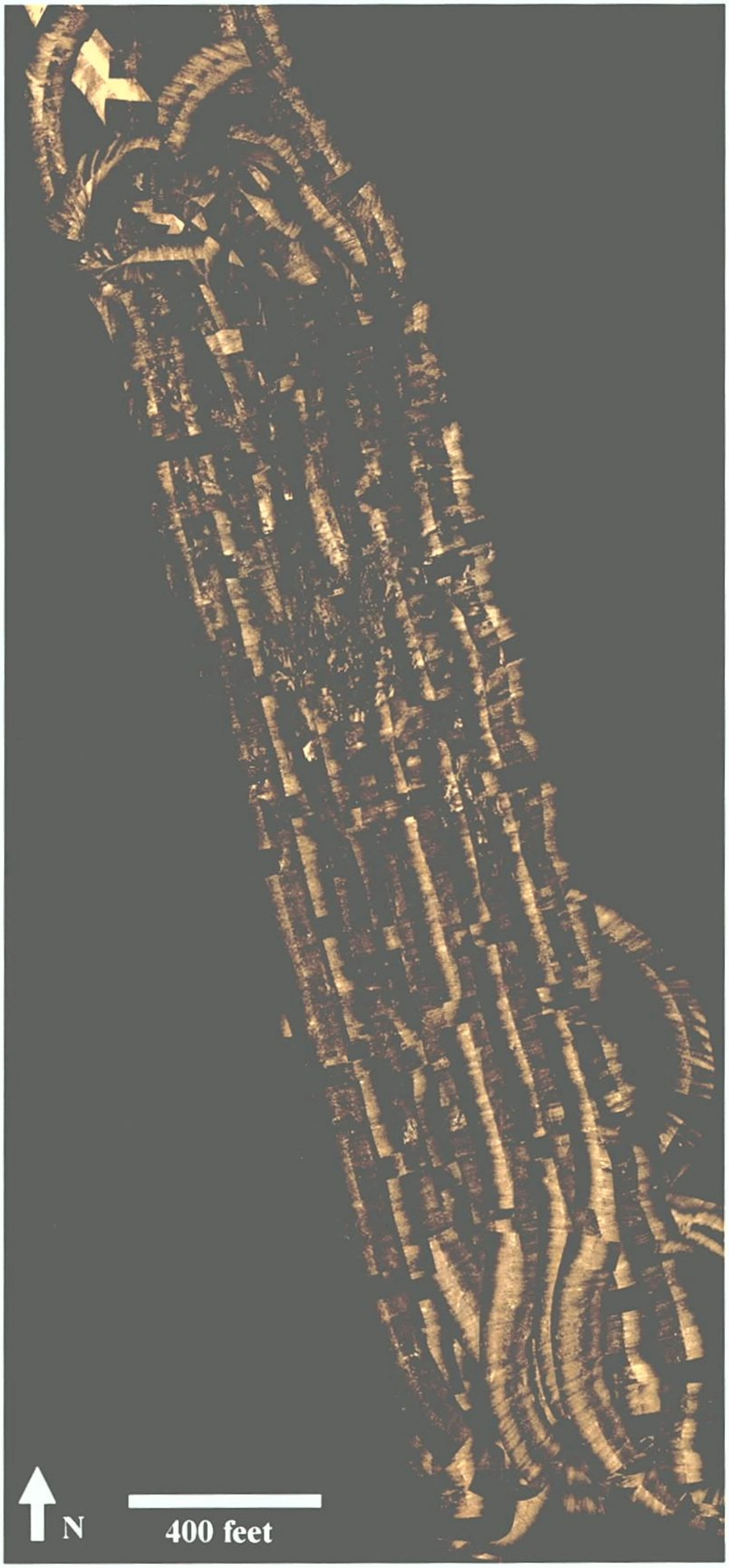


Figure 4-53. Sidescan sonar mosaic of Shoals C and D.

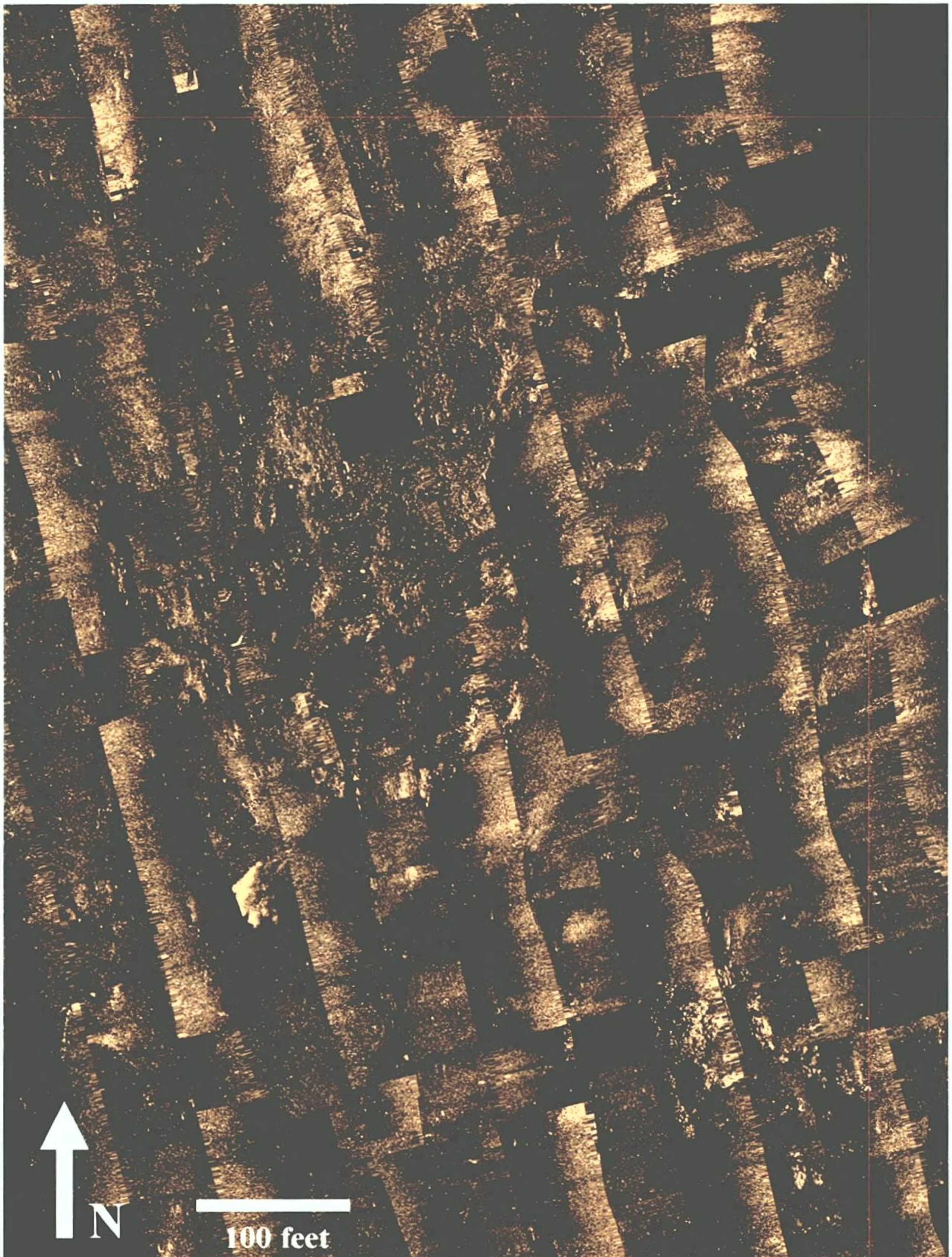


Figure 4-54. Close-up of Shoal C (north) and Shoal D (south).

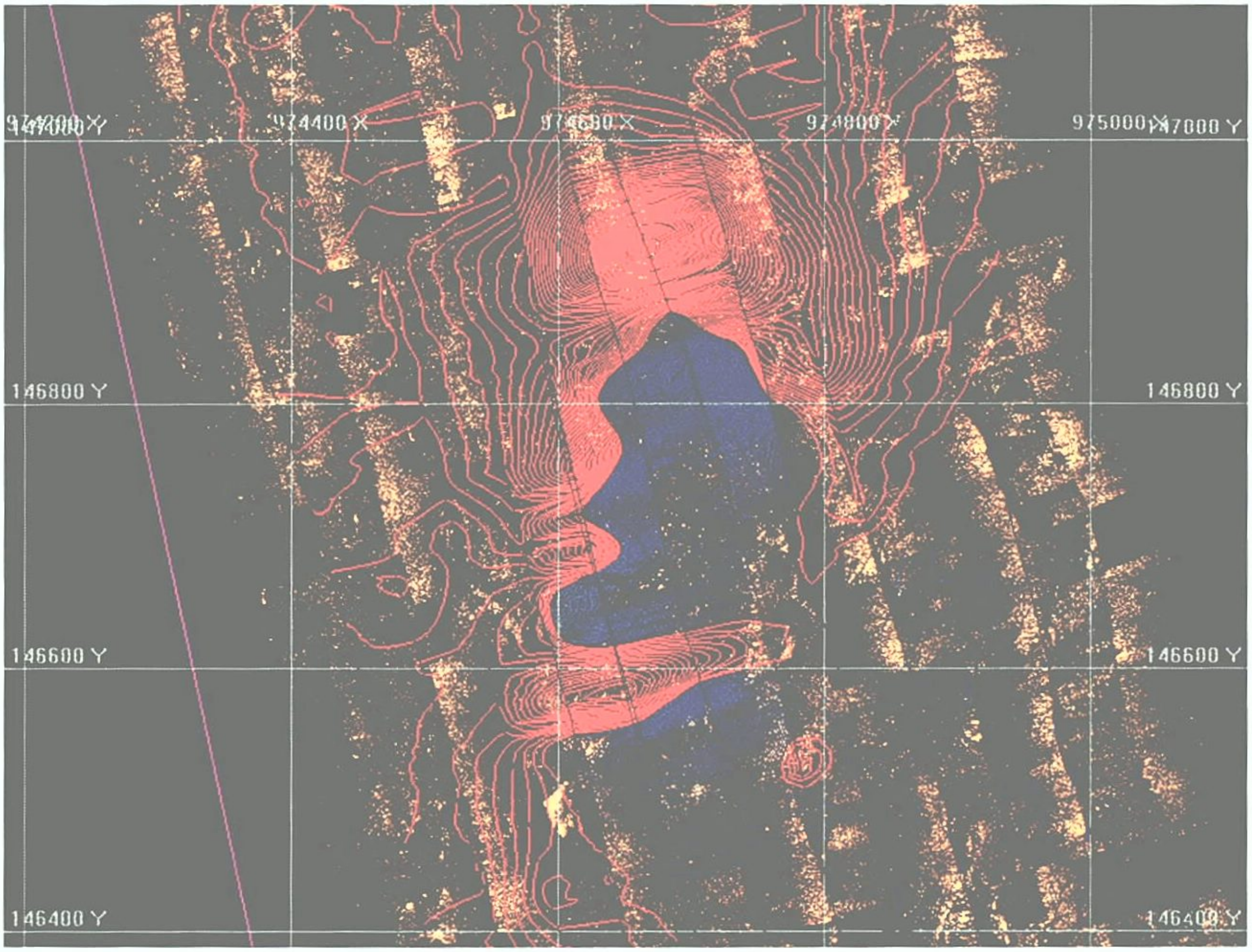


Figure 4-55. Shoals C and D mosaic with magnetic contour map.

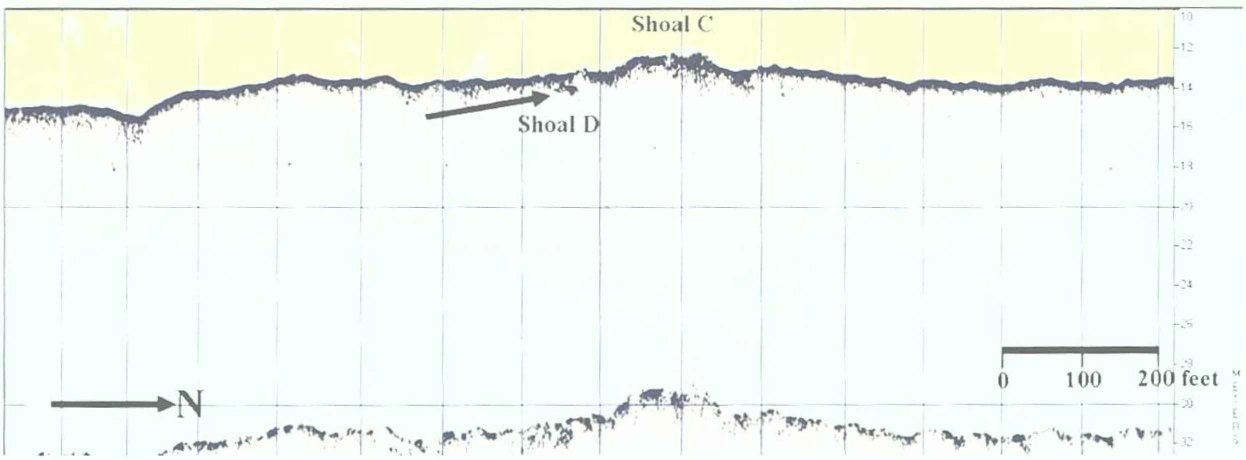


Figure 4-56. Subbottom image of Shoals C and D.

High Spot A (WK52)

Appearing on the NOAA navigation charts as a shipwreck at a depth of 52 feet, this target was previously investigated by NOAA dive teams during 1986 (AWOIS No. 1619, see Table 2-03 and Figure 2-07 in Chapter 2, *Historical Background*). It was determined to be the remains of a derrick barge with shipyard debris that was sunk in 1946, along with the remains of a second iron-hulled oceangoing vessel with boilers (Figure 4-57). It is located at 1019023 E and 108448 N.

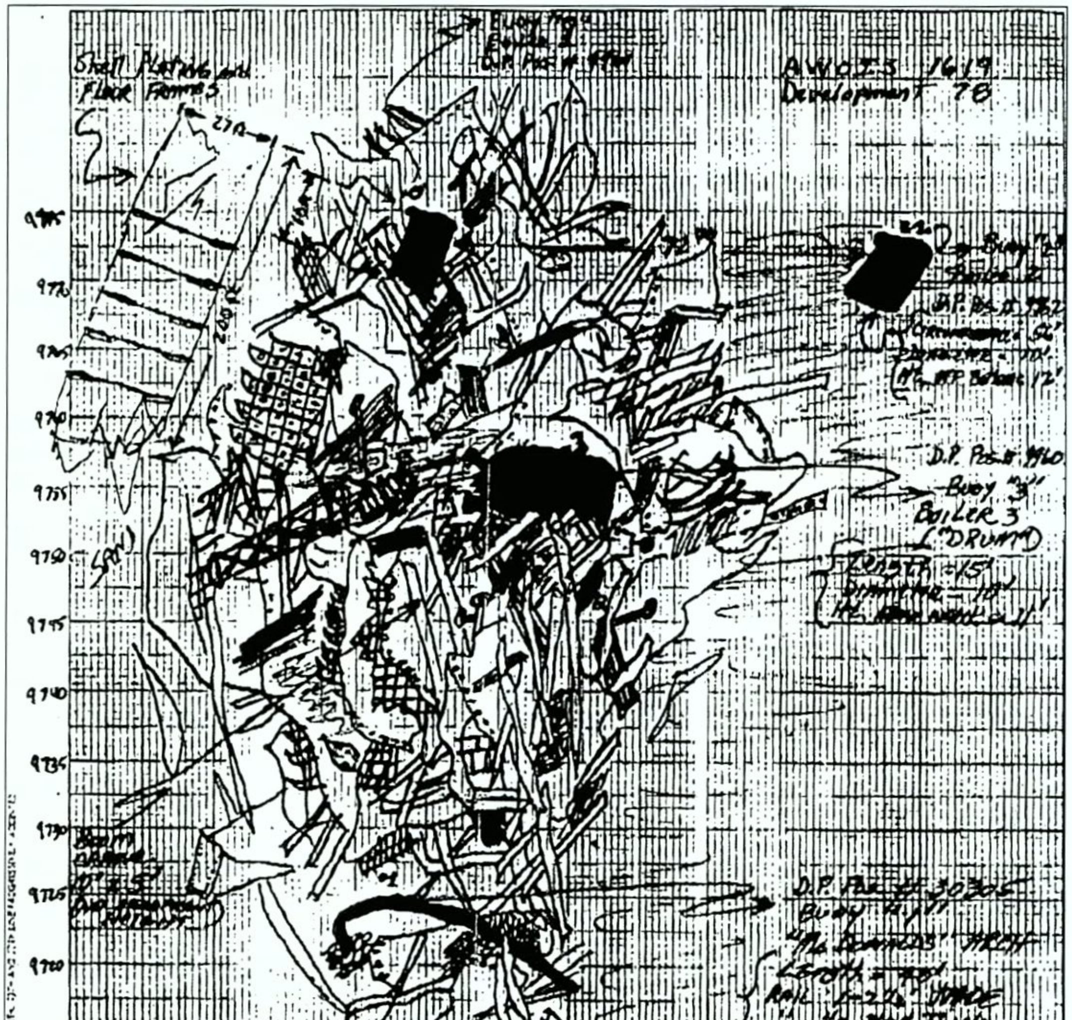


Figure 4-57. Sketch map of High Spot A, taken in 1986 (courtesy of NOAA).

The current investigations included a remote sensing refinement utilizing sidescan sonar, subbottom profiler, and magnetometer. A pattern of 22 east to west refinement lines were run, continuing until the magnetic data returned to background in the four cardinal directions. Analysis of the resulting magnetic data revealed a classic dipole anomaly with a strength of 9,665 gammas and a duration of 435 feet (Figure 4-58). The magnetic data indicated the shipwreck site to be concentrated at the given coordinates, without any additional outlying sections or debris fields.

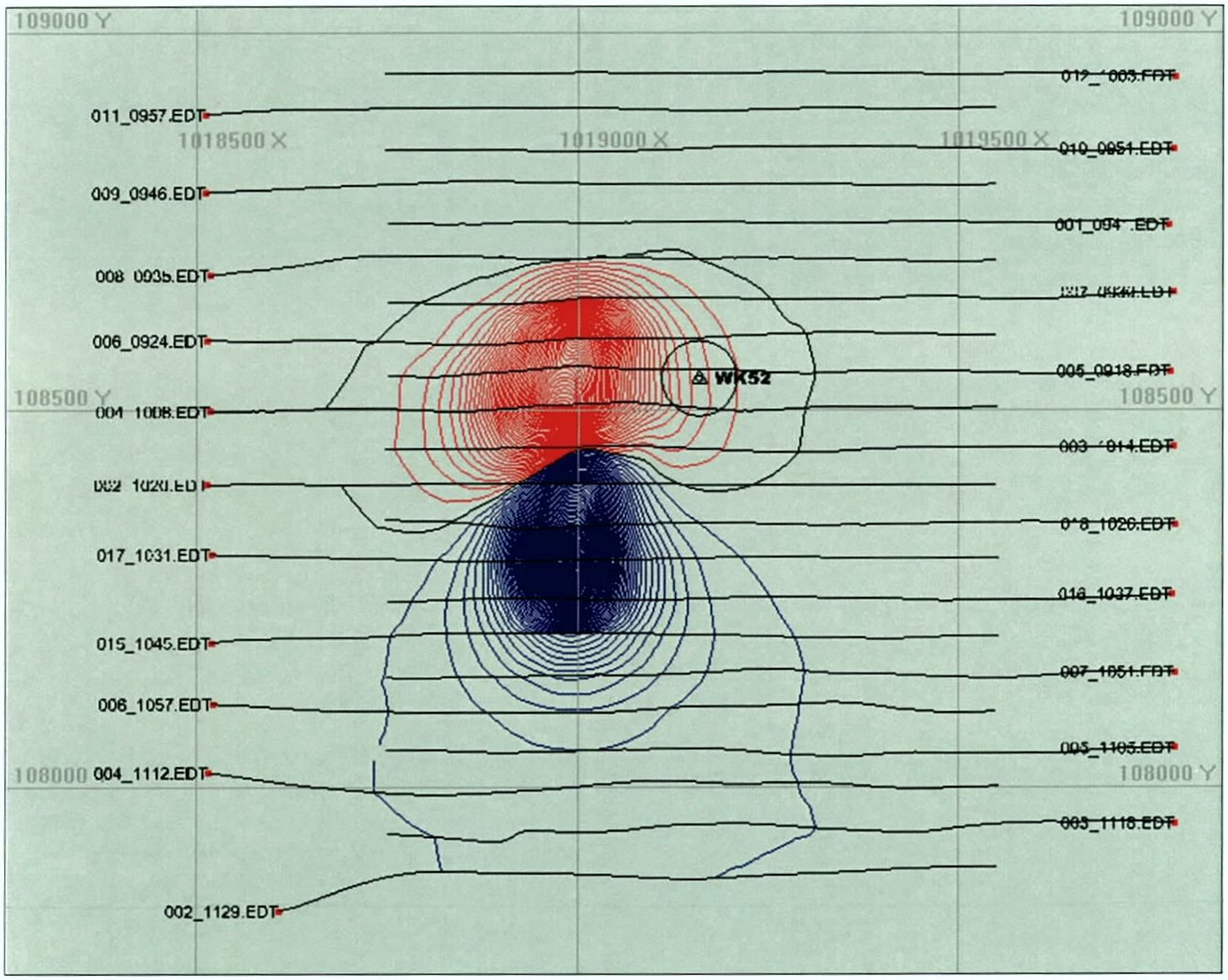


Figure 4-58. Magnetic contour and refinement tracklines of High Spot A.

Examination of the High Spot A sidescan data, both individual files and a mosaic (Figure 4-59), indicated a single component wreck site covered with scattered wreckage. Articulated shipwreck components were noted on the western end of the site, along with two boilers measuring 12 feet in diameter each (Figure 4-60). One of these boilers appears to be *in situ* (Figure 4-61), and the other boiler has been dislocated to outside the shipwreck area (Figure 4-62). The subbottom, while it cannot penetrate below the wreck site in order to determine how deep the deposit extends below the ocean floor, did not indicate the presence of any separate buried sections (Figure 4-63).

NOAA investigations conducted in 1986 and in 1987 determined the site to consist of two separate shipwrecks, including a derrick barge and a steamship, along with assorted marine shipyard debris. There is no reason to discount this assessment based on the remote sensing data alone. However, the positions of the boilers, with one being apparently *in situ*, along with the apparent parallel structure shown in Figure 4-60, indicate that the site may in fact either represent or contain a historic steamship. Indeed, local wreck diving information indicates High Spot A (WK52) to be the location of the steamship *Daghestan*, a British vessel sunk in 1908 by marine accident.

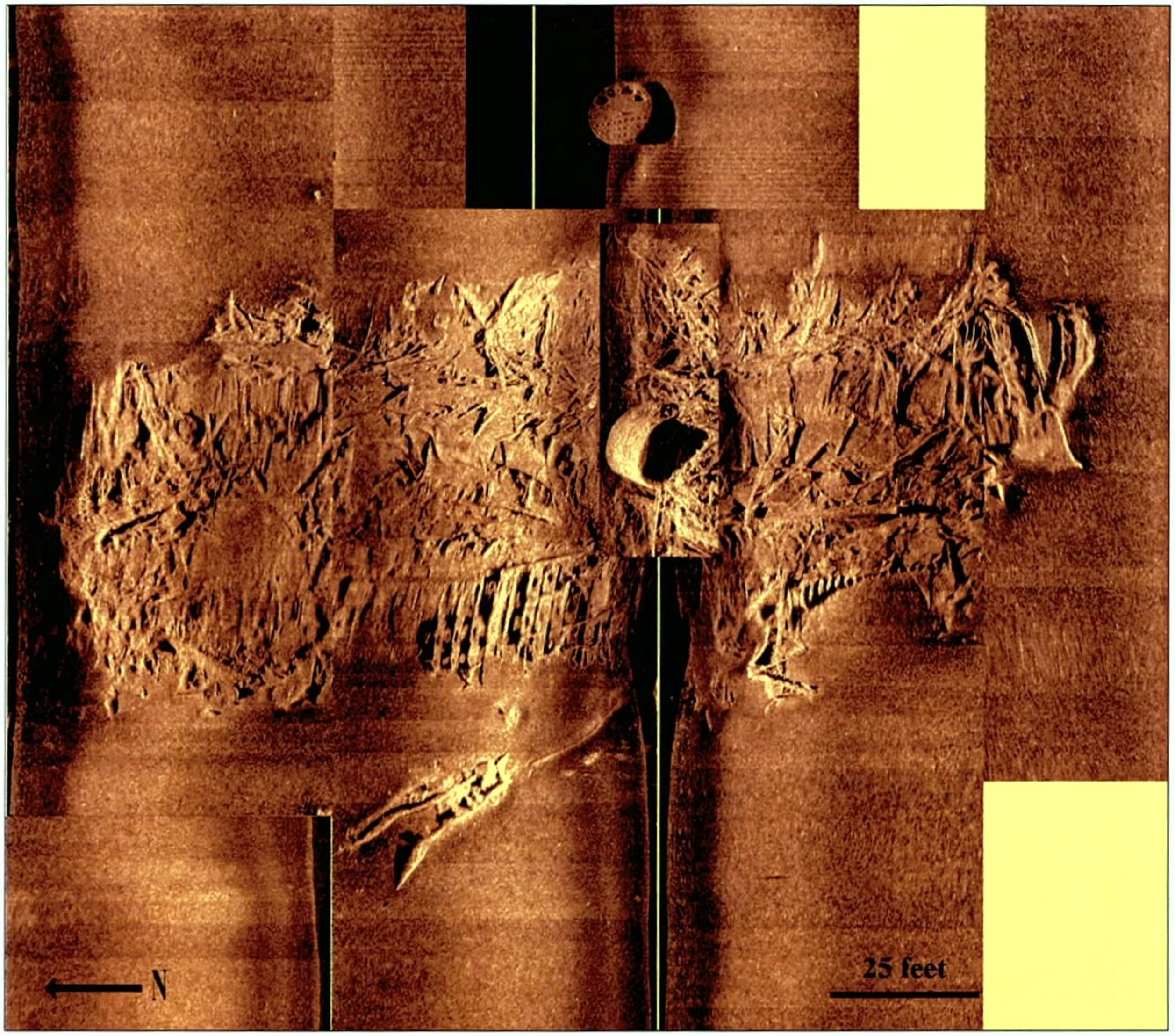


Figure 4-59. Sidescan sonar mosaic of High Spot A.

Figure 4-60. Multiple boilers present at High Spot A.

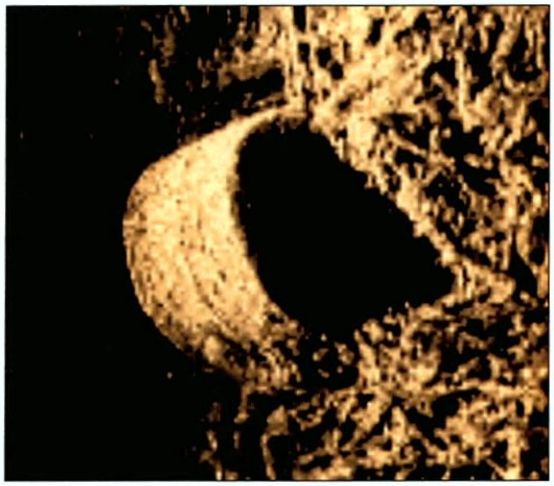


Figure 4-61. Boiler A close-up.

Figure 4-62. Boiler B close-up. Note tube sheet and firebox doors.

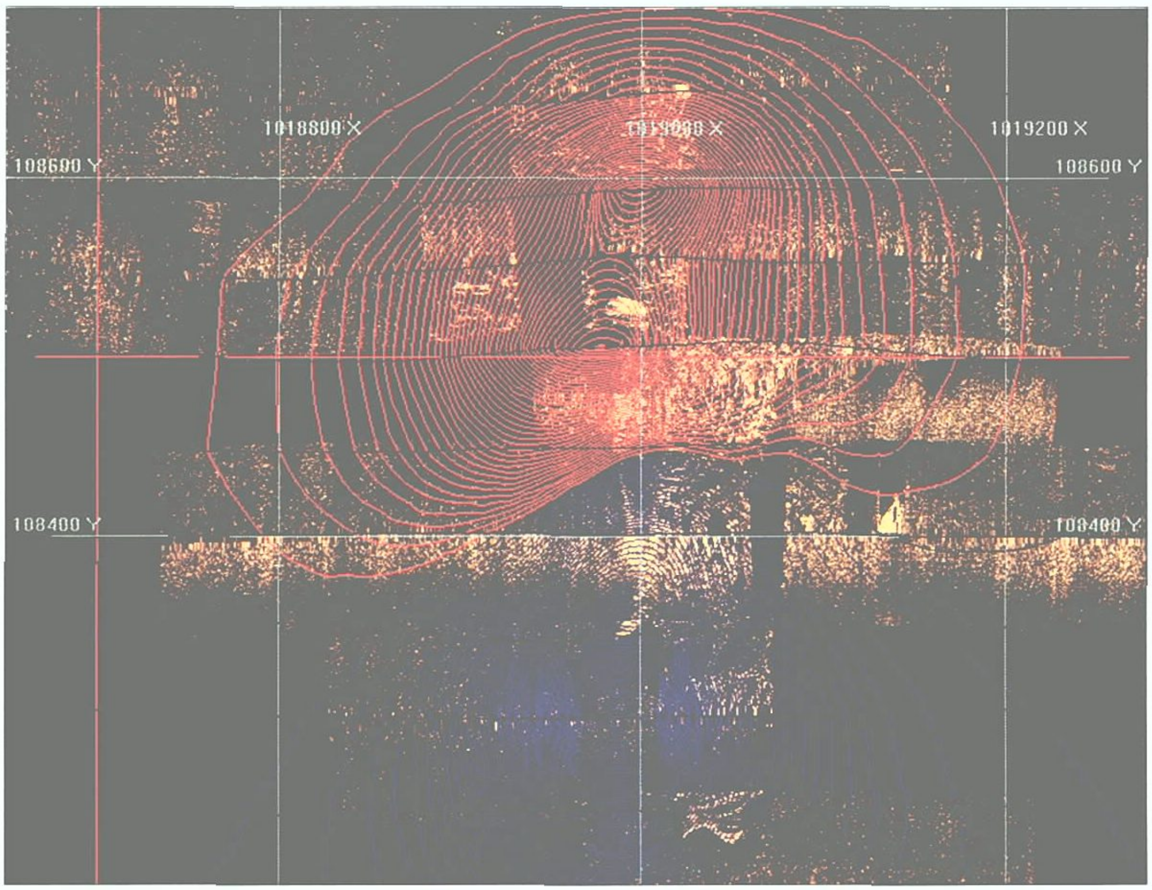


Figure 4-63. High Spot A (WK52) sidescan sonar mosaic with magnetic contour map.

High Spot B (OBSTN53)

Appearing on NOAA navigation charts as an obstruction of 53-foot depth, this target had been previously investigated by NOAA dive teams in 1986 and determined to be a large pile of concrete rubble with rebar (AWOIS No. 7935, see Table 2-03 above). Current investigations included a remote sensing refinement utilizing sidescan sonar, subbottom profiler, and magnetometer. A pattern of 11 east to west refinement lines were run, continuing until the magnetic data returned to background in the four cardinal directions. Magnetic data revealed a classic dipole anomaly with strength of 178 gammas and a duration of 278 feet (Figure 4-64), located approximately 300 feet south southwest of the original target location. The magnetic data suggested the site was concentrated in one main location, with a smaller pile located slightly to the south. Examination of the sidescan data, both individual files and a mosaic (Figures 4-65 through 4-68), indicated three separate concentrated piles of debris consistent with the NOAA assessment of concrete and rebar. No articulated structural components were apparent on the sidescan image. The subbottom data indicated a large pile of debris, and while it cannot penetrate below the wreck site to determine how deep the deposit is below the bottom, it did not indicate any separate buried sections (Figure 4-69).

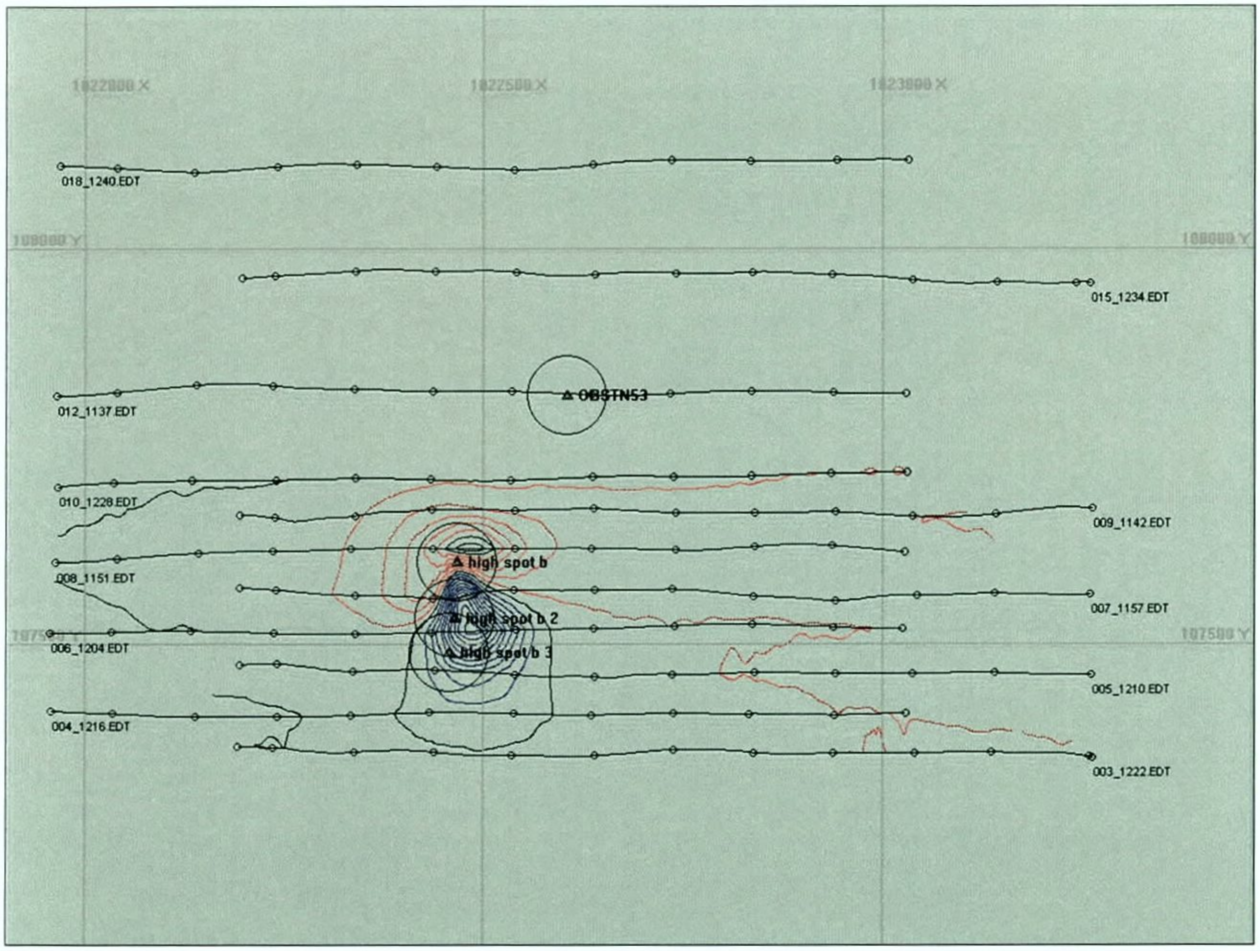


Figure 4-64. Magnetic contour map of High Spot B (OBSTN53).

The remote sensing refinement did not indicate anything to contradict the assessment of the site by previous investigations. However, it is suggested that the site be examined by an archaeologist to confirm the assessment of previous investigations, which were non-archaeological in nature, and to assess the amount of material present at the site.

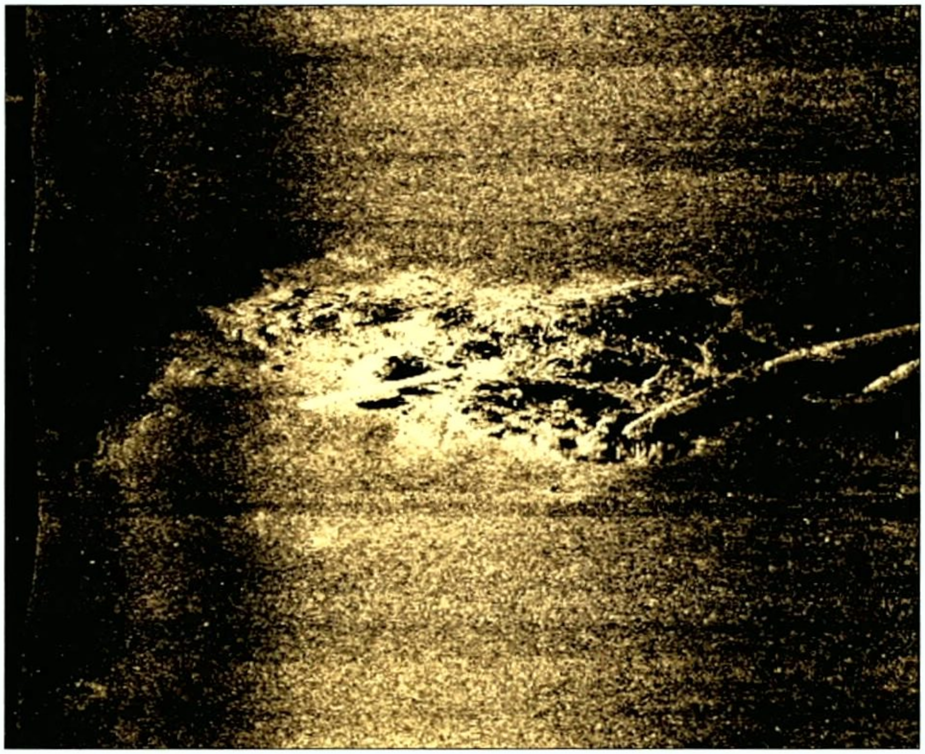


Figure 4-65. Sidescan sonar image of High Spot B (OBSTN53), northernmost section (shown in Figure 4-64 as High Spot B).

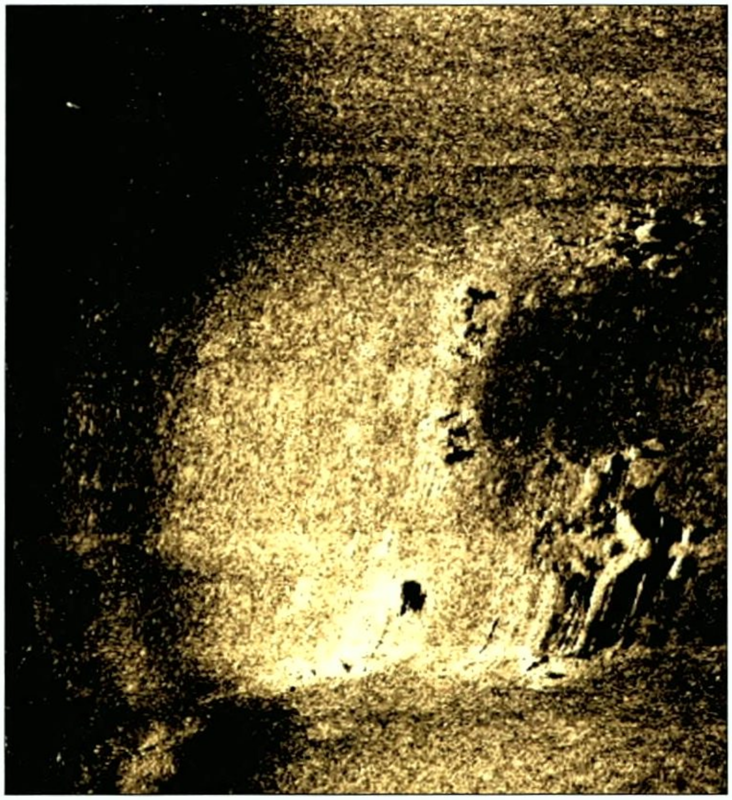


Figure 4-66. Sidescan sonar image of High Spot B (OBSTN53), central section (shown in Figure 4-64 as High Spot B 2).

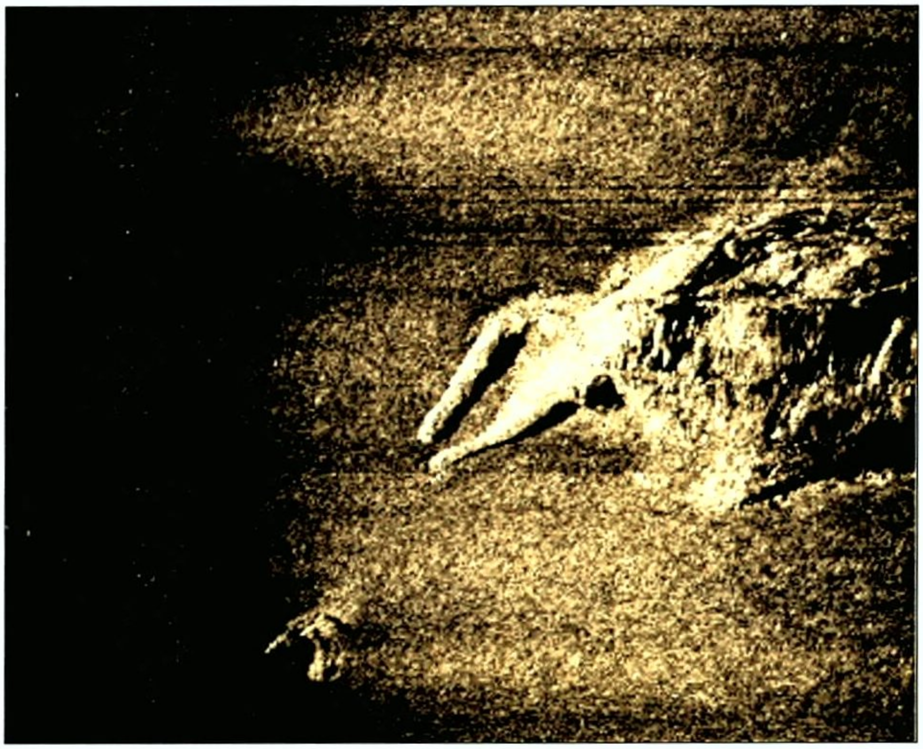


Figure 4-67. Sidescan sonar image of High Spot B (OBSTN53) southernmost section (shown in Figure 4-64 as High Spot B 3).

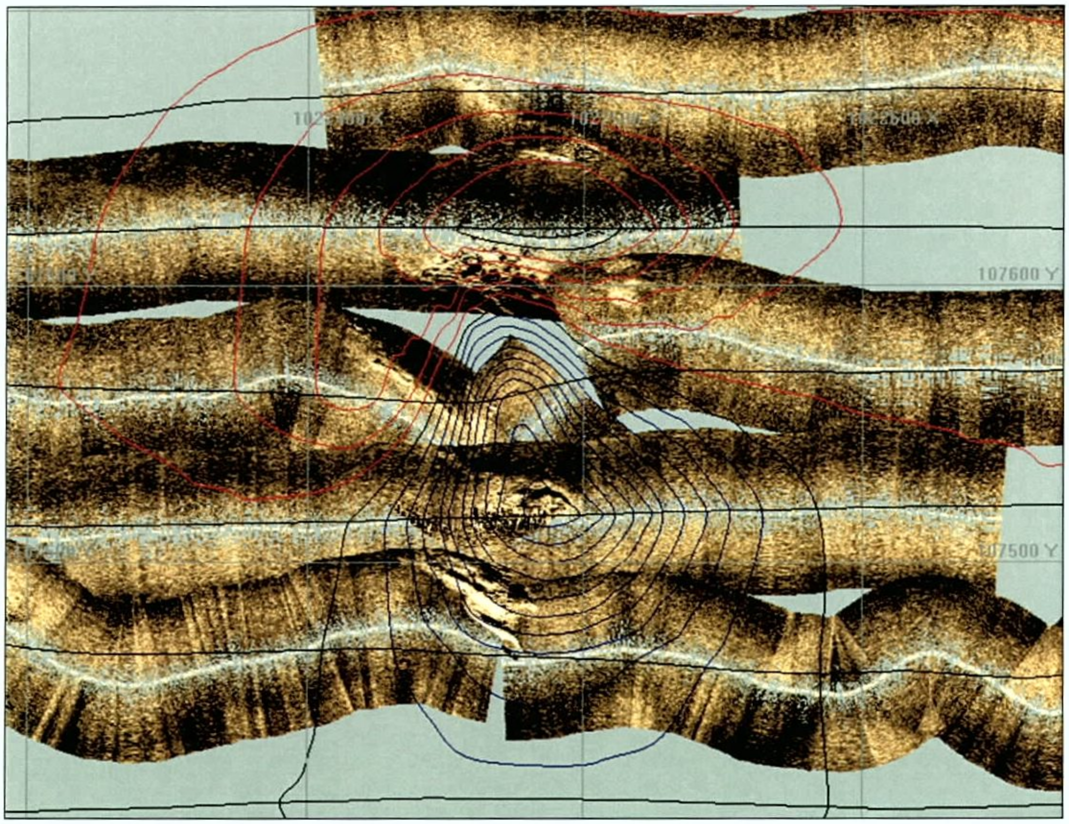


Figure 4-68. Sidescan sonar mosaic of High Spot B (OBSTN53) showing relative positions of three debris piles.

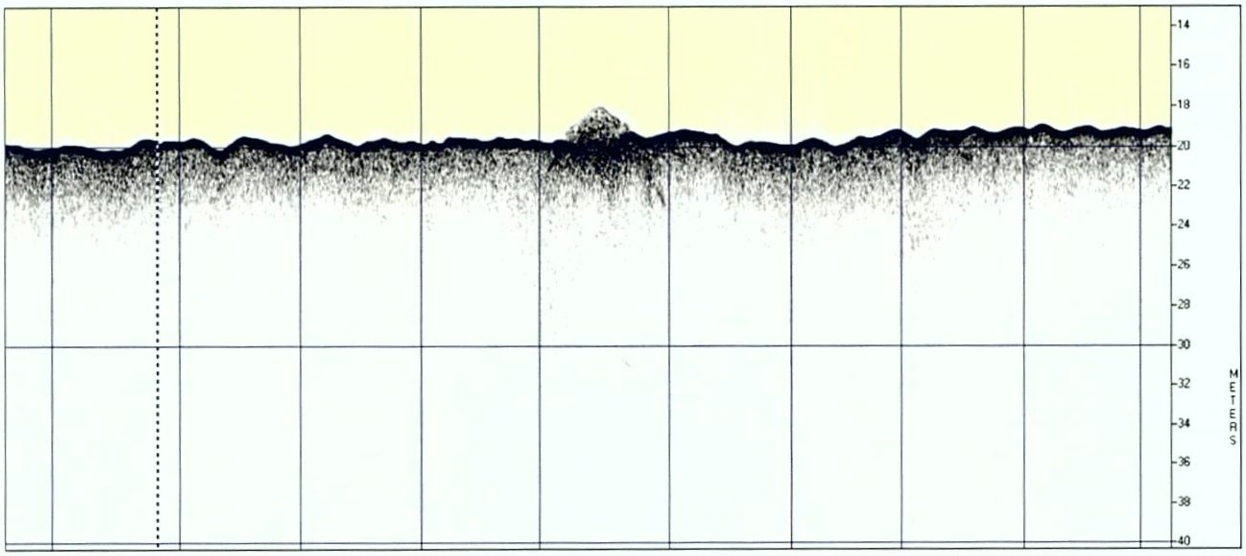


Figure 4-69. Subbottom profile image of High Spot B, northernmost section (OBSTN53).

High Spot C (OBSTN52)

This target appears on NOAA navigation charts as an obstruction with a 52-foot depth. Remote sensing refinement of this target utilized sidescan sonar, subbottom profiler, and magnetometer. A pattern of 10 east to west refinement lines were run near the original target coordinates. Magnetic data revealed no appreciable magnetic signature over the area surveyed (Figure 4-70).

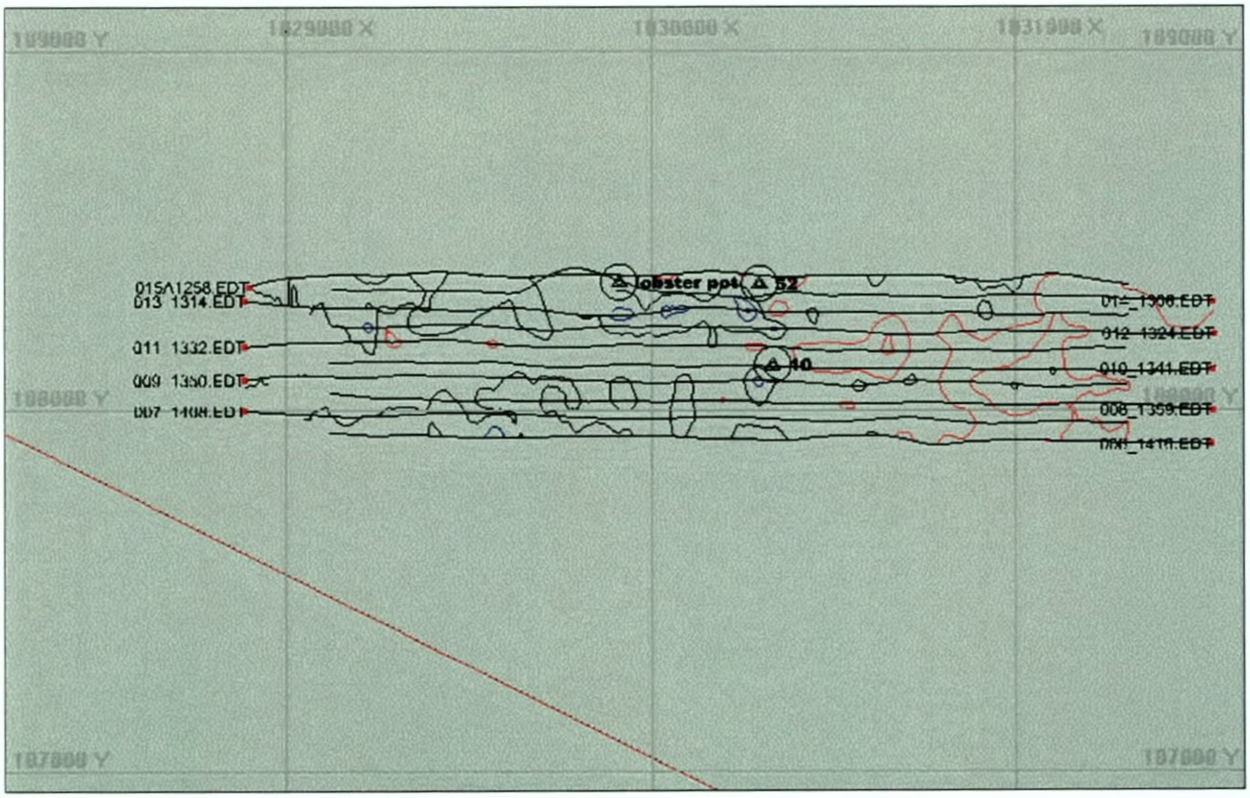


Figure 4-70. Magnetic contour map of High Spot C (OBSTN52) showing lack of magnetic anomalies.

Examination of the sidescan sonar refinement data (Figure 4-71) indicated a uniform rocky bottom; no articulated vessel structure or piles of debris were present. The subbottom data revealed an uneven bottom, but did not indicate any buried objects near the target coordinates (Figure 4-72).

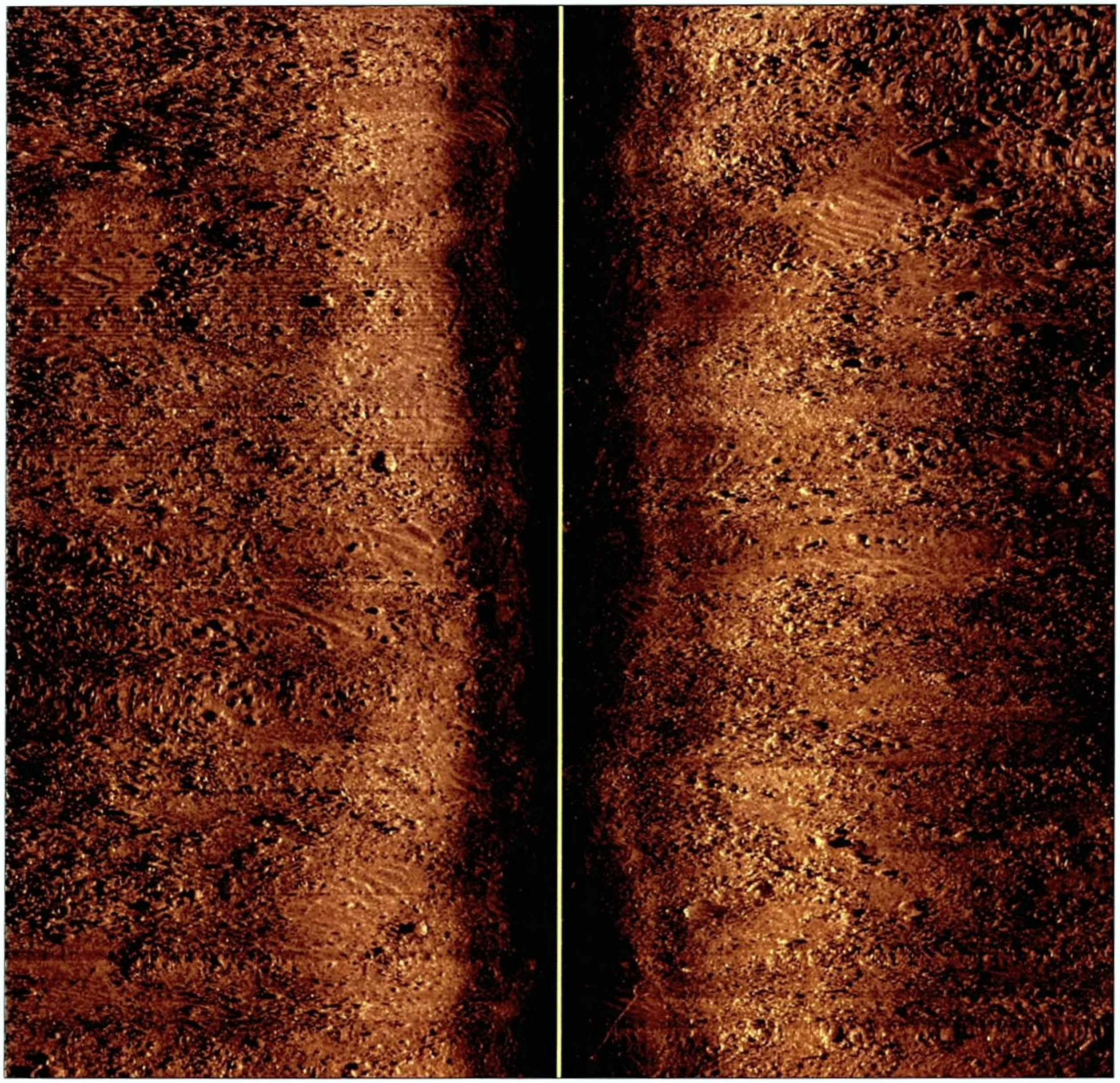


Figure 4-71. Sample sidescan sonar image of High Spot C (OBSTN52).

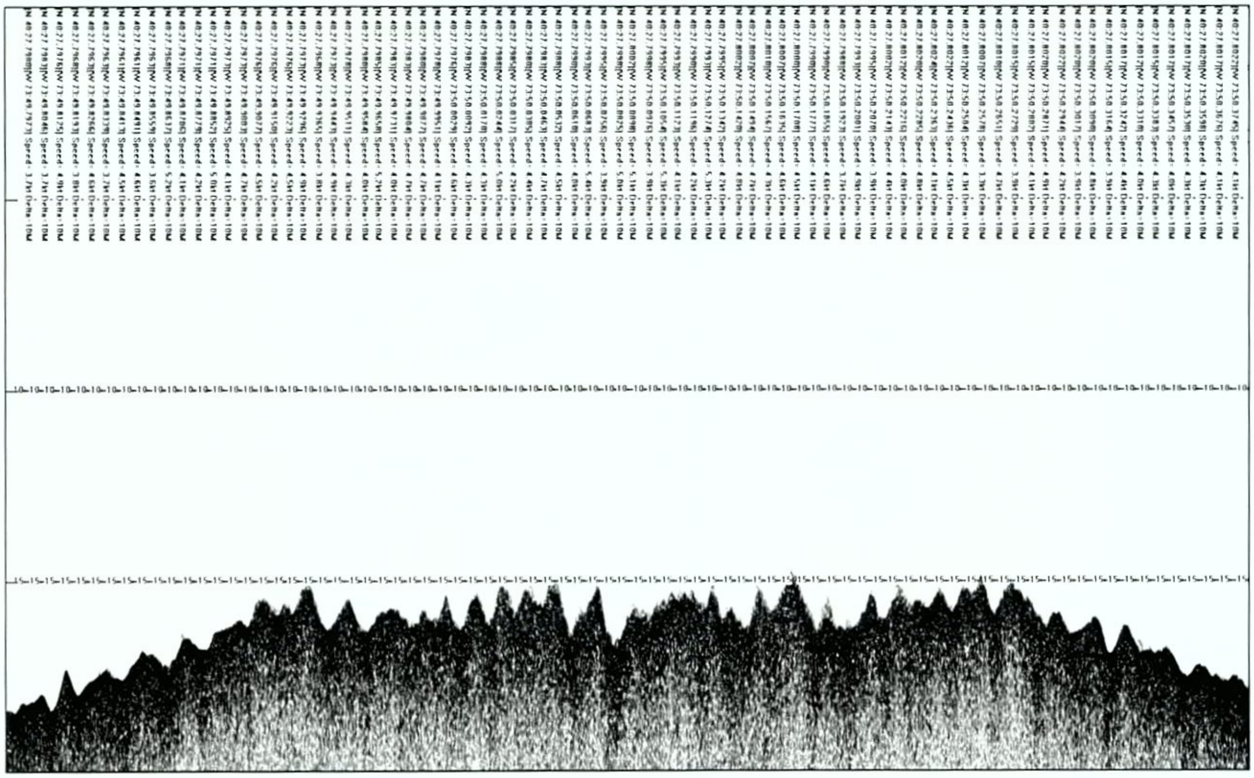


Figure 4-72. Subbottom image of High Spot C (OBSTN52).

5. CONCLUSIONS AND RECOMMENDATIONS

Results of the remote sensing survey of the stipulated northern and southern channel areas identified 16 magnetic anomalies and 51 sidescan sonar targets, many of which are associated with the anomalies. All anomalies were examined individually against the established criteria detailed above in Chapter 3. Numerous passing vessels, such as large cargo ships and freighters, did affect the data from time to time. These instances were recorded in the field notes as well as electronic data for reference during analysis.

Of the 16 magnetic anomalies, none are considered representative of potentially significant cultural resources. In addition to the magnetic data, the sidescan data was examined and sidescan sonar records indicate a seafloor of varying composition with sand/gravel areas that contain scattered cobbles and boulders (some that are three feet in height), which are adjacent to areas of sand/silt. While the acoustic targets ranged from small linear features to complete shipwrecks, most of the images were geologic, crab pots, or other isolated debris. Of the 51 acoustic targets recorded, only one, a wooden barge, is considered potentially significant. Located in 90 feet of water and therefore located outside of the APE, it is not recommended for further investigation.

In addition to the magnetic anomalies and sidescan sonar targets refined in the two survey areas discussed above, seven other target locations were examined using sidescan sonar, magnetometer, and subbottom profiler in order to determine their extent and composition and to evaluate them further for the presence of potential submerged cultural resources. These additional target locations included the three obstructions within the Sandy Hook Pilot Area, Shoals C and D (one of which was thought to be the location of a potential wreck), and two additional shoals located nearby, Shoal A and Shoal B. Of these seven target locations, four (Table 5-01) have the potential to represent significant cultural resources, as indicated by their electronic signatures. These four targets are recommended for either avoidance by project activities or additional investigation by a qualified marine archaeologist if avoidance is not possible.

Table 5-01. Targets recommended for further investigation.

Target	E	N
Shoal C	974681	146822
Shoal D	974692	146556
High Spot A (WK52)	1019023	108448
High Spot B (OBSTN53) (center)	1022470	107552

Shoals C and D

Shoal C and Shoal D, while separate targets, are discussed together as one target due to their proximity and the likelihood that they are related. Examination of the magnetic data indicates this target meets the criteria of 50 gammas over an 80-foot duration, which is generally considered indicative of a shipwreck site. Examination of the subbottom data for the site revealed extensive debris at the surface, but no indications of buried sections or debris separate from those observed on the sidescan sonar data, which confirmed the presence of two distinct areas of debris. The sidescan sonar data is most telling with respect to the character of the site. Examination of said data did not reveal the presence of an intact or articulated structure typically indicative of a shipwreck site.

While this is not necessarily a definitive factor on its own in the determination of potential eligibility, there are several other factors that lean in favor of a potentially eligible determination, including the analysis of the magnetic data. However, the most compelling evidence consists of images taken during dredging operations in the area that resulted in the location of Shoals C and D (Figure 5-01).

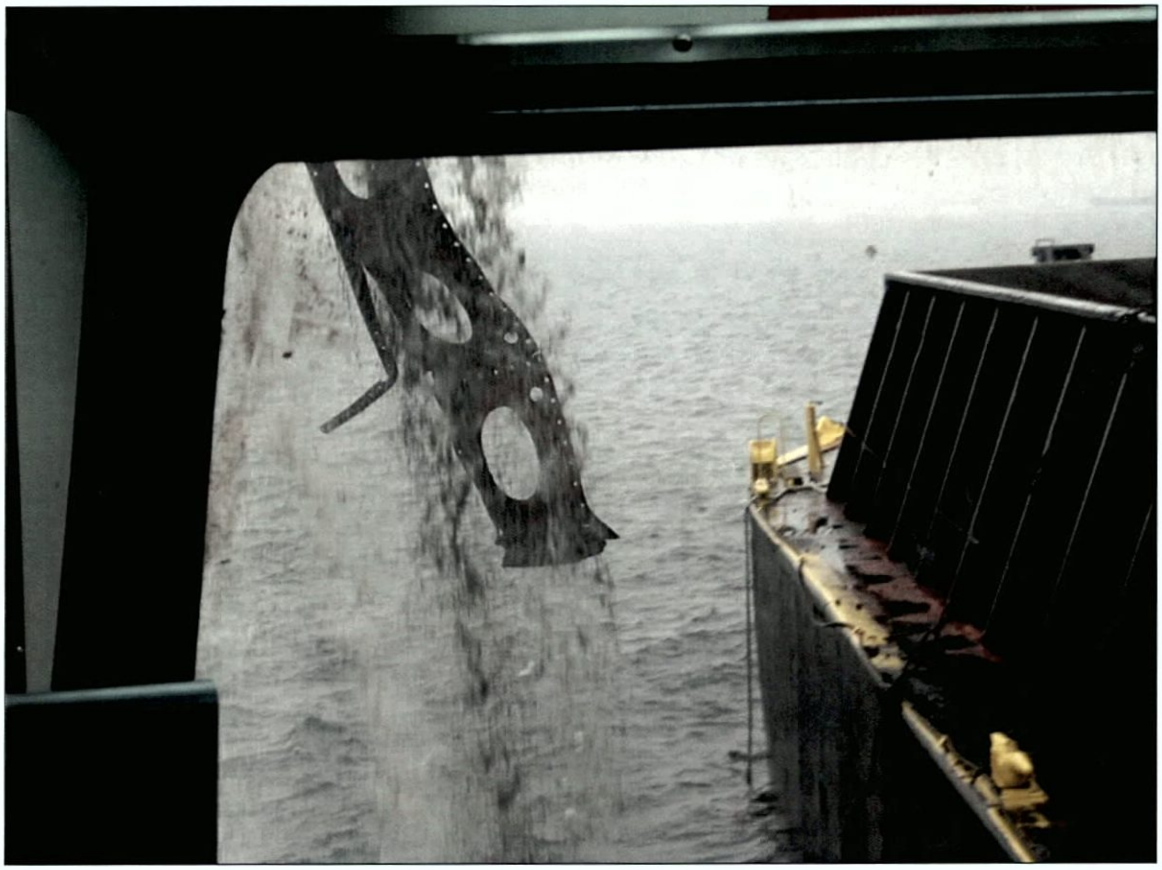


Figure 5-01. Recovery of what appears to be a section of steel or iron side girder or z-bar frame during dredging operations. Note rivet holes (photograph courtesy of the U.S. Army Corps of Engineers, New York District).

Dredging operations brought up several sections of debris that resemble components of a historic shipwreck. The most noteworthy of these were sections of iron or steel containing rivet holes, indicating a method of vessel construction that predates World War I. The most interesting piece of debris was the recovery of what appeared to be a section of z-bar frame or side girder (see Figure 5-01), which is typically found in construction of late-nineteenth-century and early-twentieth-century oceangoing vessels (Figure 5-02). Furthermore, analysis of the NOAA AWOIS database presented in Chapter 2 above states that divers located a "wreck, old ship hull and debris piles."

The target at Shoals C and D most likely represents the remains of a potentially significant historic iron-hulled vessel. Therefore, if avoidance of this location by project activities is not possible, it is recommended that this target be further investigated by a qualified marine archaeologist prior to any additional dredging or removal operations to determine its identity and assess its historical significance.

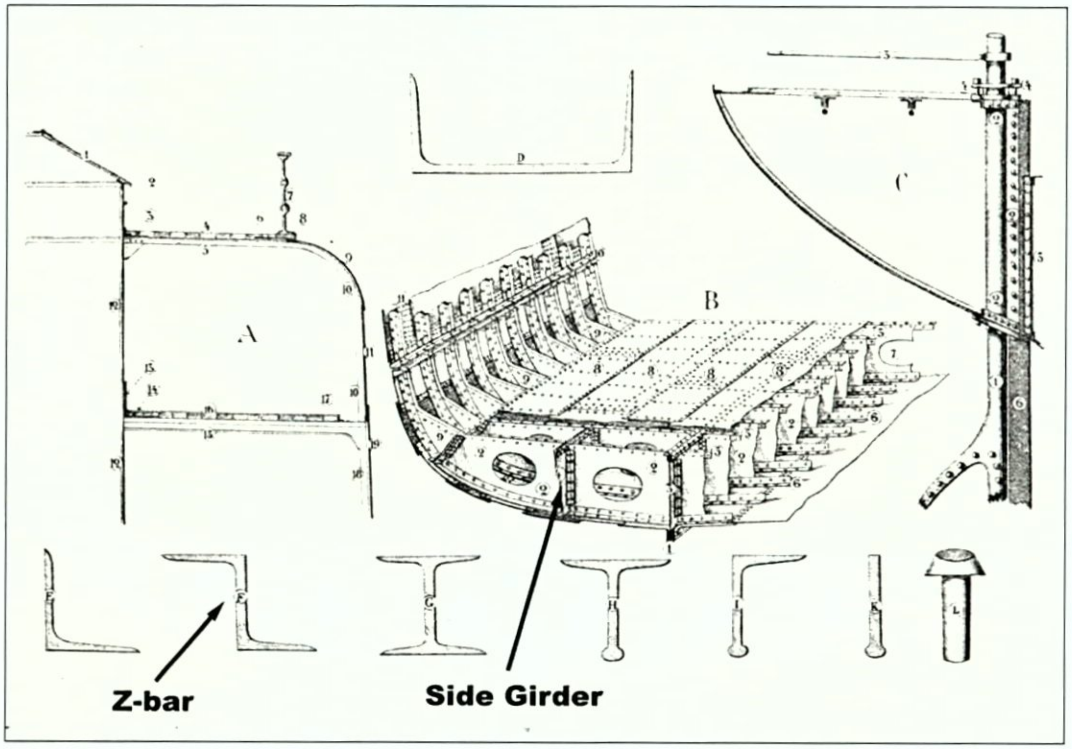


Figure 5-02. Location of side girders (longitudinal) and frames (athwartships) on a typical iron hulled steamship (as presented in Paasch 1889).

High Spot A (WK52)

High Spot A was examined with sidescan sonar, subbottom profiler, and magnetometer as part of this investigation. Previous investigations by NOAA in the 1980s concluded that High Spot A (WK52) is a multiple component wreck site consisting of a derrick barge with shipyard debris alongside the highly fragmented wreck of an oceangoing steamship. Examination of the magnetic data indicated that the magnetics of the site meet the criteria of 50-gamma strength and 80-foot duration that are generally accepted as an indicator of a shipwreck site. Subbottom data also indicated the presence of a large pile of material in the vicinity of the target coordinates, and at the same time did not indicate a significant amount of buried debris in the immediate vicinity of the visible remains.

Acoustic features of the site indicate the presence of a large oceangoing steamship. The most interesting feature of the wreck site—and the one that leads most strongly to the conclusion of the site as a wreck—is the presence of two large Scotch tube boilers. One of the boilers appears to be *in situ* on the bottom hull of a vessel, and the second is lying face up off to the east of the main body of wreckage. The presence of a pair of boilers, representing what is typically the largest surviving component on any steamship wreck site (Figure 5-03), suggests the remains represent a sizeable oceangoing steamship. The boilers at High Spot A each have a diameter of around 12 feet, suggesting a vessel in the range of 300 feet in length. The length of the wreck site, approximately 350 feet as measured from the sidescan sonar data, is consistent with this assessment.

The Scotch boiler is a cylindrical, multi-furnace fire-tube boiler in which the fire tubes, located above the furnace, bring hot gasses from a combustion chamber positioned at the rear of the furnace to a smoke box positioned at the front of the boiler. Water filled the volume of space that these fire tubes extended through, thereby creating a substantial amount of heating surface which increased the efficiency of the boiler (Griffiths 1997:66). The first Scotch-type boilers to have been installed on a seagoing ship are believed to be those in the *McGregor Laird*, built by Randolph, Elder & Company in 1862 (Griffiths 1993:106). These particular boilers worked at the moderate pressures common at the time, but would lead to the development of high pressure Scotch boilers that would still be fitted into ships almost a full century later.

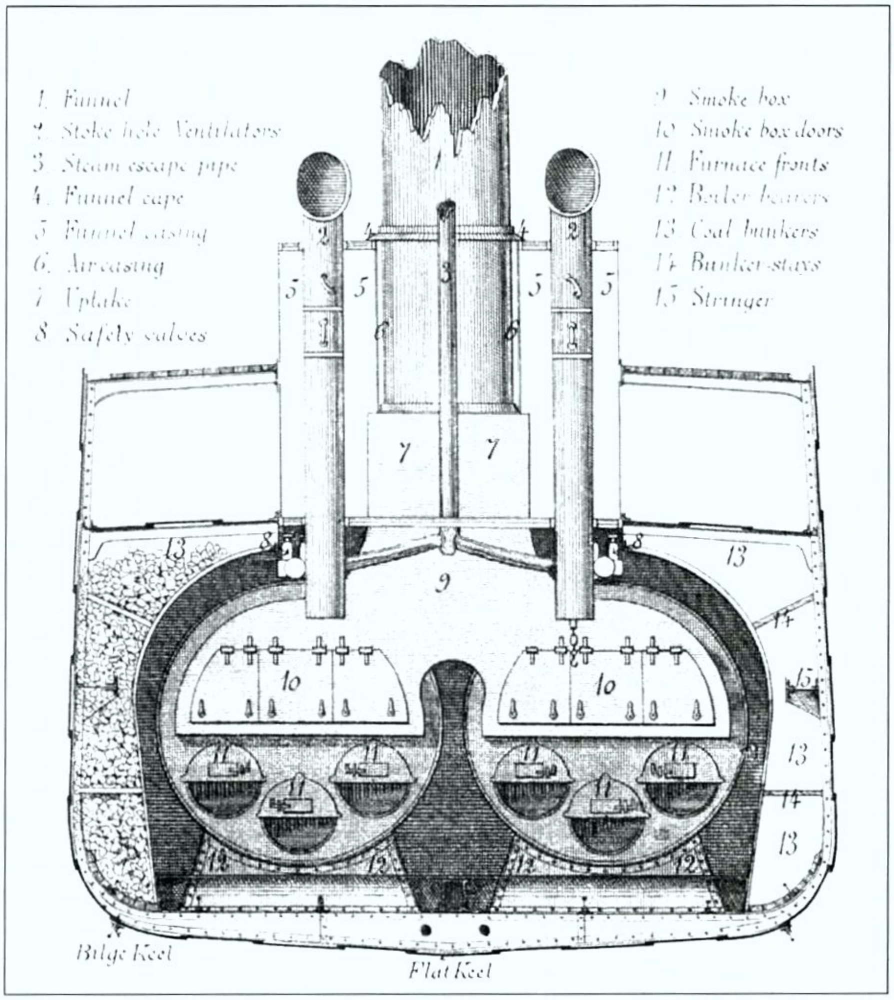


Figure 5-03. Midship section of an iron-hulled steamer, depicting the position of two Scotch boilers, coal bunkers, the funnel and ventilators, and related features (as presented in Paasch 1885).

A considerable amount of variation existed in Scotch boilers; they could be single-ended or double-ended, and could carry multiple furnaces on either end. Regardless, by the 1870s the Scotch boiler had proved so superior in regards to simplicity, reliability, and ease of maintenance that most other types became outmoded. The Scotch boiler then became the dominant form of marine steam generation in the latter half of the nineteenth century.

The other feature of the site suggesting that it is the location of a wreck is the presence of what appear to be two sections of articulated hull, located along the western edge of the site. Each section, measuring 50-75 feet in length, exhibits the repeating linear pattern of frames and side girders typical of an iron-hulled vessel. They also appear to be covered with debris, which is typical of wreck sites where the hull is the lowermost wreck feature.

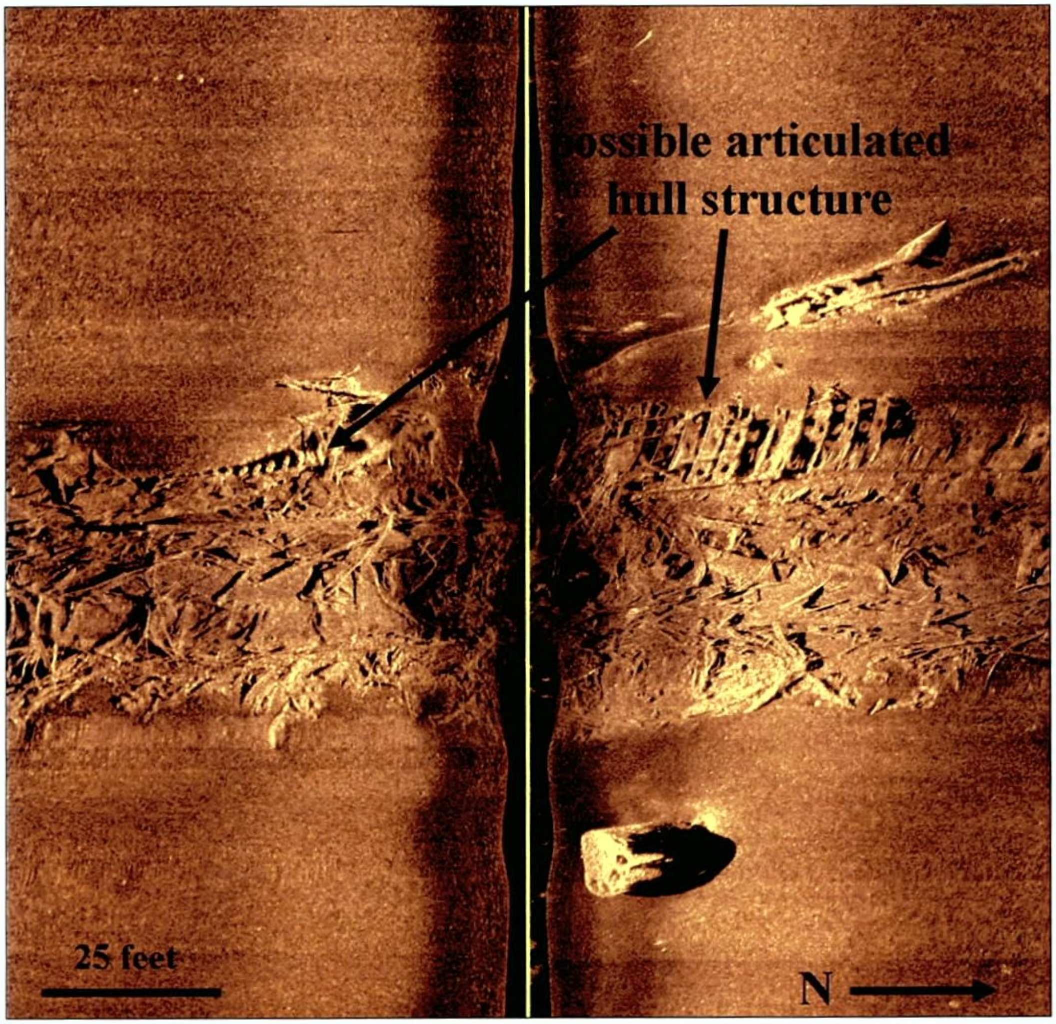


Figure 5-04. Sidescan sonar image of High Spot A (WK52) showing locations of apparent articulated hull structure.

The AWOIS database for this site (No. 1619, see Table 2-03 above) lists it as a barge, sunk in 1946 by marine casualty. Also indicated are the results of subsequent examination by NOAA divers, which indicate the site consists of a barge wreck 20 m by 45 m in size, three boilers and numerous other types of shipyard debris spread over an area measuring 360 × 165 feet, and the remains of a third wreck of which only some 200 feet of midships outer hull plating remains.

It is apparent from the data analysis that High Spot A (WK52) exhibits several characteristics of a shipwreck site. Furthermore, local wreck diving information indicates High Spot A (WK52) to be the location of the steamship *Daghestan*, a British vessel sunk in 1908 by marine accident. While its identity as the *Daghestan* is unconfirmed, the boilers are consistent with the type that the *Daghestan* or a ship of her type and age would have employed.

While the site has been examined by divers from NOAA, it has not been properly assessed by a qualified marine archaeologist. It is recommended that if the site cannot be avoided by adverse project activities, it should be assessed as to its historic significance and eligibility for NRHP status prior to dredging activities.

High Spot B (OBSTN53)

High Spot B was examined with sidescan sonar, subbottom profiler, and magnetometer as part of this investigation. Previous investigations by NOAA in the 1980s concluded that High Spot B (OBSTN53) is a pile of concrete rubble with rebar. Examination of the sidescan sonar data indicated the presence of three separate piles of debris, with the magnetic data consistent with the locations of these piles. Subbottom data did not indicate the presence of any large buried objects in the vicinity. While the magnetic data meets the criteria for the existence of a wreck site, the sidescan sonar data indicates that the identity of the site may be closer to the conclusions of the NOAA diver investigations in the 1980s that the site consists of concrete rubble with rebar. The sidescan images do not indicate the presence of any framing, structure, articulated sections of wreckage, boilers, or steam engines.

The AWOIS database for this site, Section 4, Record 7935, lists it as an obstruction, with the results of diver investigations in 1987 indicating the obstruction to be the result of the dumping of construction debris consisting of broken concrete beams, blocks, rubble, and rebar.

However, given that the previous investigations were not undertaken by a qualified marine archaeologist, they have not been properly evaluated with respect to historical significance. It is recommended that High Spot B (OBSTN53) be assessed as to its historic significance and its eligibility for NRHP status by a qualified marine archaeologist prior to dredging activities.

High Spot C (OBSTN52)

High Spot C was examined with sidescan sonar, subbottom profiler, and magnetometer as part of this investigation. Magnetic data did not indicate the presence of any large ferrous masses, nor did the subbottom data indicate the presence of any large buried masses. Analysis of sidescan sonar data revealed the presence of an area of decreased depth with a bottom characterized by gravel and sizeable boulders, but no apparent debris, structure, or other indications that the site represents a significant historic resource. In addition, the presence of numerous lobster buoys and fishing vessels indicated the area is a habitat for sea life. The AWOIS database search indicated this target coincides closely with Record 752, which is indicated as a large area of natural rock and stone rubble.

This site is not considered potentially significant and no further work is recommended.

6. REFERENCES CITED

Albion, Robert Greenhalgh

1984 *The Rise of New York Port 1815-1860.* Reprinted. Northwestern University Press, Chicago. Originally published 1939, Charles Scribner's Sons, n.p.

Bennett, Robert F.

1998 *Sand Pounders: an Interpretation of the History of the U.S. Life-Saving Service, based on its Annual Reports for the Years 1870 through 1914.* U.S. Coast Guard Historian's Office. U.S. Coast Guard Headquarters, Washington, D.C.

Berg, D.

1990 *Wreck Valley II: A Record of Shipwrecks Off Long Island's South Shore and New Jersey.* Aqua Explorers, East Rockaway, New York.

Berg, D., and D. Berg

1993 *Long Island Shore Diver.* 2nd ed. Aqua Explorers, East Rockaway, New York.

Berg, Daniel, Denise Berg, Bill Davis, and Howard Rothweiler

1993 *New Jersey Beach Diver.* Aqua Explorers, East Rockaway, New York.

Berman, Bruce D.

1972 *Encyclopaedia of American Shipwrecks.* Mariners Press, Boston.

Brouwer, N.

1987 Port of New York, 1860-1985: Moving Goods Within the Port. *Seaport* 20(4):30-35.

Cordingly, David

1995 *Under the Black Flag: The Romance and the Reality of Life Among the Pirates.* Random House, New York.

Duff, J.A.

1996 *Underwater Archaeological Investigation and Documentation of Three Anomaly Clusters Within Three Segments of Proposed Preferred Corridor for Replacement of Bonner Bridge, Oregon Inlet, North Carolina.* Panamerican Consultants, Inc., Memphis, Tennessee. Submitted to the Federal Highway Administration and the North Carolina Department of Transportation.

Engebretsen, Jan E.

1982 *New York Harbor and Adjacent Channels Study, Shipwreck Inventory.* Submitted to the U.S. Army Corps of Engineers, New York District.

Faught, Michael K.

2001 *Continental Shelf Prehistoric Archaeology: A Northwest Florida Perspective.* Department of Anthropology, Florida State University. Electronic document, http://www.adp.fsu.edu/cont_shelf_principles/cont_shelf_principles.html.

Ferguson, Jan

1986 *A Preliminary Assessment of Cultural Resources Sensitivity for the Lower New York Bay, New York and New Jersey.* Submitted to the U.S. Army Corps of Engineers, New York District.

Garrison, E., C.P. Giammona, F.J. Kelly, A.R. Trip, and G.A. Wolff
1989 *Historic Shipwrecks and Magnetic Anomalies of the Northern Gulf of Mexico: Reevaluation of Archaeological Resource Management Zone 1. Volume II: Technical Narrative.* OCS Study/MMS 89-0024. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans.

Gearhart, R.L., III
1991 *Archaeological Remote-Sensing of Borrow Area I and a Proposed Groin Field, St. Simons Island Beach Renourishment Project, Glynn County, Georgia.* Espey, Huston & Associates, Inc., Austin, Texas. Prepared for the U.S. Army Corps of Engineers, Savannah District.

Gearhart, R.L., III, and S.A. Hoyt
1990 *Channel to Liberty: Underwater Archaeological Investigations, Liberty County, Texas.* Espey, Huston & Associates, Austin, Texas. Submitted to U.S. Army Corps of Engineers, Galveston District.

Gentile, Gary
1988 *Shipwrecks of New Jersey.* Sea Sports Publications, Norwalk, Connecticut.

1996 *Shipwrecks of New York.* Gary Gentile Productions, Philadelphia.

2000 *Shipwrecks of New Jersey: North.* Gary Gentile Productions, Philadelphia.

Griffiths, Denis
1993 Triple Expansion and the First Shipping Revolution. In *The Advent of Steam: The Merchant Steamship Before 1900*, edited by R. Gardiner and B. Greenhill, pp. 106-126. Conway's History of the Ship series. Naval Institute Press, Annapolis, Maryland.

1997 *Steam at Sea: Two Centuries of Steam-Powered Ships.* Conway Maritime Press, London.

Hoyt, S.A.
1990 *National Register Assessment of the* SS Mary*, Port Aransas, Nueces County, Texas.* Espey, Huston & Associates, Austin, Texas. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Hunter, R.W., T.W. Epperson, N. Psuty, R.L. Porter, and C.M. Greiff
1985 *A Cultural Resources Reconnaissance for the New Jersey Shore from Highland Beach, Sea Bright to Deal Lake, Loch Arbour, Boroughs of Sea Bright and Monmouth Beach, City of Long Beach, Boroughs of Deal and Allenhurst, Village of Loch Arbour, Monmouth County, New Jersey.* Heritage Studies, Inc., Princeton, New Jersey. Submitted to the U.S. Army Corps of Engineers, New York District.

Irion, J.B., and C.L. Bond
1984 *Identification and Evaluation of Submerged Anomalies, Mobile Harbor, Alabama.* Espey, Huston & Associates, Austin, Texas. Submitted to the U.S. Army Corps of Engineers, Mobile District.

Irion, J.B., S.B. Smith, P. Heinrich, S. Kilner, W.P. Athens, and D. Beard

1995 *Historical Assessment and Magnetometer Survey For Construction at Two Locations Along the Mississippi River, Jefferson and Issaquena Counties, Mississippi and East Carroll and Tensas Parishes, Louisiana.* R. Christopher Goodwin & Associates, Inc., New Orleans. Submitted to the U.S. Army Corps of Engineers, Vicksburg District.

James, Stephen R., and Charles E. Pearson
1991 *Magnetometer Survey and Ground Truthing Anomalies, Corpus Christi Ship Channel, Aransas and Nueces Counties, Texas.* Coastal Environments, Inc., Baton Rouge. Submitted to the U.S. Army Corps of Engineers, Galveston District.

James, Stephen R., Jr., Charles E. Pearson, Kay Hudson, and Jack Hudson
1991 *Archaeological and Historical Investigations of the Wreck of the General C.B. Comstock, Brazoria County, Texas.* Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Johnson, Harry, and Fredrick S. Lightfoot
1980 *Maritime New York in Nineteenth-Century Photographs.* Dover, New York.

Labaree, B.W., W.M. Fowler, Jr., J.B. Hattendorf, J.J. Safford, E.W. Sloan, and A.W. German
1999 *America and the Sea: A Maritime History.* Mystic Seaport, Mystic, Connecticut.

Lonsdale, A.L., and H.R. Kaplan
1964 *Guide to Sunken Ships in American Waters.* Compass Publications, Arlington, Virginia.

Lydecker, Andrew D.W.
2008 *Assessment of Potential Wreck in Ambrose Channel to Determine Historic Significance and Undertake Selected Restoration of Remains Encountered in Connection with the New York and New Jersey Harbor Navigation Project.* Panamerican Consultants, Inc., Memphis, Tennessee, under subcontract to Great Lakes Dock and Dredge Company, Oak Brook, Illinois. Prepared for the Environmental Analysis Section, U.S. Army Corps of Engineers, New York District.

Lydecker, A.D.W., and S.R. James, Jr.
2002 *Remote Sensing Survey in Connection with the New York and New Jersey Harbor Navigation Study Upper and Lower Bay, Port of New York and New Jersey, Kings, Queens, New York, and Richmond Counties, New York, and Essex, Hudson, Monmouth and Union Counties, New Jersey.* Panamerican Consultants, Inc., Memphis, Tennessee, under subcontract to Barry A. Vittor and Associates, Inc., Mobile, Alabama. Prepared for the Environmental Analysis Section, U.S. Army Corps of Engineers, New York District.

2004 *Target Investigations in Connection with the New York and New Jersey Harbor Navigation Study Upper and Lower Bay, Port of New York and New Jersey, Kings, Queens, New York, and Richmond Counties, New York, and Essex, Hudson, Monmouth and Union Counties, New Jersey.* Panamerican Consultants, Inc., Memphis, Tennessee, under subcontract to Matrix Environmental and Geotechnical Services, Inc., Florham Park, New Jersey. Prepared for the Environmental Analysis Section, U.S. Army Corps of Engineers, New York District.

Marx, Robert
1971 *Shipwrecks of the Western Hemisphere, 1492-1825.* David McKay Co., New York.

Miller, Henry J., Joel I. Klein, and Gordon P. Watts

1990 *Cultural Resource Investigation of Sand Borrow Areas for the Sandy Hook to Barnegat Inlet Beach Erosion Control Project, Asbury Park to Manasquan Section, Monmouth County, New Jersey*. Alpine Ocean Seismic Survey, Inc., Norwood, New Jersey. Report submitted to the U.S. Army Corps of Engineers, New York District.

Mitchum, R.M., P.R. Vail, and J.B. Sangree
1977 Stratigraphic Interpretation of Seismic Reflection Patterns in Depositional Sequences. In *Seismic Stratigraphy-Applications to Hydrocarbon Exploration*, pp. 117-133. American Association of Petroleum Geologists Memoir 26.

Morris, Paul C., and William P. Quinn
1989 *Shipwrecks in New York Waters*. Parnassus Imprints, Orleans, Massachusetts.

Morrison, J.H.
1971 *The European Discovery of America*. Oxford University Press, New York.

Morrison, Peter, Stephen R. James, Jr., R. Christopher Goodwin, and Michael Pohuski
1992 *Phase II Evaluation of Three Submerged Vessels Within Chesapeake Bay, Maryland*. Panamerican Consultants, Inc., Tuscaloosa, Alabama, under contract to R. Christopher Goodwin & Associates, Inc., Baltimore, Maryland. Prepared for the U.S. Army Corps of Engineers, New York District.

Paasch, H.
1885 *From Keel to Truck*. Lyons and Burford Publishers, New York.

Pearson, C.E., B.L. Guevin, and A.R. Saltus, Jr.
1991 *Remote-Sensing Survey of the Lower Pearl and West Pearl Rivers, Louisiana and Mississippi*. Coastal Environments, Inc., Baton Rouge, Louisiana. Prepared for the U.S. Army Corps of Engineers, Vicksburg District.

Pearson, C.E., and K.G. Hudson
1990 *Magnetometer Survey of the Matagorda Ship Channel: Matagorda Peninsula to Point Comfort, Calhoun and Matagorda Counties, Texas*. Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Pearson, C.E., S.R. James, Jr., K.G. Hudson, and J. Duff
1993 *Underwater Archaeology Along the Lower Navidad and Lavaca Rivers, Jackson County, Texas*. Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Pearson, C.E., and A.R. Saltus, Jr.
1990 *Cultural Resources Investigation at Island 86, Mississippi River, Arkansas-Mississippi*. Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the U.S. Army Corps of Engineers, Vicksburg District.

1993 *Underwater Archaeology on the Ouachita River, Arkansas: The Search for the Chieftain, Haydee, and Homer*. Coastal Environments, Inc., Baton Rouge, Louisiana. Prepared for the U.S. Army Corps of Engineers, Vicksburg District.

Pearson, C.E., and J.J. Simmons, III

1995 *Underwater Archaeology of the Wreck of the Steamship Mary (41NU252) and Assessment of Seven Anomalies, Corpus Christi Entrance Channel, Nueces County, Texas.* Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Pickman, Arnold
1994 Considerations in the Evaluation of Possible Submerged Prehistoric Site Locations. Paper presented at PANYC Symposium on Environmental Reconstruction.

Quinn, R., J.R. Adams, J.K. Dix, and J.M. Bull
1998 The *Invincible* (1758) site—an integrated geophysical assessment. *International Journal of Nautical Archaeology* 27:126-138.

Quinn, R., J.M. Bull, J.K. Dix, and J.R. Adams
1997 The *Mary Rose* site-geophysical evidence for paleo-scour marks. *International Journal of Nautical Archaeology* 26:3-16.

Rattray, Jeannette Edwards
1973 *Perils of the Port of New York.* Dodd, Mead and Company, New York.

Ritchie, Robert C.
1986 *Captain Kidd and the War Against the Pirates.* Harvard University Press, Cambridge, Massachusetts.

Roberts, M., R. Moir, R. Barber, and B. Bourque
1979 *Summary and Analysis of Cultural Resource Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras*, Vol. I-IV. Institute for Conservation Archaeology, Peabody Museum, Harvard University. Prepared for the New York Outer Continental Shelf Office, Bureau of Land Management, U.S. Department of the Interior, Washington, D.C. Contract No. AA 551-CT8-18.

Rogers, R., S.D. Hoyt, C.L. Bond, L. Voellinger, and S.R. James, Jr.
1990 *Cultural Resources Investigations, Virginia Point, Galveston County, Texas.* Espey, Huston and Associates, Inc., Austin, Texas. Submitted to the U.S. Army Corps of Engineers, Galveston District.

Sheard, Bradley
1998 *Lost Voyages: Two Centuries of Shipwrecks in the Approaches to New York.* Aqua Quest Publications, New York.

Stright, M.J.
1990 *Archaeological sites on the North American Continental Shelf.* Centennial Special Vol. 4, pp. 439-465. Geological Society of America, Boulder, Colorado.

1995 *Archaic period sites on the continental shelf of North America: the effect of relative sea-level changes on archaeological site locations and preservation.* Special Paper 297. Geological Society of America, Boulder, Colorado.

Theime, Donald M.
2000 Paleoenvironmental and Archaeological Contexts in the New York and New Jersey Harbor Region. Paper presented at the 65th Annual meeting of the Society for American Archaeology, Philadelphia, Pennsylvania.

Tuttle, M.C., and A.M. Mitchell

1998 *Remote Sensing Survey, Near Shore Project Area, Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, Nassau County, New York, Storm Damage Reduction Project.* Panamerican Consultants, Inc., Memphis. Submitted to the U.S. Army Corps of Engineers, New York District.

Vail, P.R., R.M. Mitchum, R.G. Todd, J.M. Widmier, S. Thompson, J.B. Sangree, J.N. Bubb, and W.G. Hatlelid
1977 Seismic Stratigraphy and global Changes of Sea Level. In *Seismic Stratigraphy - Applications to Hydrocarbon Exploration*, edited by C.E. Payton, pp. 49-212. Memoir 26, American Association of Petroleum Geologists, Tulsa, Oklahoma.

Watts, Gordon P., Jr.
1986 *A Literature and Cultural Resources Reconnaissance of Selected Survey Corridors in Western Long Island Sound, New York. Tidewater Atlantic Research, Washington, North Carolina.* Submitted to EBASCO Services, Inc., Lyndhurst, New Jersey.

APPENDIX A: SCOPE OF WORK

Section C - Descriptions and Specifications

SCOPE OF WORK

Remote Sensing Survey
Of Portions of Ambrose Channel
In Connection with the
New York and New Jersey Harbor Navigation Project
Kings and Richmond Counties, New York

I. Introduction

The U.S. Army Corps of Engineers, New York District, (Corps), is constructing navigation improvements in New York and New Jersey Harbor (Harbor). The Corps has conducted remote sensing surveys, diving evaluations, recordation of vessels and salvage of maritime artifacts as part of the Section 106 compliance for this project. The Programmatic Agreement signed in 2000 and amended in 2003 was developed with the assumption that all relevant harbor channels under study have been maintained through periodic dredging and no historic vessels would be present in these channels. Since construction in Ambrose Channel began one wreck and one possible wreck were encountered. Ambrose Channel, the main entrance channel to the Port of New York and New Jersey, is naturally deep and in fact much of it has not been dredged historically due to it natural depth. Portions of the channel have been mined for sand and gravel. The survey area measures approximately six miles by 1000 feet. Figure 1 shows the channel. The area to be surveyed in the same as the hatched area depicted on Figure 1 but is on the opposite side of the channel.

This scope of work is to obtain a remote sensing survey of the sections of Ambrose Channel that have not been previously dredged or mined to identify potential historic resources and debris fields that must be removed during construction. Particular attention will be paid to the potential wreck encountered within Ambrose Channel, to ascertain its nature and determine the need for additional work to determine its eligibility for the National Register of Historic Places (NRHP). The potential wreck is located at approximately 1250 feet north (along center channel) from Green Buoy 19 and 700 feet west of channel center. It is "Shoal C" on Figure 2 and may correspond with NOAA chartered obstructions numbered as 11500 and 744. Images of the material encountered while dredging were emailed previously. To be surveyed also are three obstructions in the Sandy Hook Pilot Area circled on Figure 3. All anomalies will be recorded and assessed for their potential to be cultural resources. Recommendations for each identified anomaly will be made with regard to the need for further evaluation of their nature and eligibility for the NRHP. The remote sensing survey will also serve to identify any areas containing wrecks or large debris fields so that they can be anticipated during construction. The locations, approximate size, depth and composition of such features are important for engineering and construction professionals to determine the nature and extent of the material to be removed for disposal.

Ambrose is an active navigation channel and all applicable safety measure must be implemented.

Contact with the Coast Guard and other agencies will be undertaken as necessary.

II. Project Background

A. Project Location:

The Ambrose and Anchorage channels are the main entrance channels to the Port of New York and New Jersey, extending from the Atlantic Ocean through Lower Bay. The Sandy Hook Pilot Area is located at the entrance to Ambrose Channel.

B. Project Plans

The overall plan is to deepen the main channels in the Harbor to 50 feet which necessitates some widening.

III. Previous Research

A great deal of research has been undertaken on vessels and shoreline properties in the New York and New Jersey Harbor in association with the Corps' Collection and Removal of Drift Program and the Harbor Navigation Project. Numerous vessels along the Kill Van Kull, Arthur Kill and Newark Bay have been determined historically significant. As part of the Section 106 compliance work for the Harbor Navigation Project a remote sensing survey along navigation channel edges identified dozens of remote sensing targets that were evaluated as potential cultural resources. Subsequent diving investigations determined a number of these anomalies to be significant historic resources which were later documented.

IV. Contractor Services and Required Investigations

A. The general services to be provided under this contract are those required to conduct, as described below, a remote sensing survey in Ambrose Channel, as described below in Section IV (C).

B. The Contractor shall be responsible for conducting in the manner prescribed, the investigation detailed below. Failure to meet the fieldwork and reporting requirements of this Scope of Work may be cause for termination of work for default of the contract, or for an evaluation of unsatisfactory upon completion of the project.

C. Area to be surveyed:

Ambrose Channel – In channel areas not previously dredged (see Figure 1).
Sandy Hook Pilot Area, 3 obstructions (see Figure 3).

D. This Scope of Work requires the completion of the following tasks:

Task 1. Develop a Remote Sensing Survey Plan and Health and Safety Plan for the investigation. Conduct limited background research.

Three (3) copies of the Remote Sensing Plan and Health and Safety Plan shall be provided to the Corps.

a. The purpose of the plan is to specify the methods that will be used to locate potential cultural resources.

b. The survey techniques, procedures, and remote sensing equipment shall be representative of the state of current knowledge and development. The Remote Sensing Plan will include the survey methodology to be used, the arrangement of the remote sensing survey tracklines, survey location stations, and equipment to be employed. Upon Corps approval of the plans, the Contractor will proceed to the remaining tasks.

c. The Remote Sensing Survey Plan will be included as an appendix to the draft and final reports.

d. Ambrose Channel is an active navigation channel. All applicable health and safety requirements must be identified in the health and safety plan.

e. The background research conducted will be used in the identification of the potential wreck previously encountered in Ambrose Channel. It will also aid in assessing any other targets or anomalies encountered as potential cultural resources.

Task 2. Conduct a remote sensing survey in the areas specified on Figure 1 (the channel opposite the hatched areas depicted). This task includes the mobilization and demobilization for the surveys.

a. The Principal Investigator shall be experienced in underwater archaeology and the techniques of remote sensing. The Principal Investigator shall be present during the remote sensing survey.

b. The remote sensing survey shall be conducted with a magnetometer and side scan sonar, and should be of sufficient intensity to determine the presence, precise location, distribution, and possible nature of, underwater objects or magnetic anomalies within the proposed borrow area. A sub-bottom profiler will be used as appropriate to aid in determining nature and size of any anomalies encountered.

c. Remote sensing survey lines will be spaced to provide 100% coverage of the survey area as defined above. Unless otherwise indicated, the magnetometer should be equipped with dual channel recorder capable of recording on both channels simultaneously (e.g., 20/200 gammas, 100/1000 gammas). The side scan sonar should be equipped minimally with a 100Khz sensor. A sub-bottom profiler shall be employed to aid in the identification of buried resources and/or debris. The remote sensing survey tracklines should be placed parallel to each other at a maximum of 65 feet apart. All records should be annotated simultaneously with position fixes at intervals not to exceed 100 feet on each survey line. Additional position fixes shall be obtained for magnetic and/or side scan sonar targets that are suspected to be shipwrecks. To obtain the best quality survey data, vessel speed should not exceed four (4) knots.

e. The Contractor will provide a safe working environment for all persons in his/her employ as prescribed by EM 385-1-1, "Safety and Health Requirements Manual," dated November 2003. The Contractor will be responsible for all damages to persons and property that occur in connection with the work and services under this Contract, without recourse against the Government. The Contractor is responsible for having adequate insurance coverage for all activities required under this contract.

Task 3. Conduct data analysis of the results of remote sensing survey data. The analysis should be aimed at determining the location, size and nature of identified targets and anomalies so that the need for further work can be determined. If targets/anomalies are not potential historic resources then this data will be used to prepare plans for their removal. In addition to discussions in the text of the report, the data will be presented as follows:

a. a project area base map outlining all areas surveyed.

b. a map of the survey tracklines.

c. map(s) of the results of the remote sensing survey that will plot and distinguish between magnetometer anomalies and side scan targets. This map will also show all potential cultural resources, particularly possible shipwreck sites.

d. a table listing the target/anomaly or associated targets/anomalies, the coordinates for each and the potential identification of what each may be.

e. the tracklines and remote sensing anomalies should be provided in a digital, georeferenced format. The digital data must be compatible with the overall Harbor Navigation Study GIS database and the final product must include Federal Geodetic Data Committee (FGDC) compliant metadata.

Task 4. Report preparation including a detailed draft and final survey report to the standards specified in Section V below. The Corps' Environmental Analysis Branch will be provided with four (4) copies of the draft report for review. The Corps shall send the Contractor review comments that shall be addressed and the report revised accordingly for the final submission. The Contractor will provide six (6) copies of the final report of this investigation. One (1) copy shall be unbound and shall contain original photographs, if applicable. Four (4) of the final reports shall be bound and shall include original photographs, if applicable. The sixth copy shall be bound and shall contain high quality photocopies of photographs. In addition, one (1) copy of the side scan sonar and magnetometer records will be provided to the Corps' Environmental Analysis Branch when the Final Report is submitted to be kept on file with the Final Report.

a. The Remote Sensing Survey Plan will be included in the Draft and Final Reports as an Appendix.
b. Draft Reports will be submitted to the Corps for review. The Contractor will be provided with comments on the draft for inclusion in the final report.

Task 5. Project management will ensure that all requirements of this Scope are fulfilled and that there is timely submission of all reports.

V. Report Format and Content

A. The draft and final reports shall have the following characteristics:

1. Draft and final copies of the report of investigations shall reflect and report the analysis outlined in the Required Investigations section above. They shall be suitable for publication and be prepared in a format reflecting contemporary organizational and illustrative standards of professional archaeological journals. The draft report will be revised to address all review comments.

2. The report produced by a cultural resource investigation is of potential value not only for its specific recommendations, but also as a reference document. To this end, the report must be a scholarly statement that can be used as a basis for any future cultural resources evaluation. It must meet both job requirements for cultural resources protection and scientific standards as defined in 36 CFR Part 800 of the Council's Handbook.

B. The draft and final reports shall contain the following components:

1. If the report has been written by someone other than the Principal Investigator, the cover and title page of the publishable report must bear the author's name as well as the inscription **Prepared Under the Supervision of (Name), Principal Investigator.** The Principal Investigator is required to sign the original copy of the report. In addition, the Principal Investigator must prepare a forward describing the overall research context of the report, the significance of the work, and any other related background circumstances relating to the manner in which the work was undertaken.

2. The **TITLE PAGE** of the report will state the title of the cultural resource

study and the study level as indicated in the title of this Scope. The report title will specify whether the report is draft, revised draft, or final. The **TITLE PAGE** will also bear an appropriate inscription indicating authorship, the name of the Principal Investigator, and that the report was prepared for the U.S. Army Corps of Engineers, New York District. The source of funds used to conduct the reported work, the title and number of the contract and work order, the town/city/village, county and state, and the date (month, year) the report was submitted also will be inscribed.

3. A **BRIEF SYNOPSIS** of the findings, conclusions and recommendations of the study, appearing in front of the report and suitable for publication as an abstract. Include also the project name and the names of the county(ies) and municipalities involved.

4. A **TABLE OF CONTENTS,** including a list of all figures and tables presented in the report.

5. **PAGE SIZE AND FORMAT.** Each report shall be produced on 8 1/2 " x 11" paper, single spaced, with double spacing between paragraphs. The printing of the text should be of good quality, and should approximate letter quality. All text pages (including Appendices) must be consecutively numbered.

6. An **INTRODUCTION,** stating the purpose of the remote sensing survey and containing a general statement as to the type of evaluation conducted and as summary of the findings and recommendations

7. A **DESCRIPTION OF THE PROJECT** and a brief **DESCRIPTION OF THE ENVIRONMENTAL SETTING,** relating specifically to factors affecting the location of cultural resources.

8. A **CRITICAL REVIEW OF DOCUMENTARY AND BACKGROUND RESEARCH,** including a brief summary of relevant historic events and sites in the project area vicinity and previous archaeological and historical research conducted in the area. The review should incorporate and reference information obtained from individuals and organizations knowledgeable about cultural resources in the project area.

9. A description of **FIELD METHODS AND THEIR RATIONALE,** detailing the objectives, theoretical context and any specific research questions concerning the project. The manner in which data were collected and analyzed also will be made explicit. The Remote Sensing Plan will be referenced in this section.

10. **RESULTS OF THE INVESTIGATIONS** synthesizing all findings and the results of analyses. Include statements on the likelihood of impact (direct or

indirect) of project implementation on any identified potential cultural resources of potential National Register eligibility to the extent possible and the need or lack of need for further cultural resources assessment.

11. **GRAPHIC PRESENTATION OF RESULTS,** as follows:

a. All pages, including appendices and graphic presentations, will be numbered sequentially.

b. All tables shall have a number, title, appropriate explanatory notes and a source note.

c. All figures shall have a title block containing the name of the project, county and state.

d. All maps shall display a north arrow, graphical scale, year of publication, when appropriate, and key, whenever applicable.

e. All graphic presentation, including maps, charts and diagrams, shall be referred to as "Figures." All figures must be numbered, and cited by number within the body of the text.

f. Graphic presentation should include, but not be limited to the following:

1. a project area base map, outlining the location of the potential disposal areas.

2. a map of the survey tracklines.

3. a map(s) of the results of the remote sensing survey that will plot and distinguish between magnetometer anomalies and side scan targets. This map will also show all potential cultural resources.

4. a table listing the target/anomaly or associated targets/anomalies, the coordinates for each and the potential identification of what each may be.

5. a project area base map, outlining clearly and accurately, the project boundaries on the appropriate portion of the relevant U.S.G.S. quad sheet(s), with the name of the quad sheet(s) clearly indicated in the map title and year of issue. A section of the appropriate NOAA chart on which the project areas are outlined may be submitted in addition to the USGS quadrangle.

12. **RECOMMENDATIONS** as to the need for, or lack of need for further cultural resource investigations. All recommendations must be clearly justified and those justifications must be applied to both positive and negative results.

13. A **REFERENCES** section listing all references, citations, and consulted sources both within the text and within any appendices. This list must be in the format used by professional North American archaeological journals (i.e., American Antiquity).

14. **APPENDICES** will include:

1. The Remote Sensing Survey Plan.
2. A catalog of all data, instrument logs and field records.

VI. Project Schedule

A. All reports should be submitted in a timely manner as stipulated below:

1. The Remote Sensing Survey Plan and Health and Safety Plan will be submitted three (3) weeks after the receipt of the award of the work order. The Remote Sensing Survey will begin upon Corps' acceptance and approval of the Remote Sensing Survey Plan and Health and Safety Plan. The draft report will be submitted six (6) weeks after the completion of field work. The draft report shall be submitted by the Corps to the New York State Historic Preservation Offices and the New York City Landmarks Preservation Commission for review and comment.

2. All comments received will be submitted to the Contractor for incorporation in the final report. All copies of the final report will be submitted to the Corps four weeks after the receipt of comments.

B. The number of copies of each report should be submitted according to the above schedule, as follows:

1. Three (3) copies of the Remote Sensing Survey Plan and Health and Safety Plan.

3. Four (4) copies of the draft report.

4. Six (6) copies of the final report. Four (4) of these copies shall contain original photographs, if applicable.

VII. Additional Contract Requirements

A. Agencies, institutions, corporations, associations or individuals will be considered qualified when they meet the minimum criteria given below. As part of the supplemental documentation, the proposal must include vitae for the Principal Investigator and main supervisory personnel in support of their academic and experiential qualifications for the research, if it has not already been provided as part of the original contract package.

1. Archaeological Project Director or Principal Investigator (PI). For the investigations required by this Scope, the Principal Investigator position must be filled by an archaeologist who specializes in underwater/nautical archaeology as defined below and who has experience in conducting remote sensing surveys. Persons in charge of an archaeological project or research investigation contract, in addition to meeting the appropriate standards for archaeologist, must have the doctorate or an equivalent level of professional experience as evidenced by a publication record that demonstrates experience in project formulation, execution, and technical monograph reporting. Suitable professional references may also be made available to obtain estimates regarding the adequacy of prior work. If prior projects were of a sort not ordinarily resulting in a publishable report, a narrative should be included detailing the proposed project director's previous experience along with references suitable to obtain opinions regarding the adequacy of this earlier work.

2. Underwater/Nautical Archaeologist. In addition to meeting the formal qualifications for an underwater or nautical archaeologist specified here, individuals filling this position must also meet the qualifications for divers as defined below. The underwater or nautical archaeologist will have at least one (1) year of supervised experience in marine archaeology including extensive underwater training. The individual must have a familiarity with the remote sensing devices and electronic positioning systems, and have the ability to interpret the output of these devices. The underwater archaeologist must have a demonstrated knowledge and at least six (6) months experience in the methods, techniques, and use of submerged shipwreck sites. The minimum formal qualifications for individuals practicing archaeology as a profession are a B.A. or B.S. degree from an accredited college of university, followed by 2 years of graduate study with concentration in anthropology an specialization in archaeology during one of these programs, and at least two summer field schools or their equivalent under the supervision of an archaeologist of recognized competence; a Master's thesis or its equivalent in research and publication is highly recommended, as is the Ph.D. degree. Individuals lacking such formal qualifications may present evidence of a publication record and references from archaeologists who do meet these qualifications.

3. Standards for Consultants. Personnel hired or subcontracted for their special knowledge and expertise must carry academic and experiential qualifications in

their own fields of competence. Such qualifications are to be documented by means of vitae attachments to the proposal or at a later time if the consultant has not been retained at the time of proposal.

B. Principal Investigators shall be responsible for the validity of material presented in their reports. In the event of a controversy or court challenge, Principal Investigators shall be required to testify on behalf of the government in support of findings presented in their reports.

C. Neither the Contractor nor his/her representatives shall release any sketch, photograph, report or other data, or material of any nature obtained or prepared under this contract without specific written approval of the Corps prior to the time of final acceptance of the government.

D. The Contractor shall furnish all labor, transportation, instruments, survey equipment, boats and other associated materials to perform the work required by this Scope of Work.

E. The Contractor shall not publicly disclose any data generated or reviewed under this work order. The Contractor shall refer all requests for information to the Corps.

VIII. Fiscal Arrangements

A. Partial payments of the total amount allocated will be dispersed upon the receipt and acceptance of invoices. Invoices will be submitted with the Remote Sensing Plan and the Interim and Draft reports. The total amount of these invoices shall not total more than 90% of the agreed work order amount. The remaining 10% of the agreed work order amount shall be paid upon the receipt and approval of the final report, photographs, if applicable, original figures, the reports listed in Section III, which were provided by the Corps, etc. and the receipt of the final invoice.

B. Payments will be made in accordance with the "Prompt Payment" section in the base contract.

C. Scheduled completion date for the work specified in this Scope of Work is June 2008.

APPENDIX B: REMOTE SENSING SURVEY PLAN

REMOTE SENSING SURVEY PLAN

Remote Sensing Survey
Of Portions of Ambrose Channel in Connection with the
New York and New Jersey Harbor Navigation Project
Kings and Richmond Counties, New York.

Contract No. W912DS-07-D-0005, Delivery Order No. 0003

INTRODUCTION

Under subcontract to Barry Vittor and Associates, Inc., Panamerican Consultants, Inc. (PCI) presents the following technical plan to conduct a magnetometer, side scan sonar, and bathymetric survey of a proposed channel improvement project in New York Harbor along Ambrose, Anchorage, Port Jersey, Kill Van Kull, Arthur Kill (to Howland Hook), Newark Bay, Elizabeth, South Elizabeth, and Bay Ridge Channels. The following proposed technical survey plan is presented to the New York District, U.S. Army Corps of Engineers (Corps) in response to their Scope of Work (SOW) under Contract No. W912DS-07-D-0005, Delivery Order No. 0003 entitled *Remote Sensing Survey of Portions of Ambrose Channel in Connection with the New York and New Jersey Harbor Navigation Project Kings and Richmond Counties, New York.* As part of this study the New York District is responsible for identifying and determining if any properties within the project area are eligible for listing on the National Register of Historic Places (NRHP). This work is in partial fulfillment of the District's obligations under Section 106 of the National Historic Preservation Act of 1966, as amended through 1992; Executive Order 11593; the Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800); and the Abandoned Shipwreck Act of 1987.

Project Description

Panamerican Consultants, Inc. (Panamerican) provides this document to the U.S. Army Corps of Engineers, New York District (Corps) for the underwater archaeological survey of portions of Ambrose Channel. The project area consists of two separate areas located in the Ambrose Channel south of the Varizanno Narrows. The easternmost area extended from STA 24+00 to STA 152+71, while the westernmost areas extended from STA 350+00 to STA 666+21. Also included are the locations of three high spots located in the vicinity of the easternmost end of Ambrose Channel. The current project plans call for the dredging of the channel to a depth of 52 feet. The proposed investigation will include the following five tasks:

Task 1. Development of a Remote Sensing Survey Plan and a Health and Safety Plan

Task 2. Underwater Archaeological Remote Sensing Survey
Task 3. Analysis of Remote-Sensing Data
Task 4. Preparation of Reports

Task 1. Development of a Remote Sensing Survey Plan and a Health and Safety Plan

Panamerican will provide a Remote Sensing Survey Plan (this document) and a Health and Safety Plan (which will include an activity hazard analysis) prior to initiating the survey. The Health and Safety Plan will address specific work and hazards of the work environment. If methods outside of the scope (provided by the NYSOPRHP) become necessary, the Principal Investigator shall consult with the District archaeologist and the representative of the NYSOPRHP.

Task 2. Underwater Archaeological Remote Sensing Survey

A remote-sensing survey shall be conducted within the proposed channel areas identified above. This remote sensing survey will be comprised of a magnetometer, and side-scan sonar investigation, with use of subbottom profiler on any wreck or obstructions located. The remote sensing will, through the use of the magnetometer, side-scan, and DGPS navigation system, accurately map buried, and above-ocean bed features (i.e., modern debris, shipwrecks). A survey interval of 50 feet will be used. Panamerican will provide a safe working environment as per EM 385-1-1, November 2003.

Magnetometer

The remote sensing instrument that will be used to search for ferrous objects on or below the ocean floor is a Marine Magnetics SeaSpy Overhauser proton precession magnetometer. Briefly, the magnetometer is an instrument that measures the intensity of magnetic forces. The magnetometer measures (at the location of the sensor) and records both the Earth's ambient magnetic field and the presence of magnetic anomalies (deviations from the ambient background) generated by ferrous masses and various other sources. These measurements are recorded in gammas, the standard unit of magnetic intensity (equal to 0.00001 gauss). As the sensor passes through the magnetic field surrounding a ferrous mass, the strength or intensity of that anomaly is digitally recorded and electronically stored in the navigation computer. It should be noted that there are other sources, such as electrical magnetic fields surrounding power transmission lines, underground pipelines, navigation buoys, or metal bridges and structures, which may significantly affect or produce magnetometer readings.

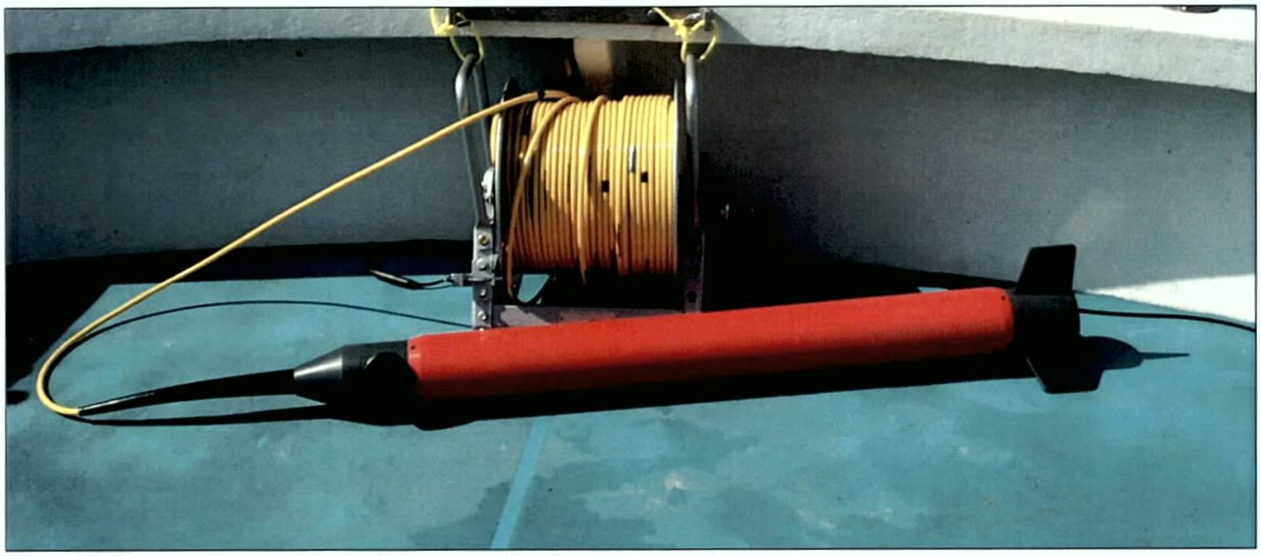


Figure 1. Panamerican's Marine Magnetics SeaSpy Magnetometer.

The ability of the magnetometer to detect magnetic anomalies, the sources of which may be related to submerged cultural resources such as shipwrecks, has caused the instrument to become a principal remote sensing tool of marine archaeologists. While it is not possible to specifically identify a ferrous source by its magnetic field, it is possible to predict shape, mass, and alignment characteristics of anomaly sources based on the magnetic field recorded. Interpretation of magnetic data can provide an indication of the likelihood of the presence or absence of submerged cultural resources. Specifically, the ferrous components of submerged historic vessels tend to produce magnetic signatures that differ from those characteristic of isolated pieces of debris. It should be noted, however, that it is impossible to specifically identify the source of any anomaly solely from the characteristics of its magnetic signature.

Side Scan Sonar

The remote sensing instrument used to search for physical features on or above the ocean floor will be a Marine Sonic Technology Sea Scan PC side scan sonar system. A Midwest Micro Personal Computer, loaded with Sea Scan software, will be employed in conjunction with a Marine Sonic Technology 600 kHz tow-fish with a 25-meter Kevlar reinforced flexible cable. When the tow-fish is deployed overboard and tied off at a safe distance, it transmits and receives the sound pulses used to produce side can images (Figure 2).

The information provided by the side scan sonar is derived from reflected acoustic energy. Transducers mounted in the system's overboard tow-fish generate high-power, short-duration acoustic pulses that are emitted at right angles to either side of the survey trackline in thin, fan-shaped patterns from directly beneath the tow-fish up to near horizontal. The acoustic energy is dissipated, absorbed, or reflected back to the tow-fish by bottom sediments, obstructions, and other acoustic reflectors. Through return-time measurements, the acoustic energy is converted to lines of data which are used to form printed two-dimensional representations of the ocean floor and any acoustically reflective features or obstructions projecting above that bottom. Under ideal circumstances, the side scan sonar is capable of providing a near-photographic representation of the bottom on either side of the trackline of a survey vessel.

Side scan sonar data are useful in searching for the physical features indicative of submerged cultural resources. Specifically, the record is examined for features showing characteristics such as height above bottom, linearity, and structural form.

Figure 2. Panamerican's Marine Sonic Technology Sea Scan PC side scan sonar system.

Subbottom Profiler

There are several types of subbottom profilers: sparkers, pingers, boomers, and chirp systems. Sparkers operate at the lowest frequencies and afford deep penetration but low resolution. Boomers operate from .5 kHz to 5 kHz and they can penetrate to between 30 m and 100 m with resolution of 0.3 m to 1.0 m. Pingers operate from 3.5 kHz and 7 kHz and penetrate seabeds from a few meters to more than 50m depending on sediment consolidation, with resolution to about 0.3 m. CHIRP systems operate around a central frequency that is swept electronically across a range of frequencies between 3 kHz to 40 kHz and resolution can be on the order of .1 m in suitable near-seabed sediments.

The current project survey deployed an Edgetech 424 XSE-500 Shallow Tow X-Star System with topside processor and towfish (Figure 3.5). This system included a Model 3100-G Topside Processor with DISCOVER Sub-Bottom Software and a 4-24 kHz SB-424 towfish.

Figure 3.5. The Edgetech subbottom SB 424 towfish used in the survey.

Positioning and Navigation

A primary consideration in the search for acoustic targets and magnetic anomalies is positioning. Accurate positioning is essential during the running of survey tracklines, and for returning to recorded locations for supplemental remote-sensing refinement operations or subsequent ground-truthing activities. These positioning functions will be accomplished on this project through the use of a Trimble Navigation DSM212H based system in concert with Hypack Max ® which is employed to control data acquisition and navigation. The 212H is a global positioning system that attains differential capabilities by internal integration with a Dual-channel MSK Beacon receiver (Figure 3). This electronic device interpret transmissions both from satellites in Earth's orbit and from a shore-based station, to provide accurate coordinate positioning data for offshore surveys. The Trimble system used has been specifically designed for survey positioning. New York, Long Island (NY-3104) State Plane coordinates, based on the 1983 North American Datum (NAD 83) coordinate system will be employed for this project. This positioning will provided continuous real-time tracking of the moving survey vessel by utilizing corrected position data provided by an on-board GPS system, which will processed both satellite data and differential data transmitted from a shore-based GPS station utilizing Radio Technical Commission for Maritime Services (RTCM) 104 corrections. The shore-based differential station will monitor the difference between the position that the shore-based receiver derived from satellite transmissions and that station's known position. Transmitting the differential that corrected the difference between received and known positions, the DGPS system aboard the survey vessel will constantly monitor the navigation beacon radio transmissions in order to provide a real-time correction to any variation between the satellite-derived and actual positions of the survey vessel.

Both the satellite transmissions and the differential transmissions received from the shore-based navigation beacon will be entered directly into a Sony Vaio laptop computer with an auxiliary display screen aboard the survey vessel for helm control. The computer and associated hardware and software will calculate and display the corrected positioning coordinates every second and store the data. The level of precision for the system is considered by the manufacture "...to achieve positions accurate to the submeter level" (Trimble Navigation Limited, 1998: 1-10). Computer software (Hypack Max ®) used to control data acquisition was written and developed by Coastal Oceanographics, Inc. specifically for survey applications.

Figure 3. Trimble navigation DSM212H DGPS unit to be used during the project.

Project area coordinates will be input into Hypack Max prior to fieldwork to produce pre-plot survey transects for each area. The remote-sensing survey plan tracklines will be placed parallel to each other at a maximum of 100 feet apart. Each trackline will overrun the boundaries of the proposed groin areas by 500 feet on either side to ensure complete coverage of the project area(s). With vessel speed not to exceed 4 knots, the average daily survey length or time will be approximately 20 line miles per day.

Survey Vessel

The survey vessel used during the survey is a 46-foot, all aluminum hulled Breaux-built crew boat. Named the *Venture III*, the vessel was well suited for remote-sensing refinement work and dive operations (Figure 9). There was ample deck area available for the placement and operation of the remote-sensing equipment and all dive equipment. The project vessel conforms to all U.S Coast Guard specifications according to class and had a full complement of safety equipment and appropriate emergency supplies including lifejackets, spare parts kit, tool kit, first-aid supplies, flare gun, and air horns. The *Venture III* will be conveniently berthed at Atlantic Highlands Municipal Marina.

Figure 9. Survey vessel, the *Venture III*.

Task 3. Data Analysis

Upon completion of the remote-sensing survey the data will be reviewed. This task essentially entails the archaeologist and remote-sensing specialist analyzing the previously acquired and processed data. Side scan features and magnetic anomalies will be tabulated and prioritized as to possible significance by employing signal characteristics e.g., spatial extent, structural features, etc. Magnetic data will be presented in a magnetic contour map(s) with track line format. Specific side scan targets will also be presented on the map and will be illustrated and discussed individually. The magnetic anomalies and/or side scan targets shown on the map(s) will be sequentially numbered, and tabulated as to location (northing and easting), as well as magnetic deviation. The contoured/labeled targets are then compared with strip chart records and attendant side scan data. Each magnetic anomaly or side scan target, described with the proper terminology and locational and positional information, will be included. If any of the remote sensing targets correlate with any documentary evidence it will be noted. Tables of remote sensing targets will be included in the report of findings. Digital data, including target locations and tracklines, will be provided in georeferenced format compliant with SDSFIE and FGDC standards.

The evaluation of the potential cultural significance of targets will be conducted and is dependent on a variety of factors. These include the detected characteristics of the individual targets (e.g., magnetic anomaly amplitude and duration, and side scan image configuration), association with other side scan or magnetic targets on the same or adjacent lines, relationships to observable target sources such as channel buoys or pipeline crossings, as well as correlation to the historic record. Magnetic anomalies are evaluated and prioritized on the basis of amplitude or deflection intensity in concert with duration or spatial extent. Targets such as isolated sections of pipe can normally be immediately discarded as non-significant.

Targets that are likely to represent potential historical shipwrecks or other potentially historic submerged resource will be identified, and recommendations will be made relative to the potential significance of the target identified. These recommendations will include a motivation as to the significance of the targets. In addition, recommendations for any further work (i.e., identification by archaeological diver) or avoidance (if an option) will be included. The archaeological methods to be used and the archaeological information desired will be indicated. Isometric maps of these potentially significant anomalies will be produced and presented in the report.

Magnetometer Analysis

It should be stated that the interpretation of data collected by the magnetometer is perhaps the most problematic to analyze. Magnetic anomalies are evaluated and prioritized on the basis of magnetic amplitude or deflection of gamma intensity in concert with duration or spatial extent; they are also correlated with side-scan targets. The problems of differentiating between modern debris and shipwrecks on the basis of remote-sensing data have been discussed by a number of authors. This difficulty is particularly true in the case of magnetic data, and therefore it has received the most attention in the current body of literature dealing with the subject. Pearson and Saltus state that "even though a considerable body of magnetic signature data for shipwrecks is now available, it is impossible to positively associate any specific signature with a shipwreck or any other feature" (1990:32). There is no doubt that the only positive way to verify a magnetic source object is through physical examination. With that said, however, the size and complexity of a magnetic signature does provide a usable key for distinguishing between modern debris and shipwreck remains (see Garrison et al. 1989; Irion et al. 1995; Pearson et al. 1993). Specifically, the magnetic signatures of most shipwrecks tend to be large in area and tend to display multiple magnetic peaks of differing amplitude.

Side Scan Sonar Analysis

By contrast, side-scan sonar analysis is less problematic. The chief factors considered in analyzing side scan data include linearity, height off bottom, size, associated magnetics, and environmental context. Since historic resources in the form of shipwrecks usually contain large amounts of ferrous compounds, side-scan targets with associated magnetic anomalies are of top importance. Targets with no associated magnetics usually turn out to be items such as rocks, trees, and other non-historic debris of no interest to the archaeologist. Also, since historic shipwrecks tend to be larger in size, smaller targets tend to be of less importance during data evaluation. In addition, the area in which the target is located can have a strong bearing on whether or not the target is selected for further work. If a target is found in an area with other known wreck sites, or an area determined to be high probability for the location of historic resources, it may be given more consideration than it would have otherwise. However, every situation, and every target located, is different, and all side-scan targets are evaluated on a case-by-case basis.

Subbottom Profiler Analysis
Subbottom profilers generate low frequency acoustic waves capable of penetrating the seabed and then reflect off boundaries or objects within the subsurface. These returns are received by hydrophone or hydrophone array operated in close proximity to the source. The data are then processed and reproduced as a cross section scaled in two way travel time (the time taken for the pulse to travel from the source to the reflector and back to the receiver). This travel time can then be interpolated to depth in the sediment column by reference to the travel time of the sound down (averaging 1500 m/s) and forward (speed of the vessel).

Subbottom in the identification of shipwreck sites
Previous research (Quinn et al. 1997; 1998) has shown that wooden wreckage can be recognized, dependent on the type of wood (hard woods better), size of the remains and context (sand or silt, etc). The strategy for identifying historic wrecks was to identify seismic features in the strata that might be coincident with magnetometer fluctuations, and thus indicate buried wreckage. In addition, the subbottom profiler record includes data on precise depth to bottom, and so can be used to reconstruct bathymetry.

Wood objects of sufficient density and size can be sensed with Chirp systems (Figure 2), but the image is dependent on "*the orientation of the incident compression wave relative to the axis of the woods elastic symmetry cellular structure*" (Quinn et al. 1997:27). In other words, the ability of the sensor to detect buried shipwreck remains is dependent on which angle the wood is approached with the sound waves, the character of the burial sediment, and the size of the remains (ibid:33).

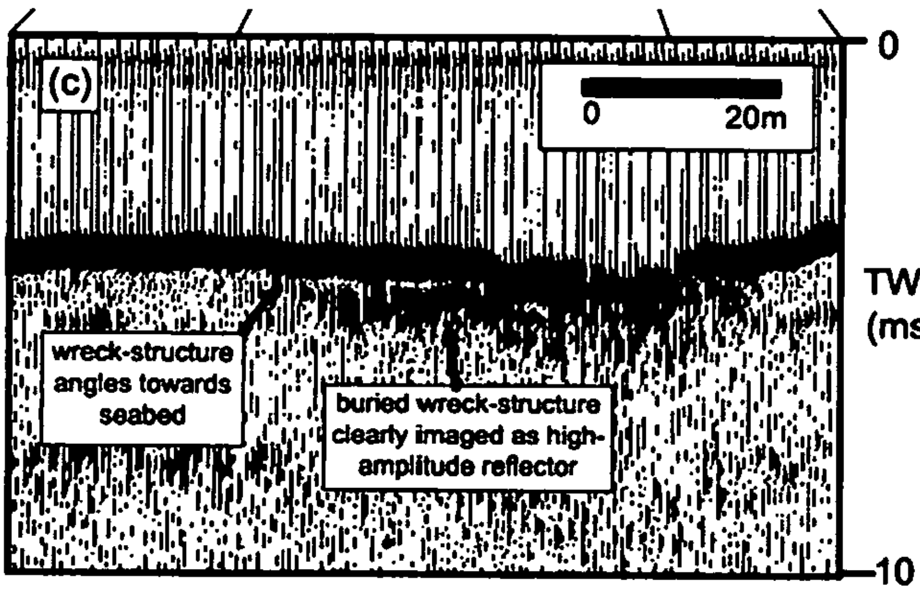


Figure 2. Example of subbottom profiler images of known 18th Century oak vessel H.M.S. *Invincible* (Quinn et al. 1997). Enlarged band-pass filtered section of the exposed starboard side (left to right in the above diagram). The buried oak wreck structure is clearly imaged as high amplitude reflector in section.

Figure 2 shows an example of a large area of wreck remote sensed with subbottom profiler, operating at a 2 to 8 kHz swept frequency band. This wreck, H.M.S. *Invincible*, is oak and partially buried by unconsolidated (sand) sediments – an environment similar to the current project area. Note that there is nothing inherent in the image that indicates wreckage except that it is known that wreckage exists where the dark areas, indicating a wide area low amplitude reflector, occur. Additional data, such as that obtained from a magnetometer, might help differentiate actual wreck sites from other objects presenting similar reflective characteristics.

Task 5. Report Preparation

Following data analysis and archival research, one interim report will be provided to the District within four weeks of completing the fieldwork. Four copies of the Draft Report will be submitted within 8 weeks from the completion of the fieldwork. The report will describe results and recommendations and will also describe and fully document the conduct of all phases of the project. A background historical overview of the project area, as well as a description of the current project area environment will be included.

The report will conform to *American Antiquity* style. The report will be authorized and signed by the Principal Investigator. The report will meet all format and presentation requirements specified in the SOW. Six copies of the final report will be submitted immediately after receipt of agency review comments. Primary authorship of the report of investigations will be the responsibility of the Principal Investigator. The necessary support personnel, e.g., Computer Programmer, Word Processor, Draftsperson, Editor, will be provided from Panamerican's permanent staff. The final report submittal will include copies of magnetometer and side scan sonar records.

Project Personnel

The survey crew will be composed of three positions: a Principal Investigator, and Underwater Archaeologist/Remote Sensing Specialist, and Remote Sensing Technician/Archaeological Diver.

Mr. Stephen R. James, Jr. will serve as Project Manager for the duration of this project and will oversee all aspects of the project. Mr. James holds a degree in anthropology from Memphis State University and a master's degree in nautical archaeology from the Institute of Nautical Archaeology, Texas A&M University. Register of Professional Archaeologists (RPA) certified since 1985, and with 25 years of experience in maritime archaeology, he has extensive project experience and has directed and conducted all phases of work on submerged sites including archival research, remote sensing surveys, anomaly assessment, site testing, and full-scale shipwreck mitigation. Furthermore, he has directed numerous projects in the State of Florida (see list above).

Mr. Andrew D. W. Lydecker, who will act as Principal Investigator for the investigation, holds dual Masters degrees in Archaeology and in the Science of Cartography and GIS, both from the University of Wisconsin. Mr. Lydecker brings a depth of applicable capabilities to the team. Mr. Lydecker has worked with Panamerican as early as 1995 in the data recovery of wrecks off New

Jersey, and recently participated in the diver assessment and data recovery on Civil War wrecks in the Yazoo River Drainage for the Vicksburg District. At home with AutoCad, Arc/Info, Erdas, Idrisi and other GIS platforms Mr. Lydecker is well-versed in remote sensing data manipulation (i.e. magnetic contour map production) and GIS presentation, he recently directed a large remote sensing survey in Chesapeake Bay, Maryland for the Maryland Environmental Service of two island restorations areas. He recently directed anomaly investigations in Tampa Harbor for the Jacksonville District under contract to the Memphis District, and he directed the original Tampa Bay Remote Sensing Survey that preceded this investigation. Relevant to this investigation, he recently directed a two month magnetometer and sidescan sonar survey of the New York Harbor 50-ft. Navigation Project for the New York District Corps and directed diving investigations of targets identified during the survey. RPA certified, Mr. Lydecker is a graduate of the U.S. Army Corps of Engineers Dive Supervisor and Safety Course taught at Key West.

Dr. Michael Faught, who has been with Panamerican for four years, will act as Underwater Archaeologist for the project. With a Ph.D. in Anthropology University of Arizona, Tucson (1996), his past tenure was Assistant Professor in the Department of Anthropology at Florida State University where he developed and taught principles and methods for continental shelf prehistoric archaeology methods of U/W site survey, remote sensing, mapping, testing, and excavation. Since joining Panamerican, he has participated in and directed numerous remote sensing survey and diving projects. He recently conducted a remote sensing shipwreck survey in Charlotte Harbor, Florida for Mote Marine Laboratory, and he just completed directing the remote sensing survey of the Arkansas River for the Little Rock District as part of their Arkansas River Navigation Improvement Project. He has recently conducted numerous similar cultural resources remote sensing in the various bays and rivers of Texas, Alabama, and Florida. RPA certified, Dr. Faught is a graduate of the U.S. Army Corps of Engineers Dive Supervisor and Safety Course, taught at Key West.

Mr. James Duff, who joined Panamerican in August of 1991 and is A.B.T. in the master's program at Texas A&M University, will act as Remote Sensing Technician. Prior to employment with Panamerican, he accumulated extensive professional experience working for the North Carolina State Underwater Archaeology Unit and participated in remote sensing surveys and anomaly investigations on projects with various universities and consulting firms. Since joining Panamerican, Mr. Duff has successfully directed and completed a variety of underwater cultural resource projects. Among these, he co-authored a shipwreck compilation and historic background report recently completed as part of a remote sensing survey for a submerged pipeline corridor from New Jersey to Staten Island, New York. That survey collected over 2,000 line miles of remote sensing survey records, including magnetometer, side scan sonar, and subbottom profiler, which were analyzed and interpreted by Mr. Duff for potentially significant cultural resources. Furthermore, he has participated in nearly all of our survey and diving projects. Mr. Duff is a graduate of the U.S. Army Corps of Engineers Dive Supervisor and Safety Course, taught at Key West.

REFERENCES CITED

Garrison, E.P., C.P. Giammona, F.J. Kelly, A.R. Trip, and G. A. Wolff
1989 *Historic Shipwrecks and Magnetic Anomalies of the Northern Gulf of Mexico: Reevaluation of Archaeological Resource Management Zone 1. Volume II: Technical Narrative. OCS Study/MMS 89-0024.* U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans.

Irion, J.B., S.B. Smith, P. Heinrich, S. Kilner, W.P. Athens, and D. Beard
1995 *Historical Assessment and Magnetometer Survey For Construction at Two Locations Along the Mississippi River, Jefferson and Issaquena Counties, Mississippi and East Carroll and Tensaw Parishes, Louisiana.* R. Christopher Goodwin & Associates, Inc. New Orleans, Louisiana. Submitted to the USACE, Vicksburg District.

Pearson, C.E., and A.R. Saltus, Jr.
1990 *Cultural Resources Investigation at Island 86, Mississippi River, Arkansas-Mississippi.* Coastal Environments, Inc., Baton Rouge, Louisiana. Submitted to the USACE, Vicksburg District.

Pearson, C.E., S.R. James, Jr., K.G. Hudson and J. A. Duff
1993 *Underwater Archaeology Along the Lower Navidad and Lavaca Rivers, Jackson County, Texas.* Conducted for the USACE, Galveston District, Galveston, Texas by Coastal Environments, Baton Rouge.

APPENDIX C: HEALTH, SAFETY, AND ACCIDENT PREVENTION PLAN

HEALTH, SAFETY AND ACCIDENT PREVENTION PLAN

REMOTE SENSING SURVEY OF PORTIONS OF AMBROSE CHANNEL IN CONNECTION WITH THE NEW YORK AND NEW JERSEY HARBOR NAVIGATION PROJECT, KINGS AND RICHMOND COUNTIES

Contract No. W912DS-07-D-0005
Delivery Order No. 0003

1.0 Introduction

1.1 Purpose

This document is the Remote Sensing Safety Plan (RSSP) to be employed by Panamerican Consultants, Inc., (Panamerican) of Memphis, Tennessee during a remote sensing survey for the New York District, U.S. Army Corps of Engineers (COE), in Ambrose Channel. Survey operations will include location, identification, and assessment of the potential significance of the wreck site. This investigation will be conducted for the COE in response to their Scope of Work (SOW) entitled *Remote Sensing Survey of Portions of Ambrose Channel in Connection with the New York and New Jersey Harbor Navigation Project, Kings and Richmond Counties, New York* under Contract No. W912DS-07-D-0005, Delivery Order No. 0003.

The following site-specific HSAP was prepared to provide safe procedures and practices for PCI personnel engaged in conducting cultural resources and archaeological investigations at the wreck site. The plan has been developed using as guidance the Occupational Safety and Health Administration (OSHA)1910.120 regulations and the US Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1; 2003). The purpose of this HSAP is to establish personnel protection standards and mandatory safety practices and procedures for this task specific effort. This plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may arise during the field archaeological and cultural resources efforts.

If for any reason the HSAP is altered in objective, personnel, or equipment, the New York District's Health and Safety Officer shall be contacted and shall review any revision prior to actual operation.

1.2 Applicability

The provisions of the plan are mandatory for all personnel engaged in archaeological and cultural resources investigations. All personnel who engage in these activities must be familiar with this plan and comply with its requirements.

All personnel will be responsible for operating in accordance with the OSHA regulations 29 CFR Part 1910.120 - 'Hazardous Waste Operations and Emergency Response' and U.S. Army Corps of Engineers EM.385-1-1. It should be noted however, that although this plan was produced in accordance with these requirements this work is not being conducted in areas designated as hazardous waste or material areas.

This plan is applicable to all aspects of the tasks detailed below associated with an archaeological and cultural resources investigations to be performed in project areas.

The plan is based on available information concerning possible industrial contaminants and physical hazards that exist, or may exist, at the project site and during planned tasks. If more data concerning the nature and/or concentrations of contaminants become available, the plan will be modified accordingly. Modifications will be made by the Site Safety Officer. All modifications will be documented in the plan and field book and provided to the Project Manager and the Health and Safety Manager for approval.

A copy of this plan will be available for review by all on-site personnel. In addition, a copy of the plan will be provided to all subcontractors prior to their initial entry onto the site.

Before field activities begin, personnel will be required to read the HSAP. All personnel must agree to comply with the minimum requirements of the site-specific plan, be responsible for health and safety, and sign the Statement of Compliance for all on-site employees before site work begins.

It should be noted the Panamerican personnel will NOT be diving during this investigation.

1.3 Field Activities

The tasks associated with the performance of the archaeological and cultural resources investigations include:

- Mobilization and Demobilization
- Documentary Research
- Remote Sensing using magnetometer, side scan sonar, and subbottom profiler
- Data Analysis

1.4 Personnel Requirements

Remote sensing will require a two person team. One person will run the navigation system and the magnetometer, while the second team member will run the sidescan sonar and the subbottom profiler (as needed). Key personnel vitae are included in Appendix A.

Key personnel are as follows:

Project Manager- Mr. Stephen R. James, Jr.
Field Director/Principal Investigator - Mr. Andrew D. W. Lydecker
Remote Sensing Specialist – Mr. James A. Duff

Site personnel and their duties are outlined below:

1) Field Director/Principal Investigator

The Field Director and/or Principal Investigator will be responsible for all personnel and subcontractors on-site and designates duties to the on-site personnel. The Field Director has the primary responsibility for:

- Assuring that personnel are aware of the provisions of this plan and are instructed in the work practices necessary to ensure safety in planned procedures and for dealing with emergencies.
- Verifying that the provisions of this plan are implemented.
- Assuring that all field personnel have the required training.
- Assuring that appropriate personnel protective equipment (PPE), if necessary, is available for and properly utilized by all personnel.
- Assuring that personnel are aware of the potential hazards associated with site operations.
- Supervising the monitoring of safety performances by all personnel to ensure that required work practices are employed.
- Maintain sign-off forms and safety briefing forms.

2) Remote Sensing Specialist

It shall remain the responsibility of each field crew member to follow the safe work practices listed in this HSAP and in general to:

- Be aware of the procedures outlined in this plan.
- Take reasonable precautions to prevent injury to himself and to his coworkers.
- Perform only those tasks that he believes can be done safely, and immediately report any accidents or unsafe conditions to the Safety Officer and Field Director.
- Notify the SSO and Field Director of any special medical problems (i.e., allergies or medical restrictions) and make certain that on-site personnel are aware of any such problems.
- Think "safety first" prior to and while conducting fieldwork.

The PCI crew can request assistance from the site safety officer or emergency personnel at any time during the course of fieldwork. Each crew member has the authority to halt work should he deem conditions to be unsafe. Visitors will be required to report to the Field Director and Site Safety Officer and follow the requirements of this plan.

2.0 COMPREHENSIVE WORK PLAN

This section comprises the organizational structure and work plan for the relocation and inspection of the Ambrose Channel wreck.

2.1 Project Phases

Located in the Ambrose Channel, the vessel lies within New York State. The SOW lists the Tasks, with the field portion as follows:

1. Perform magnetometer and side scan sonar survey of the project areas to locate any potential shipwreck sites. Perform subbottom profiler refinement of any potential shipwreck targets.

2.2 Vessel Access

The locations of the areas to be examined mandate the employment of a large crew-type dive vessel for survey. The survey areas are entirely within in the navigation channel.

2.3 Required Equipment Types

Major Equip. Type	Specific Requirement
Survey Vessel	A vessel large enough to accommodate the entire survey team plus survey equipment and peripherals such as generators is required.

2.4 Schedule and Duration of Survey

The project is tentatively scheduled for April 11th – May 11th, 2008. Work will take place on each day that weather permits safe operations. Work will not commence until the Health and Safety Plan is approved by the USACE Health and Safety Officer.

3.0 HAZARD EVALUATION

Based on the nature of these archaeological activities, which include vessel operations in high marine traffic areas, the hazard potential is deemed moderate. Activities will also be conducted in areas of historic industrial activity. The following summarizes the potential hazards associated with vessel traffic as well as potential chemical, physical and biological hazards.

3.1 Activity Hazard Analysis

3.1.1 Vessel Activity

HAZARD	MEANS OF PREVENTION	ACTION IN CASE
Weather	Monitor weather prior to leaving port. Constantly observe weather while conducting investigations. Indications of imminent foul weather are antithetical to safe investigations.	Do not have vessel leave port. Vessel return to port.
Fire aboard Vessel	All survey crew will become familiar with placement of fuel shutoff and fire suppression equipment.	Contact nearest Coast Guard facility. Engage fire suppression equipment.
Falling objects	All overhead objects will be secured.	Apply first aid or other appropriate treatment.
Falling, Tripping, and Slipping	Crew will be aware of the local environment and wear proper foot gear for environment. One hand for the boat one hand for self rule.	Apply first aid or other appropriate treatment. Seek medical help if necessary.
Man Overboard	Crew will wear Personal Flotation Device (PFD) when applicable.	Discontinue investigation. Recover man overboard.
Hypothermia	Crew will wear appropriate clothing for environmental conditions. Avoid exposure to extreme cold and unnecessary discomfort.	Supply with warm liquids and cover until body temperature returns to normal.
Drowning	Crew will wear Personal Flotation Device (PFD) when applicable. Crew will be familiar with the dive vessel and emergency equipment placement for immediate use if necessary.	Administer CPR as appropriate & seek medical attention immediately.
Vessel Sinking	Evaluate seaworthiness of vessel prior to any survey or work activity. Know location of all floatation devices and life rafts on project vessel. Know radio signal for emergencies "May Day".	Contact nearest Coast Guard facility. Abandon vessel.

3.2.2. General Hazard Analysis

ACTIVITY	POTENTIAL PROBLEMS	MEANS OF PREVENTION
Work Site	General public, pleasure and commercial vessels	Limit or Prevent Access as necessary Maintain communication via marine band radio.
Accident Prevention	Public and personal injury	Wear proper clothing and safety equipment. Signage and other applicable warning devices.
Emergencies, Injuries and Accident Reporting	Public and personal injury.	Maintain survey crew certification in both CPR and First Aid. Maintain first aid kits. Post local emergency numbers. Promptly report and investigate all accidents.
Machinery And Equipment Operation	Equipment or property damage Potential for personnel injury.	All machinery and equipment will be operated only by knowledgeable operators
Vehicle Operation	Equipment or property damage Potential for personnel injury.	All survey crew members will obey local traffic laws Project vehicles will be properly maintained.
Loading and Offloading Equipment	Equipment or property damage Potential for personnel injury.	Each crew member will know abilities and not exceed them. Assign proper number of personnel to each task.
Water Access And Equipment Operation	Drowning, falling, or slipping	All floating plant marine work will be performed in accordance with the requirements of EM385-1-1 Section 26

The above is a list of potential hazards that may be encountered during the current project. This list will be presented to each survey crew member for their review and input prior to any survey activity.

While on site other, not readily definable hazards may occur. A continuous evaluation of hazards will be conducted while engaging in project activities. Each new hazard that presents itself will be listed as they occur and preventive measures will be developed and implemented. Upon the completion of the investigation a review of the effectiveness of the present hazard analysis will be conducted to evaluate the overall effectiveness and determine if any changes or additional input is needed. Any hazards encountered during the investigation not previously listed will be included in a post survey hazard evaluation for better pre-project hazard analysis during future projects.

4.0 SAFE WORKING PRACTICES

4.1 General Practices

The following general safe work practices apply:

- Contact with potentially contaminated substances should be avoided. Puddles, pools, mud, etc. should not be walked through if possible. Kneeling, leaning, or sitting on equipment or on the ground should be avoided whenever possible.
- Unusual site conditions shall be promptly conveyed to the SSO and project management for resolution.
- A first-aid kit shall be available at the site.
- Field personnel should use all their senses to alert themselves to potentially dangerous situations (i.e., presence of strong, irritating, or nauseating odors, deteriorated surfaces, unstable debris, etc.).
- Field personnel must attend safety briefings and should be familiar with the physical characteristics of the investigation, including:
  - Accessibility to associates, equipment, and vehicles.
  - Site access.
  - Routes and procedures to be used during emergencies.
- Personnel will perform all investigation activities with a buddy who is able to:
  - Provide his or her partner with assistance.
  - Notify the SSO or Field Director if emergency help is needed.
- Work activities shall be terminated immediately in event of thunder and/or electrical storm.
- The use of alcohol or drugs at the site is strictly prohibited.

5.0 PERSONAL PROTECTIVE EQUIPMENT

As required by OSHA in 29 CFR 1920.132, this plan constitutes a workplace hazard assessment to select personal protective equipment (PPE) to perform the archaeological and the cultural resources investigation.

Protective clothing and equipment to initiate the project will include:

- Work clothes including long pants
- Steel-toed safety boots
- Safety glasses
- Hard hat
- Personal floatation device (work vest)

6.0 EMERGENCY INFORMATION

In the event of an emergency, the field team members or the SSO will employ emergency procedures. A copy of emergency information will be kept in the field vehicle and will be reviewed during the initial site briefing. Copies of emergency telephone numbers and directions to the nearest hospital will be prominently posted in the field vehicle.

6.1 Emergency Medical Treatment And First Aid

A first aid kit large enough to accommodate anticipated emergencies will be kept in the boat. If any injury should require advanced medical assistance, emergency personnel will be notified and the victim will be transported to the hospital. Keys for the field vehicle will be left in or near the ignition.

In the event of an injury or illness, work will cease until the SSO and Field Director have examined the cause of the incident and have taken appropriate corrective action.

6.2 Emergency Telephone Numbers

Emergency telephone numbers for medical and chemical emergencies will be posted in the field vehicle are listed below:

EMERGENCY	911	EMERGENCY
HOSPITAL	201-858-5000	Riverview Medical Center 1 Riverview Plaza Red Bank, NJ 07701
HOSPITAL	718-226-9000	Staten Island University Hospital 475 Seaview Ave., Staten Island, NY 10305

HOSPITAL	718-226-2000	Staten Island University Hospital 375 Seguine Ave., Staten Island, NY 10309

UNITED STATES COAST GUARD, 1ST DISTRICT

GROUP NEW YORK	212-668-7913	
SEARCH AND RESCUE	212-668-7913/7937	24-HOUR HOTLINE
Operations Office	212-668-7913	USCG, 1st District, Governor's Island
Air Station	718-765-2409	USCG Air Station Brooklyn
Waterways Office	212-668-7906	Waterways,Governor's Island

NEW JERSEY STATE MARINE POLICE, PORT NEWARK

State Marine Police	201-578-8173	Port Newark Office

6.3 Emergency Standard Operating Procedures

The following standard operating procedures are to be implemented by on-site personnel in the event of an emergency. The SSO shall manage response actions.

- Upon notification of injury to personnel, the designated **emergency signal shall be sounded**, if necessary. All personnel are to terminate their work activities and assemble with the SSO. If the emergency is determined serious or life threatening, emergency medical services will be activated by dialing 911. If the injury is minor, but requires medical attention, the SSO shall accompany the victim to the hospital and provide assistance in describing the circumstances of the accident to the attending physician.
- Upon notification of an equipment failure or accident, the SSO shall determine the effect of the failure or accident on site operations. If the failure or accident affects the safety of personnel or prevents completion of the scheduled operations, all personnel are to leave the area until the situation is evaluated and appropriate actions taken.
- Upon notification of a natural disaster, such as tornado, high winds, flood, thunderstorm or earthquake, on-site work activities are to be terminated by the SSO and all personnel are to evacuate the area.

6.4 Emergency Response Follow-Up Actions

Following activation of the Emergency Response Plan, the SSO shall notify the project manager and other PCI managers. The SSO shall submit a written report documenting the incident within two working days (see Attachments).

6.5 Medical Treatment For Site Accidents/Incidents

The SSO shall be informed of any site-related injury, exposure or medical condition resulting from work activities. All personnel are entitled to medical evaluation and treatment in the event of a site accident or incident.

SITE MEDICAL SUPPLIES AND SERVICES

The SSO or a trained first aid crew member shall evaluate all injuries at the site and render emergency first-aid treatment as appropriate. If an injury is minor but requires professional medical evaluation, the SSO shall escort the employee to the appropriate emergency room. For major injuries occurring at the site, emergency services shall be requested.

First-Aid Kits

A first-aid kit shall be available, readily accessible and fully stocked. The first-aid kit shall be located within specified vehicles used for on-site operations.

7.0 PERSONNEL TRAINING REQUIREMENTS

7.1 Initial Site Entry Briefing

Prior to initial site entry, the SSO shall provide all personnel (including site visitors) with site-specific health and safety training. A record of this training shall be maintained. This training shall consist of the following:

- Discussion of the elements contained within this plan
- Discussion of responsibilities and duties of key site personnel
- Discussion of physical, biological and chemical hazards present at the site
- Discussion of work assignments and responsibilities
- Discussion of the correct use and limitations of the required PPE
- Discussion of the emergency procedures to be followed at the site
- Safe work practices to minimize risk
- Communication procedures and equipment
- Emergency notification and procedures

7.2 Additional Training

The following additional training is required for all full-time site workers.

- Red Cross Standard First Aid
- Red Cross CPR

- Certified Oxygen Administration

7.3 Daily Safety Briefings

The SSO will determine if a daily safety briefing with all site personnel is needed. The SSO shall document the daily briefings in the field log book. This documentation shall include health and safety topics covered and attendees at the briefing. The briefing shall discuss the specific tasks scheduled for that day and the following topics:

- Specific work plans
- Physical, chemical or biological hazards anticipated
- Fire or explosion hazards
- PPE required
- Emergency procedures, including emergency escape routes, emergency medical treatment, and medical evacuation from the site
- Weather forecast for the day
- Buddy system
- Communication requirements
- Site control requirements

APPENDIX A

VITAE