

FE379

FE379

Diagram No. 1210-4

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey .. Hydrographic/Side Scan Sonar ..

Field No. RU-20-8-92

Registry No. FE-379SS

LOCALITY

State Massachusetts

General Locality Rhode Island Sound

Sublocality 2.5 NM SSW of Cuttyhunk Island

1992 - 93

CHIEF OF PARTY
LCDR N.E. Perugini

LIBRARY & ARCHIVES

DATE February 1, 1994

PRODUCTS

FEB 27 1995

FEB 27 1995

ALG

PRODUCTS

CP2
13218
12300
13200
13009
13006
13003

EXAM. no corr. at this scale

6/23/95 JB

HYDROGRAPHIC TITLE SHEET

FE-379SS

INSTRUCTIONS - The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

FIELD NO.

RU-20-8-92

State Massachusetts

General locality Rhode Island Sound

Locality 2.5 NM SSW of Cuttyhunk Island

Scale 1:20,000 Date of survey Aug 10 to Aug 20, 1992

Instructions dated April 10, 1992 Project No. OPR-B616

Vessel NOAA Ship RUDE (9040), Launch RU-3 (1290)

Chief of party Lieutenant Commander N. E. Perugini

Surveyed by P.L. Schattgen, J.A. Illg, R.T. Brennan, D.E. Williams

Soundings taken by echo sounder, ~~hand lead, pole~~ XXXXXX pneumatic depth gauge

Graphic record scaled by NEP, PLS, TRW, JAI, RTB, DEW

Graphic record checked by NEP, PLS, TRW, JAI, RTB, DEW

Protracted by N/A Automated plot by N/A *(Synetics 1201)*

Verification by N/A *Atlantic Hydrographic Section* *Plotter, AHS*

Soundings in ~~XXXXXX~~ XXXXXX meters at MLW MLLW

REMARKS: This survey encompasses AWOIS 8297.

Note in the Descriptive Report were made in red during office processing.



AWOIS AND SURF - RWD

RWW 2/24/94



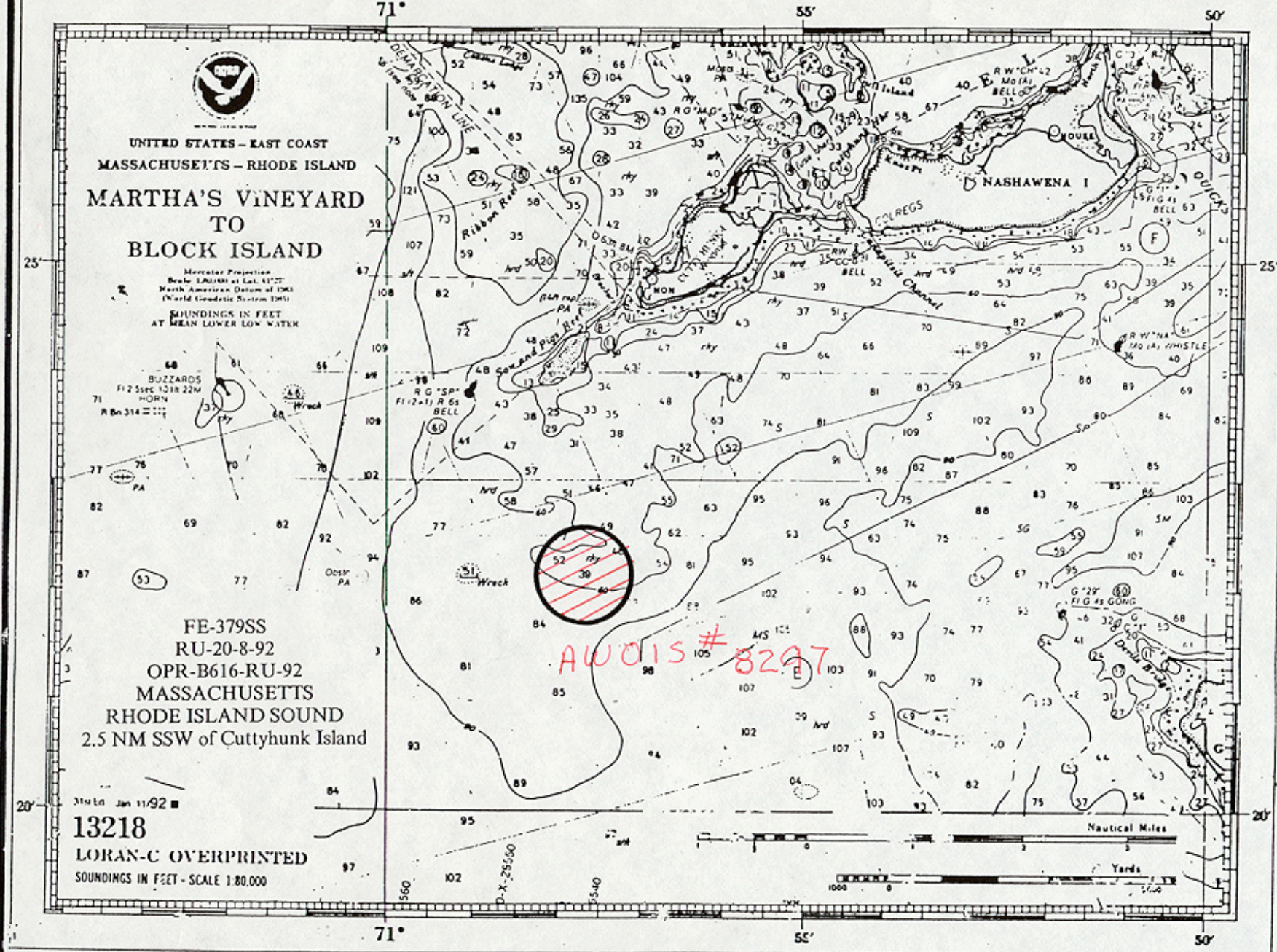
UNITED STATES - EAST COAST
 MASSACHUSETTS - RHODE ISLAND
**MARTHA'S VINEYARD
 TO
 BLOCK ISLAND**

Mercaator Projection
 Scale 1:60,000 at Lat. 41°30'
 North American Datum of 1983
 (World Geodetic System 1983)
 SOUNDINGS IN FEET
 AT MEAN LOWER LOW WATER

BUZZARDS
 Fl 2 Ssec 101R 22M
 HORN
 A Bn 314

FE-379SS
 RU-20-8-92
 OPR-B616-RU-92
 MASSACHUSETTS
 RHODE ISLAND SOUND
 2.5 NM SSW of Cuttyhunk Island

13218
 LORAN-C OVERPRINTED
 SOUNDINGS IN FEET - SCALE 1:80,000



31416 Jan 11/92

D-X-25560

Nautical Miles

Yards

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A. PROJECT

A.1 This survey was conducted in accordance with Hydrographic Project Instructions OPR-B616-RU, Buzzards Bay and Nantucket Sound, Massachusetts.

A.2 The original date of the instructions is April 10, 1992.

A.3 The following changes are relevant to this project:

Change No. 1, dated May 8, 1992, authorizes the installation of a tide station at Cuttyhunk Pond Entrance in lieu of a site at Gay Head, Massachusetts.

Change No. 2, dated August 12, 1992, authorizes the installation of a tide station at Penikese Island in lieu of a site at Gay Head, Massachusetts.

Change No. 3, dated September 14, 1992 authorizes the use of the Sakonnet Point tide station for this survey.

A special project was conducted in conjunction with this survey. In a memorandum from the Chief, Nautical Charting Division to the Director, Atlantic Marine Center, dated August 18, 1992, RUDE was directed to conduct a test of the SEABAT 9001, shallow water multibeam survey system. Data acquired on DN's 232 and 233 were used for both the SEABAT test and this survey.

A.4 A sheet letter was not specified in the project instructions.

A.5 This survey was initiated by the grounding of the luxury liner QUEEN ELIZABETH 2 (QE2). The ship went aground at approximately 10 p.m. EDST on the evening of August 7, 1992. The position of the grounding provided to the RUDE from Hydrographic Surveys Branch, Rockville, Md., was:

41° 22.1' N
070° 57.7' W

The reported grounding position was approximately 2.5 nm south southwest of Cuttyhunk Island.

B. AREA SURVEYED

B.1 This survey consists of one AWOIS item (8297) located approximately 2.5 nautical miles south southwest of Cuttyhunk Island. The AWOIS item originated after the grounding of the QE2.

B.2 The approximate limits of this survey are within an 800 meter radius of the following coordinates: *From approx Lat 41° 21' 55"*

41° 22.1 N
071° 57.7 W

to Lat 41° 22' 33"

Long. 70° 57'

Long. 70° 58' 31"

Most of the survey work was conducted in the immediate proximity of grounding. This area is approximately 200 meters ENE of the reported position.

B.3 Data acquisition began on August 10, 1992 (DN 223) and concluded on August 20, 1992 (DN 233).

C. SURVEY VESSELS

C.1 The following vessels were used during this project:

<u>VESSELS</u>	<u>ELECTRONIC DATA PROCESSING NUMBER</u>	<u>PRIMARY FUNCTION</u>
NOAA Ship RUDE (S590)	9040	Hydrography/ Side Scan Operations
RUDE Launch (RU3)	1290	Diving Operations

C.2 The SEABAT 9001 transducer was attached to a pipe which was temporarily affixed to the starboard side of the ship. SEABAT operations did not interfere with standard hydrographic data acquisition.

No other unusual vessel configurations or problems were encountered.

D. AUTOMATED DATA ACQUISITION AND PROCESSING

D.1 Survey data acquisition and processing were accomplished using the HDAPS system with the following software versions:

Program	Version	Dates Used
SURVEY	6.10	DN 223 - 233
DAS_SURV	6.20	DN 223 - 233
POSTSUR	5.20	DN 223 - 233

D.2 Other software includes VELOCITY 1.11 dated March 9, 1990 used to generate sound velocity corrector tables, and MTEN (dated between 1985 and 1986) for horizontal control verification and establishment.

D.3 Standard data acquisition and processing techniques were used to conduct this survey. Although this survey was accomplished under project instructions for OPR-B616, data were acquired under the HDAPS project OPR-B660. This was due to the fact that the ship did not receive formal project instructions until after the survey began. The ship initially assumed that the survey would fall under the same project that it had been working on before the grounding (OPR-B660). This misunderstanding has no affect on survey data.

The data is now completely under OPR-B616

E. SONAR EQUIPMENT

E.1 Side scan sonar operations were conducted using an EG&G Model 260 slant range corrected side scan sonar recorder and a Model 272-TD towfish. All side scan operations were conducted from the RUDE (vessel # 9040). The following list shows equipment serial numbers and corresponding dates used:

Equipment Type	Serial Number	Dates Used
Recorder	0012104	Entire Survey
Towfish	11908 (single 11902 frequency)	DN 223 DN 225, 230

E.2 The side scan sonar towfish was configured with a 20° beam depression, which is the normal setting yielding the best beam correction.

E.3 The 100 Khz frequency was used throughout this survey.

E.4 a) The 100-meter range scale was used to conduct the initial investigation on DN 223. East-West lines were run over the northern two-thirds of the search radius in order to obtain preliminary information concerning the location of the grounding.

On DN's 225 and 230, additional side scan sonar lines were run along the QE2's projected track, using the 50-meter and 75-meter range scales.

The primary goal of this survey was to locate the area where the QE2 grounded. This survey was not conducted with the intent of performing an item disproval. The initial side scan sonar lines on DN 223 were run at 160-meter spacing, which yielded a 40-meter overlap on adjacent lines. This overlap was not consistently achieved due to the high density of lobster pots in the area. Very often the ship was 20-meters off line while trying to avoid lobster pots.

No side scan sonar lines were run in the southern one third of the search circle. The preliminary investigation on DN 223 indicated deeper water in this region. Recognizing this, the ship opted to focus the investigation in the shoaler parts of the search circle.

b) Confidence checks were obtained by noting recognizable bottom characteristics at the edges of the side scan sonar range scale. On DN 223, two confidence checks were annotated when the sonagram showed sand waves across the entire port and starboard channel. Numerous rocks were also noted along the extent of the range scale.

E. SONAR EQUIPMENT (continued)

On DN's 225 and 230, numerous boulders in the grounding area were noted along the extent of the range scale. Ultimately, the dimensions of some of these boulders were positively identified by divers. In particular, contacts 419.25P and 423.19P were significant boulders later identified by divers. Contact 419.21P was identified as "Red Rock 1," and Contact 423.19P is a boulder which proved to be the least depth of the survey.

c) As previously mentioned, the intent of this survey was to locate the QE2 grounding site, not to perform a full coverage side scan sonar survey of the area. One hundred percent side scan sonar coverage was obtained over most, but not all, of the northern two-thirds of the 800-meter radius circle. Numerous side scan sonar lines were run along the projected track of the QE2. The percentage of coverage achieved is not applicable to this survey.

d) Several factors affected the quality of sonargrams. On most lines, the ship had to zig-zag in order to avoid snagging the towfish in lobster pot lines. On some occasions, the sonargrams showed a slightly distorted image due to the constant turning. On DN 225, a 2° to 4° rolling of the ship slightly degraded the sonargram.

On DN 230, interference from another vessel towing a side scan sonar was noted on the sonargram (vicinity of 432.2). This interference did not severely degrade the quality of the image.

e) The towfish was deployed from the stern during the entire survey.

E.5 Most significant contacts were investigated by intensive echosounder development. Contacts suspected of being part of the grounding area were given highest priority for development. Some contacts located in deeper water (>20 m) were not investigated. Numerous diver investigations were conducted in the grounding area. Refer to section N.5 of the individual AWOIS discussion for specific contact development procedures.

E.6 As stated above, this survey was not conducted as a full coverage side scan sonar survey, therefore establishing proof of coverage does not apply. Selection of side scan sonar contacts was based on criteria set forth in the Field Procedures Manual. In areas where dense concentrations of boulders existed, the largest, most prominent features were logged in lieu of logging each contact.

E. SONAR EQUIPMENT (continued)

RUDE personnel performed the initial scanning and check scanning of the sonargrams. Mr. Norris Wike, from the Atlantic Hydrographic Section, worked aboard the ship for four days and check-scanned the sonargrams. RUDE personnel annotations were made in ink while Mr. Wike's changes and additions were made in pencil.

HDAPS contact tables 44 through 48, containing a total of 129 contacts were logged in conjunction with this survey.

F. SOUNDING EQUIPMENT

F.1 All hydrographic soundings were acquired using a Raytheon 6000N Digital Survey Fathometer (DSF). One DSF 6000N was used during the entire survey: S/N A106N.

F.2 Ten diver investigations were conducted on five days during this survey. Diver least depths were measured with a 3-D Instruments, Inc. precision direct drive depth gauge:

0 - 70 fsw (feet salt water)

S/N 201637

Pneumatic depth gauge checks were conducted in accordance with Hydrographic Survey Guideline No. 55. On several days, the angle of the leadline approached 10°, thus yielding slightly shoaler pneumatic depths than the slant leadline depth. In all cases, pneumatic depths were slightly shoaler than leadline depths, a phenomenon to be expected given the difficulty in obtaining a zero degree wire angle in a high current area.

F.3 There were no problems with sounding equipment that affected the accuracy or quality of the data.

F.4 Both the high (100 Khz) and low (24 Khz) frequency sounding data were recorded during data acquisition. Only high frequency soundings were plotted.

G. CORRECTIONS TO SOUNDINGS

G.1 a) The velocity of sound through water was determined using a Digibar Sound Velocity Probe (S/N 169), made by Odom. A Data Quality Assurance Test was conducted before the velocity cast to ensure the meter was within tolerance.

All data were processed using Velocity 1.11 software. The computed velocity correctors were entered into the HDAPS sound velocity table and applied on-line to both high and low frequency soundings. The sound velocity correctors applied to this survey are based on the casts recorded on the following dates:

Cast Num.	DN	Latitude	Longitude	HDAPS Table	Applied to Days
14	225	41° 21.7' N	070° 58.1' W	14	223-228
15	232	41 21.9' N	070 57.0' W	15	230-233

b) There was no variation in the DSF-6000N instrument initial.

c) No instrument correctors to the DSF-6000N were required.

d) A dual lead line comparison with the DSF-6000N was made in the project area on DN 224 at the following position:

41° 26.5' N
070° 53.8' W (11.6 m depth)

The greatest variation between leadline and DSF soundings was 0.1 meters. This is excellent agreement and provides an adequate check that the echosounder was functioning properly. Data from these comparisons are found in Separate IV.

Both of the leadlines used in the leadline to DSF 6000 comparison were calibrated by steel tape prior to the above comparison. A leadline correction of -0.3 feet was applied to leadline SN 100-2 while a -0.1 ft correction was applied to leadline SN 100-1.

e) All sounding correctors were applied to both the narrow (100 kHz) and wide (24 kHz) DSF 6000N beams.

G. CORRECTIONS TO SOUNDINGS (continued)

f) During the winter 1988 dry dock period, an exact vertical measurement was taken from the DSF transducer to a fixed point on the bridge wing. After the ship was re-floated, the height above the waterline was determined for this point. The ship's static draft was thereby calculated to be exactly 2.26 meters (7.4 feet). This draft value was applied to the sounding data via the HDAPS offset table.

g) Settlement and squat correctors for the RUDE were determined on the Elizabeth River, Norfolk, Virginia on March 13, 1991. An observer, stationed with a level on a pier, measured changes in relative height by sighting to a staff held at the longitudinal position of the ship's transducer. The ship steamed directly toward and then away from the observer. The toward and away runs were averaged and applied to soundings through the HDAPS offset table.

h) Heave data were acquired by a Datawell heave, roll and pitch sensor (S/N 19128-C), and were applied to soundings in real time. Only the heave corrections were applied to the plotted soundings.

See Separate IV for data records. *filed with the original field records*

G.2 There were no unusual or unique methods or instruments used for correcting echo soundings.

G.3 The sound velocity correctors resulting from velocity casts 14 and 15 were reapplied to the data at the end of survey activities. Section G.1 a) gives the periods that each velocity cast correctors were used for.

G.4 The ship's shallow water (0-70 fsw) pneumatic depth gauge was calibrated on January 16, 1992. This gauge was bought new prior to the start of the 1992 field season and calibrated by the manufacturer. Corrector data from the calibration was not applied to pneumatic depths since it was less than 0.1 meters.

G.5 Generally, sea conditions greater than one meter affected the sounding record, creating a trace of constant peaks and dips. Application of heave correctors to raw echo soundings appeared to accurately represent true depths.

G.6 a) The tidal datum for this project is Mean Lower Low Water. The operating tide station at Newport, Rhode Island (845-2660) served as direct control for datum determination. This station also served as the reference station for predicted tides. Data for predicted tides were provided on floppy magnetic disk before the start of the project.

G. CORRECTIONS TO SOUNDINGS (continued)

b) Tidal data used during data acquisition were obtained from Table 2 of the East Coast of North and South America Tide Predictions, and applied to the digital tide data using the HDAPS software. The subordinate station for predicted tides was:

NO.	PLACE	POSITION	TIME		HEIGHT	
			High water	Low water	High water	Low water
1105	Cuttyhunk Pond	41° 25'N 70° 55'W	+0:01	+0:01	*0.97	*0.97

Tidal correctors were applied on-line using the HDAPS predicted tide table number 18. *Approved Tides & Zonings were applied during office processing*

c) Zoning for this project is not consistent with the original project instructions. Change No. 3 to the project instructions waives the requirement for establishing tide stations at Penikese Island, Gay Head, and West Chop Light, Massachusetts. In lieu of establishing these stations, the tide station at Sakonnet Point, Rhode Island (845-0768) and the control station at Newport, Rhode Island (845-2660) remained operational throughout the survey period. The Newport tide gauge operates year-round while the Sakonnet Point gauge has been operational since April, 1992.

A request for approved tides was mailed on September 9, 1992. The request for approved tides was not mailed immediately upon the completion of field work. After the initial investigation, there was discussion about the possibility of conducting more field work in the area, therefore the request was delayed until a decision was made to forward the data to AHS.

H. CONTROL STATIONS See also Section 2.a. of the Evaluation Report

H.1 The horizontal datum for this project is the North American Datum of 1983 (NAD 83).

H.2 The list of Horizontal Control Stations is ~~located in Appendix III.~~ appended to this report

H.3 No horizontal control stations were established for this survey. Existing NGS stations were used. All horizontal control stations used during this survey are third-order.

H.4 All horizontal control stations are within NGS Quadrants N0410703, N0410711 and N0410712. All are referenced to the NAD 83 Horizontal Datum.

H.5 Verification of horizontal control was accomplished by standard ground survey techniques. Field records have been forwarded to Coastal Surveys Unit in Norfolk.

H.6 There are no photogrammetric problems, positioning problems or unconventional survey methods pertinent to this survey.

I. HYDROGRAPHIC POSITION CONTROL *See also Section 2a. of the Evaluation Report*

I.1 With the exception of eight detached positions recorded on DN 228 (Pos 379-386), this survey was conducted entirely with the use of the Differential Global Positioning System (DGPS). Positions 379 to 386 were recorded using Falcon multiple lines of position. These positions were ultimately rejected as redundant data.

The Coast Guard-maintained radiobeacon at Montauk Point supplied DGPS correctors. The position of the radiobeacon is:

41° 04' 02.047" N
071° 51' 38.274" W

I.2 Hydrographic position accuracy requirements were met as specified by the Hydrographic Manual and Field Procedures Manual (FPM). On seven of the nine days when DGPS position control were used, at least one Falcon LOP was available to continually check the accuracy of the DGPS positions. On many occasions, up to three Falcon LOPs were used for these checks.

"Positions for ... side scan sonar surveys shall not exceed an Expected Positional Error (EPE) of 1.5mm at the scale of the survey." (FPM 3.4.2). Therefore, data were not collected with an EPE greater than 35 for this 1:20,000-scale survey.

The HDOP limit was computed using the following equation:

$EPE = HDOP * \sqrt{ESE^2 + EDE^2}$, where

EPE = Expected Positional Accuracy = 35 meters
ESE = Estimated System Error = 4 meters
EDE = Estimated Distance Error = 2 meters
(less than 100 miles to Montauk Point)

From the above equation, the HDOP limit = 7.8.

Data were acquired during this survey using a 1:10,000 scale plotter sheet. Therefore, HDAPS was using a 1:10,000 standard for HDOP and EPE even though the scale of the survey was 1:20,000. On some occasions, HDAPS automatically flagged some HDOP and EPE values on the printout as being high. In reality, these values were very often within tolerance for a 1:20,000 scale survey.

If there was some question concerning the accuracy of a DGPS position, the Falcon residual(s) would be checked during post-processing. After examining the residual(s), and viewing how the questionable position corresponded with other good positions, a determination was made to smooth the position or retain the original coordinates.

I. HYDROGRAPHIC POSITION CONTROL (continued)

I.3 Control Equipment:

DGPS:

Ashtech Satellite Receiver: S/N CD0000458769, Firmware 1E03
Receiver Version: TD08

Motorola Magnavox MX50R Radiobeacon Receiver: S/N 036

Mini-Ranger:

Falcon 484 by Motorola Inc.

Baseline Calibration 4, C-0 Table 5

DN: 171	S/N	
	RPU	E0138
	R/T	F-3411
	R/S:	E-2915 (code 2)
		E-2969 (code 6)
		F-3217 (code 9)

I.4 DGPS performance checks were conducted in accordance with the Field Procedures Manual, section 3.4.4. Checks were performed by comparing Falcon multiple-LOP positions with DGPS positions. Checks were conducted on DN's 225, 226, 227, and 228. Although the scale of the survey was 1:20,000, the performance checks were conducted to 1:10,000 scale standards.

Baseline calibration #4 was conducted in New Bedford, Mass. on DN 171. The results of this baseline calibrations is found in
* SEPERATE III.

I.5 No calibration data were applied to raw DGPS positions. Baseline calibration number 4 correctors from HDAPS C-0 Table 5 were applied to Falcon ranges.

I.6 a) No unusual methods were used to calibrate or operate the electronic positioning equipment.

b) There were no equipment malfunctions. On several occasions, DGPS HDOP and EPE exceeded specified tolerances. Data acquisition was then suspended until these values returned to acceptable levels.

c) There were no occurrences of unusual atmospheric conditions that may have affected data quality.

d) There was no occurrence of weak DGPS signals. Poor satellite geometry was indicated by high HDOP values. Data acquisition was halted when this condition occurred. Calibration of the DGPS by Falcon was performed when both systems were in areas of strong geometry.

* Removed from original D.R., filed with field ~~rec~~ records

I. HYDROGRAPHIC POSITION CONTROL (continued)

e) No systematic errors were detected that required adjustments.

f) Antenna positions were corrected for offset and layback, and referenced to the position of the DSF 6000N transducer. These correctors were located in the HDAPS Offset table, and applied on-line to the positioning algorithm. Refer to Separate III for a copy of offset table 1.

g) Offset and layback distances for the A-frame (tow point) were located in the HDAPS Offset table and applied on-line. These offsets, along with the cable length, towfish height, and depth of water, were used by the HDAPS system to compute the position of the towfish. *Refer to Separate III for a copy of offset table 1.

** Removed from original Descriptive Report,
filed with field records.*

J. **SHORELINE** See Section 2. b. in The Evaluation Report

No field sheets encompassed any shoreline.

K. **CROSSLINES** See Section 3. a. in The Evaluation Report

1. Numerous lines were run in a variety of directions over the grounding area. In general, a series of lines running 060° - 240° T were run along the projected track of the QE2. A similar number of lines were run in a 150° - 330° T orientation across the ship's projected track.

2. Generally, crosslines agreed with along track lines within 0.5 meters.

3. No significant differences were noted between cross lines and along track lines.

4. The same echo sounder was used for cross and along lines.

L. **JUNCTIONS** See Section 5. in The Evaluation Report

This survey does not junction with any current surveys.

M. **COMPARISON WITH PRIOR SURVEYS** See Section 6. in The Evaluation Report

The current survey was not compared to the prior survey. The currently charted 39 foot depth originated from prior survey H-6445, 1939 (1:40,000 scale).

N. COMPARISON WITH THE CHART See also Section 7. in the Evaluation Report

AWOIS 8297

N.1 Source of Item

On August 7, 1992, 10:00 PM EDST, the luxury liner Queen Elizabeth 2 was outbound, Vineyard Sound on an approximate course of 240° T. After spending most of the day anchored off Vineyard Haven, Martha's Vineyard, the ship was on its last leg of a five day voyage, bound for New York City. The ship, which had a reported draft of 32 feet, apparently hit bottom in the area of a charted 39 foot depth, approximately 2.5 nm south southwest of Cuttyhunk Island. The ship was reportedly travelling at a speed of 25 knots when the grounding occurred.

On August 8, 1992, RUDE received verbal orders from the Director, Coast and Geodetic Survey, to immediately begin investigating the grounding. With the consent of the Acting Director, Atlantic Marine Center, the ship began the investigation on August 10, 1992.

The Commanding Officer, of the RUDE and the Chief, Operations Section, Hydrographic Surveys Branch (HSB), agreed that the survey should be geared toward finding the precise location where the QE2 ran aground. Investigations of features discovered in deeper water would be given second priority.

The Coast Guard furnished HSB with the approximate position of the grounding. This position was then forwarded to the RUDE:

41° 22.1' N
071° 57.7' W

The QE2 reportedly was taking 6 minute radar fixes before the grounding and recorded a GPS position 3 minutes after the grounding. Based on this information, RUDE concluded that the reported position was probably quite accurate. A search radius of 800 meters was set about the reported position.

Information concerning the largest scale chart of the area follows:

NOS Chart No: 13218
Scale: 1:80,000
ED: 31st
Date: January 11, 1992

The reported position of the grounding is approximately 220 meters southwest of the charted 39-foot depth. At the scale of the chart, this distance translates to approximately 3 millimeters.

N. COMPARISON WITH THE CHART (continued)

N.2. Survey Chronology: Method of Investigation

The following is a detailed chronology of work associated with this survey. Critical position and depth information are furnished at the end of this section.

DN 223 - August 10, 1992

RUDE began the investigation by running a series of side scan sonar lines, oriented East-West, across the 800-meter radius circle. The area was densely covered with lobster pots making full coverage and overlap difficult to achieve. A line spacing of 160 meters was used with a side scan sonar range scale of 100 meters. This should have yielded a 40 meter overlap, however, the ship had to jog off line quite frequently to avoid lobster pot lines.

Seven side scan sonar lines were run in the northern two-thirds of the search circle. A very rocky area in the eastern part of the circle was identified as a high probability area for the grounding. The search in the southern one third of the circle was abandoned after water depths greater than 70 feet were observed.

An echo sounding development was then conducted in the eastern portion of the survey area. A rocky area was developed with north-south and east-west lines run at 10 and 20 meter line spacing.⁵ By the end of the first day, the survey's least depth was 10.7 meters (35.4⁸ ft). *smooth tides applied Pos 142/1 Not plotted (NP)*

DN 224 - August 11, 1992

An intensive echo sounding investigation continued along the rocky plateau discovered on DN 223. Sounding lines were run along the axis of the rocky area in a 056° - 236° T orientation. Weather conditions deteriorated during the afternoon, affecting the ship's ability to perform precise echo sounder developments. A decision was then made to conduct a dive investigation along the rocky plateau. Two buoys were dropped about 93 meters apart along the axis of the plateau. The weights of these buoys were connected by a "ground line". This particular investigation is referred to in the records as "Ground Line 1". The divers swam along this line and noted numerous large boulders, however none appeared to have been involved with the grounding. The northernmost buoy was moved over the location of a large boulder. An echo sounder least depth of 10.5⁰ m at MLLW was determined on this boulder at position 213. *(32.84+) smooth tides applied NP*

A significant echo sounder spike, detached from the plateau was discovered during survey operations. An echo sounding least depth of ~~10.0~~ m (32.8⁵ ft) was determined on the spike.

9.9

smooth tides applied Pos 199/1 NP

N. COMPARISON WITH THE CHART (continued)

DN 225 - August 12, 1992

Two dives on prominent boulders were conducted in the morning. Divers noted that both boulders were heavily covered with kelp leading them to believe that neither was a point of impact. The first dive (Pos 228) ultimately resulted in the shoalest depth of the survey (9.6 m - 31.5 ft). * *Lat 41-22-13.57N Long 70-57-19.19W* #8297

Echo sounder lines at 10 meter spacing were run along the axis of the rocky area for the remainder of the day.

DN 226 - August 13, 1992

The day began with a dive on a prominent boulder in the rocky area. The least depth over the boulder was found to be 34.5¹ft * (10.4m) (MLLW) at fix 328.

An attempt was then made to have the divers search the ridge by dropping a second ground line between two buoys. The two buoys were dropped 132 meters apart on an azimuth of 106° across the plateau. The divers were Lieutenant Schattgen and Lieutenant Waddington. The divers swam west to east along "Ground Line 2." Toward the eastern end of the line, Lieutenant Waddington spotted a peculiar looking boulder which rose about 7 feet off the bottom and had a 12 foot square base.

The divers noted that this boulder, like most others encountered in Buzzards Bay, had marine growth around its sides. However, there was an absence of growth along the top (no kelp, seaweed, or barnacles). The top of the rock was fairly flat and there appeared to be small patches of a silvery/reddish substance along the top and upper sides. In addition, a 1/2" chip along the top center of the rock was noted. One of the divers felt it might be a fairly recent chip but the other was hesitant to confirm this assertion.

The divers scrapped several small pieces of the red substance from the rock. A least depth and position was then determined on the rock. The least depth was found to be 34.6⁴feet. (10.5m) * Pos 339

Ultimately, we came to identify this rock as "Red Rock 1." We believe this solitary boulder to be the rock which caused the first impact. It appears that the QE2 skimmed over the top of Red Rock 1 as it was traveling an approximate course of 240° T. The samples of the red substance were forwarded to the Coast Guard for analysis. The results are still pending.

DN 227 - August 14, 1992

Divers recorded underwater video of Red Rock 1 in the morning. After this dive, the best position was determined over Red Rock 1 (fix 372). The weather degraded in the afternoon making further survey impossible.

* smooth tides applied

N. COMPARISON WITH THE CHART (continued)

DN 228 - August 15, 1992

A 240° T track was layed out from Red Rock 1 in hopes of locating more of the grounding area. A position approximately 150 meters downtrack of Red Rock 1 was selected for a divers circle search. Upon descending the line, divers Lieutenant Schattgen and Ensign Illg immediately found a rock which we now believe was the point of major impact. In later correspondence, we came to call this "Red Rock 2."

Divers recovered small strips of twisted steel and large pieces of paint chips from the vicinity of Red Rock 2. There appeared to be a large fracture on the top this rock. This was not a solitary boulder as was the case with Red Rock 1. Divers described the boulder as being 8' x 10' in size and rising approximately 6 feet off the bottom.

Later that day, a second dive was made on Red Rock 2 in order to obtain underwater video of the rock. This was given priority since the underwater video camera had to be returned to Woods Hole on the following day. The day ended with marginal weather and sea conditions.

DN 230 - August 17, 1992

The day began by laying out "Ground Line 3" for use by divers. The first order of business was obtaining a diver pneumatic depth gauge depth on Red Rock 2. (Ultimately a shoaler echo sounder depth was determined over Red Rock 2). The ground line began at Red Rock 2 and ran in a 234° direction for about 63 meters. The southern terminus of this line was the same position used as the southern point of ground line 1. Along the line, divers noted several boulders that showed evidence of major contact with the QE2. Divers noted that the area was generally disturbed. The boulders observed were more of the solitary nature as noted in the vicinity of Red Rock 1, rather than the dense clustering of boulders as noted in Red Rock 2. One particular boulder appeared to have been tipped over or turned on its side, likely caused by the impact with the QE2. Divers described this boulder as approximately 8'x 4' and rose off the bottom approximately 7 feet.

After the first dive, an echo sounder drift search was made between the two dive buoys. A second dive, east of the grounding area, provided no further evidence of the grounding.

The remainder of the day was spent running side scan sonar lines along the grounding area. Range scales of 50 and 75 meters were used.

DN 232 and 233 - August 19 and 20, 1992

These days were spent testing out the SEABAT 9001 by running tightly spaced lines (10 meters) over the grounding area. Echo sounding data to support this survey were acquired simultaneously.

N. COMPARISON WITH THE CHART (continued)

N.4 Echo Sounder and Dive Developments

Critical features were developed very thoroughly by echo sounder and dive investigation. Least depths on significant features were determined by both echo sounder and pneumatic depth gauge. In some instances, the pneumatic depth gauge yielded the least depth, while in other cases, the echo sounder depth was shoaler. In all cases, agreement between the two types of depth measurements was within one meter and in all but one case, within 0.5 meters.

Since the pneumatic depth gauge was not electronically connected to the HDAPS, the depth measured by divers and the position of the feature were not recorded simultaneously. The standard sequence of events in this survey was to have the divers record a pneumatic depth reading and then move the anchor for the dive buoy atop the feature. After the divers exited the water, the ship maneuvered near the dive buoy in order to obtain a detached position (DP). If the pneumatic depth gauge reading was shoaler than the echo sounder depth, then the pneumatic depth was edited into an HDAPS data record in post processing. If the pneumatic depth gauge reading is not shoaler than the echo sounder depth, then records do not have to be altered in post-processing.

Tables at the end of this section summarize the least depth and position information for the critical depths.

N.5 Investigation Results

Results of the survey are presented on field sheets at scales of 1:10,000 and 1:1,000. Depth plots in meters and feet at both survey scales are submitted. "Critical depth" overlays are also included.

- * The QE2 struck several uncharted boulders near the reported position of the grounding. Representative least depths from this survey should supersede currently charted depths. The survey least depth of 31 feet should be displayed on the chart.

(9.6m) AWOIS # 8297

* See also Section 7.9. in the Evaluation Report

CRITICAL POSITIONS AND DEPTHS
FE-379SS

8297

Pos No	Critical Feature Description	Day	Depth @ MLLW	Latitude Longitude	Remarks
201	Dive Buoy Ground Line 1 (Northern)	224	N/A	41° 22' 10.487" N 070° 57' 36.011" W	Diver search found no evidence of impact.
202	Dive Buoy Ground Line 1 (Southern)	224	N/A	41° 22' 08.149" N 070° 57' 38.650" W	Distance betw buoys = 93 m Az = 40°
213	Boulder @ North end of Ground Line 1. Non-impact	224	10.5 ⁶ m by * Echo sounder (no pneumo)	41° 22' 10.862 ⁸⁸ " N 070° 57' 35.613 ⁶² " W	Rock about 10 m past N. end of Gr. Ln
228	Boulder (Dive) Least Depth of Entire Survey (Non-impact)	225	Echo Sounder LD = 9.6 m @ MLLW = 31.5 ft * Pneumo LD = 9.7 m	41° 22' 13.554 ⁵⁷ " N 070° 57' 19.182 ¹⁹ " W	Echo sounder LD shoaler than Pneumo.
235	Boulder - Dive (Non-impact)	225	Echo Sounder LD = 10.0 m @ MLLW = 32.8 ft * Pneumo LD = 10.1 m	41° 22' 11.026 ⁰⁴ " N 070° 57' 29.265 ²⁷ " W	Echo sounder LD shoaler than pneumo.
328	Boulder - Dive (Non-impact)	226	Pneumo LD = 10.5 ⁴ m = 34.4 ¹⁵ ft * ES = 11.4 m	41° 22' 07.134 ¹⁵ " N 070° 57' 30.420" W	Pneumo shoaler than echo sounder LD

* Smooth Tides Applied

CRITICAL POSITIONS AND DEPTHS
FE-379SS

Pos No	Critical Feature Description	Day	Depth @ MLLW	Latitude Longitude	Remarks
335	Ground Line 2 Eastern buoy	226	N/A	41° 22' 11.034" N 070° 57' 29.704" W	Red Rock 1 Discovered by Divers along this line
338	Ground Line 2 Western buoy	226	N/A	41° 22' 12.542" N 070° 57' 34.885" W	Dist betwn buoys = 132 m AZ = 106° T
339	Red Rock 1 (Dive) First Impact	226	Pneumo = 10.5 m = 34.4 ft *	41° 22' 12.099" N 070° 57' 31.110" W	Pneumo least depth shoaler than ES
376.7	Red Rock 2 (Dive) Major Impact - Also pos. for Ground line 3 Northern end	228 > 230 >	ES LD = 10.1 ² m = 33.15ft * PNEUMO = 10.5 ⁷ m (DN 230)	41° 22' 09.295" N 070° 57' 36.315" W ^{3/} _{3Z}	Echo sounder least depth shoaler than pneumo.
202	Dive Buoy Ground Line 3 Southern end	224 (Dive on DN 230)	N/A	41° 22' 08.149" N 070° 57' 38.650" W	Distance bet. buoys = 63 m AZ = 234°

* Smooth Tides Applied

LEAST DEPTHS RECORDED OVER CRITICAL FEATURES

DIVE: BOULDER - DN 225
(Non-impact feature)

LAT: 41° 22' ⁵⁷13.554" N (Fix 228)
LON: 070° 57' 19.182" W

Least Depth Dive Data	Least Depth Echo Sounder Data
Fix Numbers: 226-231	Fix Number: 228
Time of Pneumo: 15:39:00Z	Time of ES: 15:47:48Z
Pneumo Reading: 10.1 m <u>Pre. Tide Corr: -0.4 m</u> Depth @ MLLW 9.7 m	ES Raw Depth: 7.8 +2.3 Tra. Draft -0.2 Heave <i>smooth</i> -0.3 (Pred tide) <u>0.0 Sound Vel</u> 9.6 m at MLLW

8297

Remarks: DP's 226 to 231 taken over dive buoy.

Least Depth Recommendation: Chart the echo sounder least depth 9.6 m at based on fix 228. *Concur - see also the Evaluation Report*

DIVE: BOULDER - DN 225
(Non-impact feature)

LAT: 41° 22' 11.026" N (Fix 235)
LON: 070° 57' 29.265" W

Least Depth Dive Data	Least Depth Echo Sounder Data
Fix Number: 232-236	Fix Number: 235
Time of Pneumo: 16:25:00Z	Time of ES: 17:08:47Z
Pneumo Reading: 10.3 m <u>Pre. Tide Corr: -0.2 m</u> Depth @ MLLW 10.1 m	ES Raw Depth: 7.8 +2.3 Tra. Draft 0.0 Heave <i>smooth</i> -0.1 (Pred. tide) <u>0.0 Sound Vel</u> 10.0 m at MLLW

Remarks: DP's 232 to 236 recorded over dive buoy.

Least Depth Recommendation: ~~Chart the echo sounder least depth of 10.0 m based on fix 235.~~ *see Evaluation Report*

LEAST DEPTHS RECORDED OVER CRITICAL FEATURES (Cont)

DIVE: BOULDER - DN 224
(Non-impact feature)

LAT: 41° 22' 10.⁸⁸62" N (Fix 213)
LON: 070° 57' 35.⁶¹³13" W

Dive Least Depth (Pneumo)	Least Depth Echo Sounder Data
Fix Numbers: No pneumo LD	Fix Number: 213
Time of Pneumo: NA	Time of ES: 19:24:06Z
Pneumo Reading: NONE	ES Raw Depth: 8.8 +2.3 Tra. Draft -0.1 Heave <i>smooth</i> -0.5 ⁴ Pred tide <u>0.0 Sound Vel</u> 10.5 ⁶ m at MLLW

Remarks: DP taken on rock at the north end of ground line 1. No pneumatic depth taken over this feature.

Least Depth Recommendation: ~~Chart the 10.5 m least depth based on position 213.~~ See Section 7.9. in The Evaluation Report

DIVE: BOULDER - DN 226
(Non-impact feature)

LAT: 41° 22' 07.¹⁵34" N (Fix 328)
LON: 070° 57' 30.420" W

Least Depth Dive Data	Least Depth Echo Sounder Data
Fix Numbers: 328	Fix Number: 328
Time of Pneumo: 15:42:00Z	Time of ES: 16:03:41Z
Pneumo Reading: 10.9 m <i>smooth</i> Pre. Tide Corr: -0.4 ⁵ m Depth @ MLLW 10.5 ⁴ m 34.1 ft	ES Raw Depth: 9.0 +2.3 Tra. Draft +0.5 Heave <i>smooth</i> -0.4 Pred tide <u>0.0 Sound Vel</u> 11.4 m at MLLW

Remarks: DP's 328 to 332 recorded over dive buoy.

Least Depth Recommendation: ~~Chart the 10.5 m diver least depth determined by pneumatic depth gauge.~~ The pneumo gauge depth has been edited into fix record 328. The time of this record should be changed to 15:42:00Z when transferred to the AHS office processing system. See Section 7.9. in The Evaluation Report

LEAST DEPTHS RECORDED OVER CRITICAL FEATURES (Cont)

DIVE: BOULDER - DN 226,227 LAT: 41° 22' 12.¹²~~099~~" N Fix 339*
 RED ROCK 1 LON: 070° 57' 31.110" W Fix ~~372~~*
 Suspected First Impact

Least Depth Dive Data	Least Depth Echo Sounder Data
Fix Numbers: 339, 372	Fix Number: 372 (DN 227)
Time of Pneumo: 18:05:00Z	Time of ES: 17:15:22
Pneumo Reading: 10.6 m <u>Pre. Tide Corr: -0.1 m</u> Depth @ MLLW 10.5 m	ES Raw Depth: 8.6 +2.3 Tra. Draft 0.0 Heave -0.2 Pred tide <u>0.0 Sound Vel</u> 10.7 m at MLLW

*Remarks: On DN 226, immediately following the dive, an attempt was made to determine a position over Red Rock 1. The current was very strong at this time and the sea conditions were not conducive to precise maneuvering alongside the dive buoy. Instead of coming alongside the buoy and risk dragging the buoy off the rock, five detached positions were recorded with the buoy located very close to the ship's bow (Pos 339-343). For each position, the buoy's distance and ship's heading were recorded. The distance from the bow to the ship's transducer is fixed at 10 meters. Knowing these parameters, five approximate positions were computed for the buoy (see printout).

Five detached positions were then recorded alongside the buoy (344 to 348). These positions agreed very well with the approximate positions computed above, however, no indication of the rock was observed on the echo sounder. Divers reported that the rock extended approximately 2 meters off the bottom. The inability to detect the rock on the echo sounder can be attributed to the strong current coupled with the scope in the buoy line. Since weather conditions were marginal at this time, a decision was made to attempt to obtain a better position on the following day.

On DN 227, a dive buoy was again dropped on Red Rock 1. Divers recorded underwater video of the rock. After the dive, an attempt was made to locate the ship directly over the rock so the best position could be ascertained. Positions 370 to 372 were alongside the buoy, over the rock. We believe the best position for the rock is fix 372. On this fix, the echo sounder record shows a rock extending about two meters off the bottom. This corresponds well to the divers descriptions of the dimensions of Red Rock 1.

**LEAST DEPTHS RECORDED OVER CRITICAL FEATURES
RED ROCK 1 - Continued**

Since the least depth was determined on DN 226 by pneumatic depth gauge and the best position was determined on DN 227, the position and depth needed to be merged in processing. The closest HDAPS fix corresponding to the time of the least depth was fix 339 on DN 226. This position was the first of the five DP's recorded immediately after the pneumatic depth gauge reading. Since the original position on fix 339 represented only an approximate position of the dive buoy, it was decided to use this HDAPS record to merge the best position and depth information for the feature.

Using the HDAPS edit function, the position determined on fix 372 (DN 227) was edited into the HDAPS record for fix 339 (DN 226). In addition, the pneumatic gauge least depth was also edited into the record. The transducer depth, heave, and sound velocity correctors were then zeroed out as they are inapplicable for a pneumatic depth gauge depth. The original position, depth and corrector data for fix 339 were overwritten in this process, however, they still exist on the original printout.

It should be noted that the time of fix number 339 still needs to be edited in the AHS processing system to correspond to the time of the dive. The time should be changed from 18:48:23 to 18:05:00.

~~Least Depth Recommendation: Chart the pneumatic gauge least depth of 10.5 m @ MLLW based on fix 339.~~

See section 7a. in The Evaluation Report

LEAST DEPTHS RECORDED OVER CRITICAL FEATURES (Cont)

DIVE: BOULDER - DN 228,230
 RED ROCK 2
 Major impact area

LAT: 41° 22' ^{9 31} 08.149" N Fix 376.7
 LON: 070° 57' 36.315" W
 2

Least Depth Dive Data	Least Depth Echo Sounder Data
Fix Numbers: 395 (DN 230)	Fix Number: 376.7 (DN 228)
Time of Pneumo: 15:15:00Z	Time of ES: 14:38:15.Z
Pneumo Reading: 11.6 m <u>Pre. Tide Corr: -1.19m</u> Depth @ MLLW 10.57m 35.1 ft	ES Raw Depth: 9.1 +2.3 Tra. Draft -0.2 Heave ^{smooth} -1.2 ^s Pred tide <u>0.0 Sound Vel</u> 10.22m at MLLW 33.4 ft

Remarks: Red Rock 2 was discovered by divers on DN 228. We believe this rock to be the major point of impact where the QE2 grounded. Two dives were conducted on this day. Divers collected samples of metal shavings and paint chips during the first dive. An underwater video was recorded during the second dive. Weather conditions deteriorated later that afternoon making a pneumatic least depth impossible.

After the completion of the second dive, an echo sounding drift search was conducted alongside the dive buoy, which was located over Red Rock 2. This drift search yielded a least depth of 10.7² m at position 376.7. Ultimately, this echo sounder depth proved to be shoaler than the pneumatic gauge recorded on DN 230.

On DN 230, divers recorded a pneumatic gauge least depth of 11.6 m (10.5 m at MLLW). Positions 387 to 395 were recorded in the vicinity of the dive buoy. Position 395 was selected as the best position for the pneumatic gauge least depth. This depth was edited into fix 395. The time of this record should be changed from 15:43:21 to 15:15:00Z when transferred to the AHS office processing system. Again, this pneumatic gauge least depth is deeper than the echo sounder depth at 376.7.

Least Depth Recommendation: ~~Chart the pneumatic gauge least depth of 10.1 m @ MLLW based on fix 376.7.~~

See section 7.a. in The Evaluation Report

O. ADEQUACY OF SURVEY See also Section 9. in the Evaluation Report

O.1 The survey conducted in the immediate area of the QE2 grounding is adequate to supersede all prior surveys of the area. All dangers to navigation within this limited area have been defined.

O.2 Since the focus of this survey was the immediate area of the grounding, some features in deeper water have not been addressed. The Atlantic Hydrographic Section will review this survey and make recommendations for additional work.

P. AIDS TO NAVIGATION See also Section 7. b. in The Evaluation Report

P.1 The RUDE conducted no correspondence with the U.S. Coast Guard regarding floating aids to navigation.

P.2 No aids to navigation fell within or near the confines of this survey.

P.3 No aids not already listed in the Light List were located during this survey.

P.4 No bridges, overhead cables or overhead pipelines are located within the survey area.

P.5 No submarine cables, pipelines or ferry routes are located within the survey area.

P.6 No ferry terminals are located within the survey area.

Q. STATISTICS

Q.1	a) Number of positions	640
	b) Lineal nautical miles of sounding lines	
	-nautical miles of survey with the use of the side scan sonar	13.5
	-nautical miles of survey without the use of the side scan sonar	53.9
Q.2	a) square nautical miles of hydrography	0.4
	b) days of production	9
	c) detached positions	22
	d) bottom samples	0
	e) tide stations	1
	f) current stations	0
	g) velocity casts	2
	h) magnetic stations	0
	i) XBT drops	0

R. MISCELLANEOUS

R.1 a) No evidence of silting was found during this survey.

b) No evidence of unusual submarine features was found during this survey.

c) No evidence of anomalous tidal conditions was found during this survey.

d) The tidal current tables for the area predict currents to be generally one to two knots. Observations by divers concur with this.

e) No evidence of magnetic anomalies was found during this survey.

R.2 No bottom samples were obtained during this survey.

R.3 The Commanding Officer of the RUDE presented the preliminary results of this survey to a hearing conducted by the National Transportation Safety Board on August 26, 1992.

S. RECOMMENDATIONS

S.1 No survey inadequacies have been noted. This survey adequately defines the area of the grounding and all potential dangers to navigation within the 800 meter radius of the AWOIS item. Some side scan sonar contacts that are located in deeper parts of the search area may require further development. It is expected that the Atlantic Hydrographic Section will recommend additional work to be conducted in the area.*

S.2 The RUDE is aware of no construction or dredging that will affect the results of this survey.

S.3 No further investigation of the immediate grounding area is recommended. Serious consideration should be given to conducting a basic re-survey of Vineyard Sound.*

* See Section 9. in The Evaluation Report

T. REFERRAL TO REPORTS

One Danger to Navigation report was submitted in conjunction with this survey. A "Report on DGPS Performance Aboard the NOAA Ship RUDE" was submitted to the Director, Atlantic Marine Center on August 7, 1992. No other formal reports have been submitted in conjunction with this survey.

ADDENDUM TO FE-379SS
ADDITIONAL FIELD WORK CONDUCTED IN 1993
NOAA SHIP RUDE

A. PROJECT

This survey was conducted in accordance with Hydrographic Project Instructions OPR-B616-RU. The survey involves additional work to FE-379SS, conducted in 1992 by the NOAA Ship RUDE in the vicinity of the Queen Elizabeth 2 (QE2) grounding site.

The goal of the additional work was to resolve discrepancies between the NOAA Ship RUDE and American Underwater Survey Search and Survey, Ltd., (AUSS). The AUSS survey was commissioned by Cunard Lines, Ltd., owners and operators of the QE2. The resultant AUSS report was entitled "Survey of the Area Impacted by The Grounding of the Queen Elizabeth II on 7 August 1992."

Six specific impact sites were identified by the AUSS survey. Positions and least depths of these impact sites follow:

	Position	Depth in FT MLLW
Impact 1 (NOAA RR1)	41° 22.205' N 70° 57.514' W	34.0
Impact 2	41° 22.158' N 70° 57.602' W	30.6
Impact 3	41° 22.162' N 70° 57.607' W	31.2
Impact 4	41° 22.159' N 70° 57.608' W	31.4
Impact 5 (NOAA RR2)	41° 22.155' N 70° 57.605' W	31.0
Impact 6	41° 22.128' N 70° 57.627' W	30.0

The above depths were significantly shoaler than the 1992 RUDE survey.

B. AREA SURVEYED

Most of this survey was conducted within a 50 meter radius of the rock designated by the RUDE in 1992 as Red Rock 2 (RR2), at the following position:

41° 22' 09.31" N
70° 57' 36.32" W

Additional work was conducted in the vicinity of Red Rock 1 (RR1) at the following position:

41° 22' 12.12" N
70° 57' 31.11" W

Data acquisition began on March 31, 1993 (DN 90) and concluded on May 18, 1993 (DN 138).

C. SURVEY VESSELS

Echo soundings were recorded by the NOAA Ship RUDE (Electronic Data Processing Number 9040). Diving operations were conducted from RUDE Launch 1290.

D. AUTOMATED DATA ACQUISITION AND PROCESSING

D.1 Survey data acquisition and processing were accomplished during DN 90 -138 using the Hydrographic Data Acquisition and Processing System (HDAPS). the programs and survey versions used were: SURVEY ver 6.10, DAS_SURV ver 6.20 and POSTSUR ver 5.20.

D.2 VELOCITY 1.11 was used to generate sound velocity corrector tables.

E. SONAR EQUIPMENT

Side Scan Sonar was not used during this survey.

F. SOUNDING EQUIPMENT

F.1 All hydrographic soundings were acquired using the Raytheon DSF-6000N echo sounder. Two DSF-6000N's were used during the survey: SN A107N - DN 90, 105-138
SN C006 - DN 99

F.2 Ten dives were conducted during this survey; DN 90- 2 dives, DN 99 - 2 dives, DN 105 - 2 dives, and DN 138 - 4 dives.

Diver least depths were measured with 3-D Instruments, Inc. precision direct depth gauge:

0- 70 ft	S/N 201637-12
0-140 ft	S/N 8606822

F.3 There were no problems with sounding equipment that affected the accuracy or quality of the data.

F.4 Both the high (100 Khz) and low (24 KHZ) frequency sounding data were recorded during data acquisition. Only high frequency

soundings were plotted.

G. CORRECTIONS TO SOUNDINGS

G.1.a The velocity of sound through water was determined using a Digibar Sound Velocity Probe (S/N 169) made by Odom.

All data were processed using Velocity 1.11 software. The casts were recorded on the following dates:

Cast Number	Day	Latitude	Longitude	HDAPS Table	Days Applied
2	90	41° 24' 00" N	71° 00' 06" W	2	90
3	98	41° 28' 18" N	70° 55' 18" W	3	99
4	104	41° 24' 30" N	71° 00' 00" W	4	105-138

b. There was no variation of the DSF-6000N instrument initial.

c. No instrument correctors to the DSF-6000N instrument were required.

d. A dual lead line comparison with the DSF-6000N was made on DN 76 at the following position:

41° 37' 00" N 70° 54' 00" W (11.6 meters)

The digital instrument corrector was found to be 0.09 meters. This provides an adequate check that the DSF-6000N was working properly.

Port and starboard lead lines were calibrated on DN 87. The following correctors were applied to leadlines:

S/n 100-1	-0.4 ft
s/n 100-2	-0.5 ft

e. All sounding correctors were applied to both the narrow (100 khz) and wide (24 khz) DSF-6000N beams.

f. The ship's static draft was measured to be 2.26 meters during the 1988 dry dock period. Refer to 1992 descriptive report for further details.

g. Settlement and squat trials were run in the Elizabeth River, Norfolk, Va., on March 3, 1993. The same procedure as described in the 1992 descriptive report was employed.

h. Heave data were acquired by a Datawell heave, roll and pitch sensor (S/N 19128-C), and were applied to soundings in real time. Only the heave corrections were applied to plotted soundings.

G.2 There were no unusual or unique methods or instruments used for correcting echo soundings.

See Separate ^{*}IV for data records. *Removed from D.R., filed with field Records*
G.3 Sound velocity correctors were applied during data acquisition.

G.4 The ship's Pneumatic depth gauges, SN 201637-12 (0-70 ft) and S/N 8606822 (0-140 ft) were calibrated on February 11, 1993; S/N 201637 was repaired on April 22, 1993. No correctors were applied to s/n 8606822.

G.5 Generally, sea conditions greater than one meter affected the sounding record, creating a trace of constant peaks and deeps. Application of heave correctors to raw echo soundings appeared to accurately represent true depths.

G.6 The tidal datum for this project is Mean Lower Low water. The operating tide station at Newport, Rhode Island (845-2660) served as direct control for datum determination. This station also served as the reference station for predicted tides. These correctors were applied from HDAPS tables 3 and 4.

Approved Tides & Zonings were applied during office processing
Also in operation during this survey was a gauge located at Sakonnet Point, Rhode Island (845-0768).

The Request for Smooth Tides was made by phone through the Hydrographic Surveys Branch, Silver Spring, Maryland. No written request was made. Smooth tides were then furnished to AHS.

H. CONTROL STATIONS *See also Section 2.a. in The Evaluation Report*

The horizontal datum for this project is the North American Datum of 1983 (NAD 83).

No horizontal control stations were established in support of this survey. DGPS hydrographic position control from Coast Guard radio beacons located at Montauk Point, NY, and Portsmouth, NH, were employed.

I. HYDROGRAPHIC POSITION CONTROL *See also Section 2.a. in the Evaluation Report*

I.1 This survey was conducted entirely with DGPS, using the Montauk Point Radio Beacon. The Portsmouth NH, radiobeacon was used for calibration checks.

Position of the Montauk Point receiver: 41° 04' 02.047" N
71° 51' 38.274" W

I.2 Hydrographic position accuracy requirements for a 1:20,000 scale survey were met as specified by the Hydrographic Manual and Field Procedures Manual.

I.3 The ship employed an Ashtech Satellite Receiver (no S/N) and a MX50R radio beacon receiver (S/N B1012).

I.4 The radio beacon at Portsmouth, NH was used as a check. The second shipboard system was also composed of an Ashtech receiver (No s/n) and a MX50R radio beacon receiver (S/N B1083).

I.5 No calibration data were applied to raw DGPS positions.

J. SHORELINE See Section 2.6 in the Evaluation Report

No field sheets encompassed any shoreline.

K. CROSSLINES See also Section 3.9. in the Evaluation Report

There was good agreement with 1992 data.

L. JUNCTIONS See also Section 5. in the Evaluation Report

This survey does not junction with any current surveys.

M. COMPARISON WITH PRIOR SURVEYS See Section 6. in the Evaluation Report

Refer to the 1992 Descriptive report for FE-379SS.

N. COMPARISON WITH THE CHART See Section 7. in the Evaluation Report

The following is a summary of activities conducted during this survey:

DN 90

Dive 1 - The object of this dive investigation was to locate the submerged boulder referred to as Red Rock 2 (RR2) and to determine its dimensions and least depth. A ground line 20 meters long, was laid due north from RR2, to be used as a reference point for searches north of RR2. Divers recorded a least depth on RR2 using a pneumatic depth gauge. Its position, as originally reported in the 1992 survey, was verified.

Dive 2 - The object of the second dive was to locate and identify other AUSS impact sites. Divers swam along the ground line laid during Dive 1. The search area was 10 meters on both sides of the ground line. Divers discovered what appeared to be AUSS Impact sites 3 and 4. Both rocks were smeared with bottom paint and oriented in the same manner as described in the AUSS survey. The position of AUSS Impact 4 was verified and a pneumatic least depth was acquired.

DN 99

Dive 1 - The objective of this dive was to locate Impact 6. After dropping a buoy in the AUSS position of Impact 6, divers found that boulders in the area showed no signs of impact as seen on other boulders. Of the items in the area, the average boulder rose 3 to 4 feet off the bottom, with the largest rising 5 to 6

feet. An intense echo-sounder investigation, as well as divers depth gage readings, revealed depths between 40 and 42 feet (MLLW); AUSS investigation reported a least depth of 30 feet.

Dive 2 - The objective of this dive was to locate RR2 and use it as a reference to locate Impact 2. Semi-circle searches were conducted from RR2 and a rock fitting the description of Impact 2, but considerably smaller, was located. The entire rock was covered with marine growth, unlike RR2, Impact 3 and Impact 4, which are easily identified due to their lack of marine growth. It is evident that this boulder had no signs of impact.

DN 105

Dive 1 - The object of this dive investigation was to search an area in which a ground line was laid and swam between Red Rock 2 (position: 41° 22' 09.3" N, 070° 57' 36.6" W) at 220 degrees, along a shoal crest to the position of a 36' sounding (position: 41° 22' 07.886" N, 070° 57' 38.636" W), a distance of 50 meters. A boulder fitting the description of Impact 6 was located approximately three quarters along the ground line and showed evidence of impact. The position of this boulder will be used to describe Impact 6R.

Dive 2 - The object of this dive was to search for the AUSS Impact 2 boulder. An extensive search for Impact 2 in the area reported by AUSS was conducted without finding the described boulder. Divers decided to position Impact 3 and 4 relative to Red Rock 2. Divers found RR2 and Impact 4 to lie approximately 10 meters apart, which is roughly the same distance apart that Impact 2 and Impact 4 should lie. From this, it should be considered that the position for Impact 2 is not in the position reported by AUSS. Divers then searched in an area southwest of RR2, under the assumption that in the AUSS survey RR2 was mistaken for Impact 2. A boulder fitting the description of Impact 2 was located approximately 11 meters from RR2. This boulder is labeled Impact 2R.

DN 138

Dive 1 - The objective of this dive was to position and obtain an updated pneumo reading of least depth on Red Rock 1 (RR1). Through an inspection of the boulder, it was apparent that there had been some movement due to exposed clay that underlies the layer of gravel that covers the sea floor, the exact amount of movement could not be determined. The 1992 position was verified and a pneumatic least depth was acquired.

Dive 2 - The object of this dive was to obtain a least depth and measurements on Impact 6R.

Dive 3 - The object of this dive was to obtain a least depth and dimensions on Impact 2R and obtain a least depth on Impact 3.

Dive 4 - The object of Dive 4 was to position Impact 2R by measuring the distance and bearing between RR2 and Impact 2R. This was done by positioning buoys over each boulder and measurements were taken by divers and the NOAA RUDE. An average reading of 265 degrees magnetic, corrected for 10 degree east compass error, to 275 degrees true was recorded. By the range and azimuth measured on the dive values were calculated to position the boulder.

ANALYSIS OF 1993 FIELD WORK

- There was excellent sounding agreement between RUDE's 1993 work and the ship's 1992 work. Agreement in most cases was within 0.5 meters. No significant shoaler depths were discovered in 1993.

- The AUSS survey and the RUDE's 1992 and 1993 surveys agree well on the positions for Red Rock 1 (Impact 1) and Red Rock 2 (Impact 5). RUDE's 1993 survey confirmed the accuracy of these positions.

- RUDE's 1993 survey work confirms the existence and positions of AUSS Impacts 3 and 4. RUDE determined positions for these rocks by divers measuring distances and azimuths from Red Rock 2.

- There appears to be a gross error in the AUSS position of Impact 6. Both 1992 and 1993 RUDE survey soundings in the vicinity of AUSS's position were greater than 40 feet. A boulder fitting the description of Impact 6, was discovered by NOAA divers 31 meters to the WNW of the reported position. This rock is referred to as Impact 6R (R for RUDE). NOAA depths were found to be significantly deeper. See the table below.

- There also appears to be a significant error in the position of AUSS's Impact 2. Numerous circle searches were conducted about the position of Red Rock 2 (AUSS' Impact 5). The position of Impact 2 should have been within 10 meters of Red Rock 2, approximately to the Northeast. A rock fitting the description of Impact 2 was discovered 18 meters to the WSW. Again, RUDE's least depth was significantly deeper than the depth reported by AUSS.

- Echo sounding and pneumatic depth gauge measurements recorded in 1992 and 1993 by the NOAA Ship RUDE show depths consistently deeper than those shown provided by AUSS. It is recommended that RUDE data be used for charting.

AUSS VERSUS NOAA SHIP RUDE: COMPARISON OF POSITIONS AND LEAST DEPTHS OF QE2 IMPACT SITES

Item	AUSS LAT/LON	NOAA 1992 LAT/LON	NOAA 1993 LAT/LON	AUSS Least Depth MLLW ¹ Smooth Tides	NOAA 1992 Least Depth MLLW ² Smooth Tides	NOAA 1993 Least Depth MLLW ² Smooth Tides	Comments
Impact 1 Red Rock 1	41-22-12.28 70-57-30.89	41-22-12.12 70-57-31.11	41-22-12.12 70-57-31.11	10.4 m 34.0 ft	10.5 m 34.4 ft	10.8 m 35.4 ft	Good agreement position and depth
Impact 2	41-22-09.48 70-57-36.12	Not Identified	See "2R"	9.3 m 30.6 ft			Numerous circle searches, Rock not located in AUSS position. See "2R"
Impact 2R RUDE '93		Not Identified	41-22-09.35 70-57-36.87			10.9 m 35.8 ft	Rock fits description of "2", different position Least depth discrepancy
Impact 3	41-22-09.72 70-57-36.42	Not Identified	41-22-09.72 70-57-36.42	9.5 m 31.2 ft		11.0 m 36.1 ft	AUSS Position verified. Least depth discrepancy
Impact 4	41-22-09.54 70-57-36.48	Not Identified	41-22-09.54 70-57-36.48	9.6 m 31.4 ft		10.9 m 35.8 ft	AUSS Position Verified. Least depth discrepancy
Impact 5 Red Rock 2	41-22-09.29 70-57-36.31	41-22-09.31 70-57-36.32	41-22-09.31 70-57-36.32	9.4 m 31.0 ft	10.2 m 33.4 ft	10.7 m 35.1 ft	Position agreement Least depth discrepancy
Impact 6	41-22-07.68 70-57-37.62	Not Identified	See "6R"	9.1 m 30.0 ft			NOAA '93 survey did not find Impact 6 in AUSS reported position
Impact 6R RUDE '93		Not Identified	41-22-08.01 70-57-38.89			10.2 m 33.4 ft	Rock fits AUSS description of "6". Position and depth discrepancy

IMPACT 1 (Red Rock 1) - AUSS and NOAA positions and least depths agree well.

IMPACT 2 - NOAA '93 conducted numerous dive circle searches in AUSS reported position. AUSS position was 10 m east of RR2. NOAA '93 found boulder fitting "2" description 18 m WSW of RR2. The position and least depth are shown in the above table under "2R"

IMPACT 3 - NOAA '93 position verified AUSS position. NOAA '93 least depth corroborates NOAA '92 survey. Both are deeper than AUSS.

IMPACT 4 - NOAA '93 position verified AUSS position. NOAA '93 least depth corroborates NOAA '92 survey. Both are deeper than AUSS.

IMPACT 5 (Red Rock 2) - NOAA '93 position verified AUSS position. NOAA '93 least depth fall in line with NOAA '92 survey. Both are deeper than AUSS.

Impact 6 - NOAA '93 conducted echo sounder and dive investigation in vicinity of AUSS "6". Found no rock and depths were greater than 40 ft. Discovered rock fitting description of "6" approximately 31 meters WNW of reported position. Position and least depth are shown in "6R".

¹ Add 0.6 ft to AUSS Depth for depth at time of QE2 impact

² Add 0.3 m to NOAA depths for depths at time of QE2 impact

O. ADEQUACY OF SURVEY See also Section 9. of the Evaluation Report

This survey adequately supplements the 1992 survey conducted in the areas of Red Rock 1 and Red Rock 2. Refer to the 1992 Descriptive Report for survey FE-379SS.

P. AIDS TO NAVIGATION See also Section 9. in the Evaluation Report

No aids to navigation were addressed in this survey.

Q. STATISTICS

Number of Positions	95
Linear Nautical Miles	4.2
Days of Production	4
Detached Positions	31
Bottom Samples	0
Tide stations	0
Current Stations	0
Velocity Casts	3
Magnetic Stations	0
XBT Drops	0

R. MISCELLANEOUS

None

S. RECOMMENDATIONS See also Section 9. in the Evaluation Report

See the 1992 report for recommendations

T. REFERRAL TO REPORTS

This survey originated from the report:

"SURVEY OF THE AREA IMPACTED BY THE GROUNDING OF QUEEN ELIZABETH II ON AUGUST 7, 1992"

submitted by American Underwater Search and Survey, LTD,
Cataumet, Ma., 02534, dated 15 December 1992.

CONTROL STATIONS as of 11 Sep 1992

No	Type	Latitude	Longitude	H Cont	Freq	Vel Code	MN/DD/YY	Station Name
121	F	041:29:57.744	071:29:57.787	20	250	0.0	04/04/92	BEAVERTAIL LIGHT OFFSET, 1991
130	F	041:29:37.723	071:44:07.573	15	250	0.0	04/02/92	CARNETT, 1940
131	F	041:27:40.811	071:10:19.818	7	250	0.0	2 04/02/92	WARREN RESET, 1940
132	F	041:24:52.193	070:56:58.452	19	250	0.0	6 06/17/92	CUTTYHUNK LIGHTHOUSE, 1904
133	F	041:30:26.413	071:05:17.106	9	250	0.0	9 08/10/92	WESTPORT LIGHT, 1934
134	F	041:27:03.916	070:55:24.393	20	250	0.0	5 03/01/91	PENIKESE, 1946
000	F	042:38:38.888	071:05:38.888	0	0	0.0	0 03/04/01	GPS BUNKY
777	F	042:31:00.000	071:05:00.000	0	0	0.0	0 03/04/01	GPS BUNKY
200	G	041:04:02.047	071:51:38.274	0	0	0.0	09/09/92	GPS MPRS, 1992

Amexi RM4
AMC
1

CY TO
C.O., RJ
N/C6244



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Coast and Geodetic Survey
Rockville, Maryland 20852

AUG 12 1992

Commander (OAN)
First Coast Guard District
Aids to Navigation Office
408 Atlantic Avenue
Boston, Massachusetts 02110-3350

Dear Sir:

The NOAA Ship RUDE is currently involved in a hydrographic survey offshore Cuttyhunk Island, MA. The following preliminary results of the survey are being submitted as dangers to navigation which affect chart 13218 (31st ed., January 11, 1992). This preliminary information is based on predicted tides and is plotted using chart datum NAD 83.

Feature	Reported Depth	Latitude	Longitude
Rock	31.8 Feet	41°22'13.56"N	070°57'19.06"W
Rock on Ridge	33.8 Feet	41°22'11.16"N	070°57'29.18"W

It is recommended that these dangers to navigation be included in the Local Notice to Mariners.

The hydrographic survey is ongoing. Questions concerning this report should be directed to Lieutenant Commander John D. Wilder, NOAA; 301-443-8752.

Sincerely,

Donald J. Florwick
Captain, NOAA
Chief, Nautical Charting Division



AUG 17 1992

SURVEY QE 2
GROUND LINE #1
DIVE INVESTIGATION REPORT

DATE: 11 AUGUST 92 DOY: 224

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- LT WADDINGTON

- ENS ILLG

COXSWAIN\TENDER- ENS BRENNAN

VISIBILITY: 25 FEET

CURRENT: SW 2 KNOT

MAXIMUM DEPTH: 48 FEET

BOTTOM TIME: 33 MIN.

NARRATIVE REPORT: The purpose of this dive was to explore a ridge suspected of being the possible location of the grounding of the QUEEN ELIZABETH 2. This ridge is located within the search area of this survey and represented by a least depth of 34 feet (with predicted tides) at MLLW in one location and 35 feet at another. These depths were obtained by a combined side scan sonar and echosounder investigation.

The position of the southern buoy, fix 202, which is in close proximity to the 34' sounding is:

41° 22' 08.149" N

70° 57' 38.650" W

The position of the northern buoy, fix 201, which is in close proximity to the 35' sounding is:

41° 22' 10.487" N

70° 57' 36.011" W

Distance and azimuth between the two buoys: 040°

93 meters

This dive investigation was done somewhat differently from others. Using standard practices a weighted buoy was dropped on the 34 foot sounding and one also on the 35 foot sounding. Following this, personnel in the ship's small boat attached to one buoy a weighted line. They then motored to the other buoy while paying out line and then attached the other end of the weighted line to this other buoy. For the purposes of this report this line shall be called a ground line. While this was taking place, the divers were preparing to enter the water from the stern of the RUDE as she drifted by the upwind dive buoy (the southern buoy). The divers entered the water, floated down to the buoy and descended to the bottom.

After the divers reached the bottom they snapped a tag line into the line running between the two previously deployed buoys, the trot line. This tag line was paid out perpendicularly to the trot line. One diver moved out approximately five meters from the trot line and the other diver moved out five meters from the first diver. In this fashion the diver on the outside was approximately 10 meters from the trot line. They then swam the entire length of the trot line from one buoy to the other. This gave them an effective visual swath coverage of approximately 65 to 70 feet. This same procedure was used to return back to the start buoy on the other side of the trot line. Again this gave an effective visual swath coverage of 65 to 70 feet with an overlap along the trot line of approximately 10 feet.

The divers found very many boulders. In fact, the bottom is almost completely covered by rocks of various sizes. A large area was covered by the divers in this very busy dive so a constant mental record of the depths along the ground line could not be made. However, the general depth of the area was between 40 and 50 feet. In the course of their bottom coverage they measured least depths by diver's depth gauge on some of the larger boulders. With one exception, these least depths did not approach the critical depth of 34 or 35 feet they were looking for. At the far buoy at the end of the first leg of their investigation the divers found a very large boulder not far from the buoy. This boulder was much larger than the rest. Its least depth by diver's depth gauge was 34 feet. An echosounder position on fix 213 showed a least depth of 10.5 meters @MLLW on this boulder.

Upon completion of their investigation along the other side of the ground line which took them back to the buoy they started from, the diver found themselves low on air. This prevented them from investigating the immediate area to find the boulder conforming to the 35' sounding on the ridge. At this point the dive was terminated.

QE 2 INVESTIGATION
DIVE INVESTIGATION REPORT

DATE: 12 AUGUST 92 DOY: 225

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

ENS ILLG

COXSWAIN- ENS BRENNAN

TENDER- LT WADDINGTON

VISIBILITY: 12 METERS

CURRENT: 1 KNOT

MAXIMUM DEPTH: 13.4 METERS

BOTTOM TIME: 13 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITION

HDAPS POSITION: FIX 228

EASTING: 181624.2

NORTHING: 263272.2

LATITUDE: 41° 22' 13.55 N

LONGITUDE: 70° 57' 19.18 W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 10.1 METERS

TIME OF READING: 1539Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.4

LEAST DEPTH DETERMINED @MLLW 9.7⁸ METERS

NARRATIVE REPORT: The object of this investigation was a boulder which rises approximately 3.4 meters off the bottom in the area where the QE 2 reportedly grounded. The bottom around the boulder was 13.4 meters deep, as measured by the divers depth gauge.

* Note-a corrected shoaler depth of 9.6 meters @ MLLW was recorded by echosounder for this feature.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 12 Aug 92		DN 225				
AWOIS Item No. QE2		Survey No.				
Pneumatic Depth Gauge						
<input checked="" type="checkbox"/> 0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822				
Time of readings 1539Z		Tide Corrector -0.4³				
Reading No. 1 10.1		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 9.7 meters <small>8</small> </div>				
Reading No. 2 10.1						
Reading No. 3 10.1						
Average Reading 10.1m						
Dive Buoy Position Information						
Range of D.P.'s 226-231						
Fix No.	226	227	228	229	230	231
Raw Depth	8.4	8.6	7.8	7.9	7.3	7.7
Corrected	10.8	10.6	9.6	9.7	9.7	9.7
D.P. Selected Least Depth				228	9.6m	
Easting 181624.2			Lat 41-22-13.554 N			
Northing 263272.2			Lon 70-57-19.182 W			
Loran-C Position on Dive Buoy						
Chain	25546.8	14272.2	43914.7	60164.1		
SNR	999	755	763	245		
Master	814					

REMARKS:

QE 2 INVESTIGATION
DIVE INVESTIGATION REPORT

DATE: 12 AUGUST 92 DOY: 225

PERSONNEL:

DIVEMASTER- LTJG SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- LT WADDINGTON

- ENS ILLG

COXSWAIN\TENDER- ENS BRENNAN

VISIBILITY: 15 FEET

CURRENT: 1/2 KNOT

MAXIMUM DEPTH: 44 FEET

BOTTOM TIME: 11 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITIONS

HDAPS POSITION: FIX 235

EASTING: 181390.2

NORTHING: 263193.2

LATITUDE: 41° 22' 11.026" N

LONGITUDE: 70° 57' 29.265" W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 10.3 METERS

TIME OF READING: 1625Z

PNEUMATIC DEPTH GAUGE CORRECTOR:

0.0

smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR:

-0.2¹

LEAST DEPTH DETERMINED @MLLW

10.2² METERS
(33.1 FEET)

NARRATIVE REPORT: The object of this investigation was a kelp covered boulder lying in 44 feet of water. The least depth was measured by three consecutive readings with a pneumatic depth gauge on the shoalest point of the rock. This reading was 10.3 meters (33.1 feet). The least depth measured by diver's depth gauge was 33.5 feet.

* Note-a corrected shoaler depth of 10.0 meters @ MLLW was recorded for this feature.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 12 Aug 92		DN 225				
AWOIS Item No. QE 2		Survey No.				
Pneumatic Depth Gauge						
<input checked="" type="checkbox"/> 0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822				
Time of readings 1625Z		Tide Corrector -0.2 1				
Reading No. 1 10.3		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge 10.1²m </div>				
Reading No. 2 10.3						
Reading No. 3 10.3						
Average Reading 10.3m						
Dive Buoy Position Information						
Range of D.P.'s 232-236						
Fix No.	232	233	234	235	236	
Raw Depth	8.0	8.3	8.4	7.8	8.0	
Corrected	10.6	10.4	10.5	10.0	10.1	
D.P. Selected Least Depth				235 10.0m (32.81')		
Easting 181390.2		Lat 41:22:11.026				
Northing 263193.2		Lon 70:57:29.265				
Loran-C Position on Dive Buoy						
Chain	43914.7	60163.9	14273.3	25548.2		
SNR	745	297	756	999		
Master	810					

REMARKS:

QE 2 INVESTIGATION
DIVE INVESTIGATION REPORT

DATE: 13 AUGUST 92 DOY: 226

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- ENS ILLG

- LT WADDINGTON

COXSWAIN\TENDER- ENS BRENNAN

VISIBILITY: 20 FEET

CURRENT: 1/2 KNOT

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 22 MIN.

NARRATIVE REPORT: The purpose of this dive was to investigate the area between two bottom features previously marked by the RUDE. This area was thought to be a possible sight of the grounding of the QE 2. Using the same methods employed on the August 11 dive investigation, two buoys were deployed to serve as the beginning and end of the diver's investigation.

As the divers began their swim the bottom was covered with numerous small boulders (ranging in size from 2 feet in diameter to 1/2 foot in diameter). Approximately 40 meters into the swim there was an area of coarse white sand and broken shells. This area was approximately 30 meters wide as transited by the ground line. The bottom then became covered with numerous small boulders as before. The depths along the ground line were 40 to 45 feet.

Approximately 100 meters along the ground line LT Waddington (on the northern end of the search line) noticed a large boulder 3 meters to his left. A quick check revealed a prominent boulder with an absence of marine growth along the top. All other rocks encountered had significant growth - kelp or ribbon weed and barnacles.

LT Waddington signaled the other diver LT Schattgen and they did a quick reconnaissance around the rock. They then released a pelican float to mark the rock's position. The divers then scraped samples from the top of the rock and stowed them in LT Schattgen's dive glove. The divers depth gauge read 35 feet at the shoalest point of this rock. The depth at the base of the rock by diver's depth gauge was 42 feet.

The divers then continued along the ground line to the anchor of buoy No. 2. Upon arriving at the anchor the divers spotted another boulder approximately 5 meters east of buoy No 2's anchor. The divers investigated this boulder and found no signs

of contact and it was completely covered with kelp or ribbon weed and other marine growth. The top of this boulder was at 33 feet as measured with the diver's depth gauge. The least depth of this boulder was determined by pneumatic depth gauge. It is not reported here since this boulder is unremarkable and of ~~know~~ real interest.

NO

ROCK
FIX NO. 235 D.P.
LEAST DEPTH 9.9 M (32.4 FT)
LAT 41:22:11.03 N
LON 70:57:29.26 W

X = 181390.2
Y = 263193.2

FIX NO. 362.1
LEAST DEPTH 10.5 M
(34.6 FT)
LAT 41:22:12.23 N
LON 70:57:30.89 W

X = 181352.2
Y = 263231.7

Red Rock 1
See pos# 339 - LID = 10.5m
ROCK FROM WHICH
SAMPLES WERE
TAKEN

BUOY NO. 2 LAT 41:22:11.03 N
LON 70:57:29.26 W

X = 181390.2
Y = 263193.2

065° T
080° MAG
30 M
DIVERS
TAGLINE

7 M

BUOY NO. 3

132 M
106° TRUE

← NORTH

LT WADDINGTON

LT SCHATTGEN

5 M

5 M

GROUND LINE

BUOY NO. 1
LAT 41:22:12.16 E
LON 70:57:34.75 W

X = 181262.7
Y = 263227.6

△ BUOY ANCHOR

⬡ ROCK

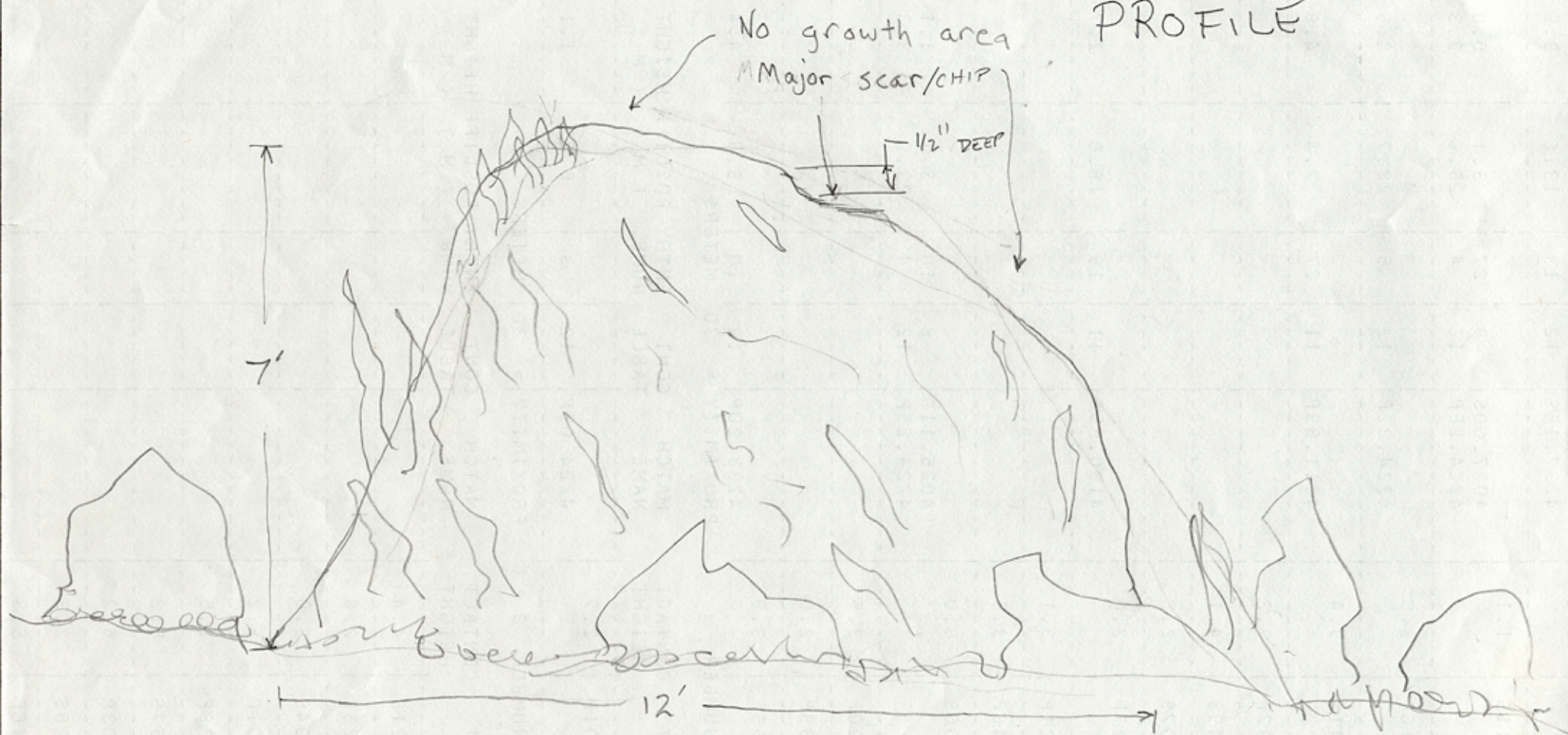
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

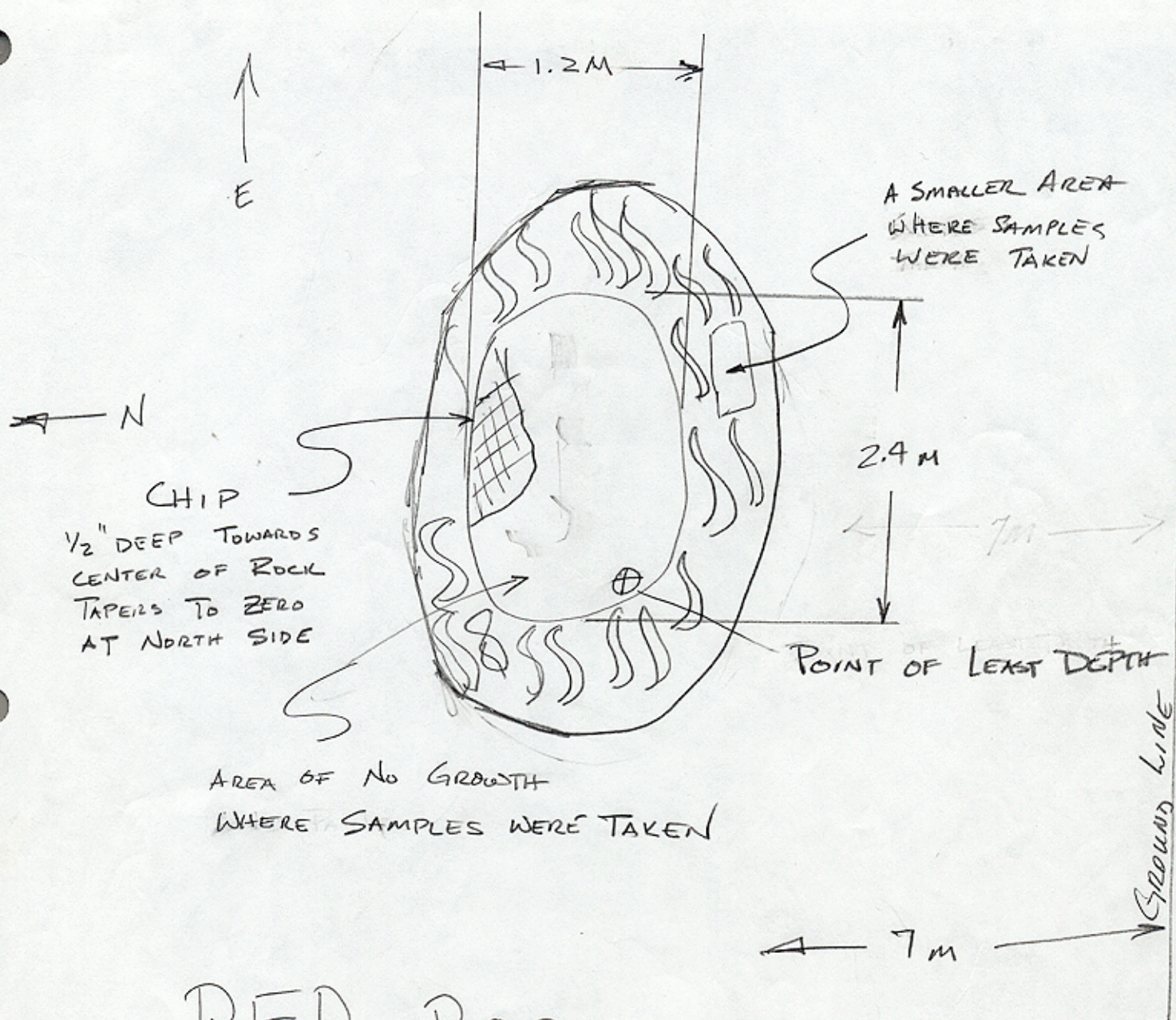


RUDE Rocks



"RED ROCK" PROFILE





RED ROCK PLAN VIEW

TOP VIEW

TOP ROCK OF TREE FROM WHICH SAMPLES

This is the least depth information for a boulder found at the far end of the second ground line deployed for this investigation. It is an unremarkable boulder.

DIVE # 2

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 13 August 1992		DN 224	
AWOIS Item No. QE II		Survey No.	
Pneumatic Depth Gauge			
0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822	
Time of readings		Tide Corrector - .2	
Reading No. 1		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge [32.48 Ft] 9.9m </div>	
Reading No. 2			
Reading No. 3			
Average Reading 10.1			
Dive Buoy Position Information			
Range of D.P.'s use D.P. 235 ^{DOY: 225} AND PNEUMO			
Fix No.		DPS NOT TAKEN TODAY	
Raw Depth			
Corrected			
D.P. Selected Least Depth			
Easting		Lat	
Northing		Lon	
Loran-C Position on Dive Buoy			
Chain			
SNR			
Master			

REMARKS:

QE 2 INVESTIGATION
DEVELOPMENT #5
DIVE INVESTIGATION REPORT

DATE: 13 AUGUST 92 DOY: 226

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- ENS ILLG

- LT WADDINGTON

COXSWAIN\TENDER- ENS BRENNAN

VISIBILITY: 15 FEET

CURRENT: 1/2 KNOT

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 13 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITIONS

HDAPS POSITION: FIX 328

EASTING: 181363.9

NORTHING: 263073.0

LATITUDE: 41° 22' 07.¹⁵~~134~~" N

LONGITUDE: 70° 57' 30.420" W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 10.9 METERS

TIME OF READING: 1542Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.⁴⁵

LEAST DEPTH DETERMINED @MLLW 10.⁴~~5~~ METERS
(34.45 FEET)

NARRATIVE REPORT: The object of this investigation was a kelp covered boulder lying in 44 feet of water. The least depth was measured by three consecutive readings with a pneumatic depth gauge on the shoalest point of the rock. This reading was 10.95 meters (35.9 feet). The least depth measured by diver's depth gauge was 36 feet.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 13 Aug 92		DN 226					
AWOIS Item No. QE 2		Survey No.					
Pneumatic Depth Gauge							
<input checked="" type="checkbox"/> 0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822					
Time of readings 1542Z		Tide Corrector -0.45					
Reading No. 1 10.9		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge 10.5⁴ m </div>					
Reading No. 2 10.9							
Reading No. 3 10.9							
Average Reading 10.9 m							
Dive Buoy Position Information							
Range of D.P.'s 328-334							
Fix No.	328	329	330	331	332	333	334 10.6 12.8
Raw Depth	9.0	9.1	Reject	9.0	9.3	Reject	
Corrected	11.4	12.7	11.9	11.8	12.8	13.3	
D.P. Selected Least Depth 328				11.4 m			
Easting 181363.9				Lat 41:22:07.134 N			
Northing 263073.0				Lon 70:57:30.420 N			
Loran-C Position on Dive Buoy							
Chain	14273.8	43914.3	25548.4	60163.7			
SNR	790	814	950	300			
Master	818						

REMARKS:

QE 2 INVESTIGATION
RED ROCK 1
DIVE INVESTIGATION REPORT

DATE: 13 AUGUST 92 DOY: 226

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- ENS ILLG

- LT WADDINGTON

COXSWAIN\TENDER- ENS BRENNAN

VISIBILITY: 20 FEET

CURRENT: 1/2 KNOT

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 17 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITIONS

HDAPS POSITION: FIX 339

EASTING: 181363.9

NORTHING: 263073.0

LATITUDE: 41° 22' 12.¹²~~099~~" N

LONGITUDE: 70° 57' 31.110" W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 10.6 METERS

TIME OF READING: 1805Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.1

LEAST DEPTH DETERMINED @MLLW 10.5 METERS
(34.4 FEET)

NARRATIVE REPORT: The purpose of this dive was to determine a least depth for the rock found on the previous dive that was suspected of being a point of contact with the QE 2. This rock exceeded the height of all other boulders nearby and a search around the immediate vicinity found no other signs of suspected contact. A least depth was determined by three consecutive readings by pneumatic depth gauge. This depth was 10.6 meters (34.8 feet).

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 13 Aug 92		DN 226	
AWOIS Item No. QE2		Survey No.	
Pneumatic Depth Gauge			
<input checked="" type="checkbox"/>	0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822
Time of readings 1805 Z		Tide Corrector -0.1	
Reading No. 1 10.6		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 10.5 meters </div>	
Reading No. 2 10.6			
Reading No. 3 10.6			
Average Reading 10.6 m			
Dive Buoy Position Information			
Range of D.P.'s 339-348			
Fix No.	339	340	341
	342	343	344
	345	346	347
	348		
Raw Depth	10.6	10.5	9.6
	9.5	10.3	9.9
	9.4	10.8	10.6
	11.2		
Corrected	10.5	12.7	11.9
	11.9	12.6	11.8
	11.7	12.7	12.7
	13.0		
D.P. Selected Least Depth 339 10.5 m			
Easting 181363.9		Lat 41-22-12.099	
Northing 263073.0		Lon 70-57-31.110	
Loran-C Position on Dive Buoy			
Chain	43914.8	60163.8	14273.5
	25548.5		
SNR	775	216	788
	945		
Master	853		

REMARKS:

QE 2 INVESTIGATION
RED ROCK 1
DIVE INVESTIGATION REPORT

DATE: 14 AUGUST 92 DOY: 227

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- LT WADDINGTON

- ENS ILLG

COXSWAIN- ENS BRENNAN

VISIBILITY: 10 FEET

CURRENT: 1 KNOT

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 33 MIN.

NARRATIVE REPORT: The object of this investigation was a rock suspected of being the site of the grounding of the QUEEN ELIZABETH 2. No position or least depth information is included in this report since that data is included in another report from a previous dive. The primary purpose of this dive was to film the rock as evidence with an underwater video camera.

Since I have been aboard the NOAA Ship RUDE I have probably been involved in dive investigations for over forty such boulders. In addition to those particular boulders I have seen hundreds more in the course of these dives. Depending upon the water depth, these boulders are always covered with some form of marine life. In deeper water the rocks are covered with primarily tightly clinging sea anemones and some other small organisms. Recently, prior to the investigation of the QE 2, the ship has been involved in dive investigations of boulders in waters of a similar depth north of Cuttyhunk Island. As we have seen on those boulders and on those being investigated in the course of the QE II investigation, the boulders are not covered with sea anemones. Instead, the boulders are covered with what the diver's have begun to call kelp. This may not be the correct name for it, but it suits our purposes. This kelp grows in such profusion that the diver's get entangled in it when they occupy the top of a boulder to obtain a least depth by pneumatic depth gauge. In fact, the diver's have to clear an open space through it to expose the top of the boulder.

When I dove this boulder for this dive it was the first time I had seen it. I had not been part of the dive team that initially investigated it. As I descended from the water surface to the boulder I was immediately struck by the fact that the uppermost side of the boulder was completely free of kelp. In fact, it was bare exposed rock with no sign of any life except for what appeared to be the bases of barnacle type organisms that had been

scraped away. I found it so remarkable that the rock was thus exposed that this to me this was convincing evidence that something of size had been dragged across the boulder. I should mention also that though there was no vegetation on this exposed face of the boulder there was kelp growing from around the edges. It was as if this one face has been scraped clean.

I also noted on the boulder some discoloration in a narrow band that resembled rust and blackish paint. Realizing that color in waters with such poor visibility is severely muted I can not speculate on the true color of it. LT Schattgen again took samples of this discoloration and stowed them in the cuff of his glove. Upon reaching the surface these samples were stowed securely and presented to the Commanding Officer once the dive launch reached the ship.

The real purpose of this dive was to record evidence of the boulder via an underwater video camera. The dive conditions were not the most favorable for filming. However, we were able to record images of the boulder from several different perspectives including some close up segments of the discoloration. To increase the chances of success in recording this evidence four different equipment configurations were tried. One was with a red lens filter, and one without, and one with the camera's strobe on and one with only natural lighting. The film was afterwards placed in custody with the Commanding Officer.

QE 2 INVESTIGATION
RED ROCK 2
DIVE INVESTIGATION REPORT

DATE: 15 AUGUST 92 DN: 228

PERSONNEL:

DIVEMASTER- LT SCHATTGEN

DIVERS- LT SCHATTGEN

TENDER- ENS BRENNAN

- ENS ILLG

COXSWAIN\TENDER- SS BRAWLEY

VISIBILITY: 15 FEET

CURRENT: 1.5 KNOTS

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 18 MIN
35 MIN

NARRATIVE REPORT: This report details the findings of two consecutive dive investigations on the same feature. This feature, referred to as Red Rock 2 is suspected of being one of the impact points of the QUEEN ELIZABETH 2 grounding.

On the first dive the divers descended the buoy line and immediately found several large pieces of paint. These pieces varied in size and shape but all were approximately 1/16" thick. The two largest pieces were somewhat triangular in shape and roughly six inches in length on all sides. One side of these paint chips was gold and the other a pinkish color. These paint chips were not recovered.

The divers extended the circle search line to the south approximately 10 meters and began the search in an easterly direction. Upon reaching the southeast quadrant of the circle they found a boulder approximately 8' X 10' feet with an uncommonly flat top. The boulder lies on a sloping bottom with the western side rising six feet from the bottom and the eastern side rising three feet off the bottom. The least depth measured by diver's depth gauge was 35 feet.

On the surface of this boulder divers found obvious signs of impact. There was much fractured granite and the entire top of the boulder was clean and exposed as opposed to covered with algae and other marine growth that is typical of boulders and rocks in the area. Also, on top of this boulder were many pieces of metal shavings that looked as if they had been sheared from what could of been a ship's hull. More paint chips were found on the bottom surrounding this boulder as well as rocks that appeared to of been crushed and pulverized.

The divers then made a quick search of the surrounding area using underwater sleds to look for other signs of impact. In many places the bottom seem disrupted as it was covered in places with tumbled and exposed rocks. The dive was then terminated.

On the second dive the divers returned prepared to film an underwater video and to collect samples of the broken rock, paint chips and metal shavings. This dive centered on only this particular boulder. One of the divers filmed the boulder and surrounding area to record what are suspected to be signs of impact. The other diver spent this dive collecting samples and making observations. Both the film and samples were handled as evidence and placed in the custody of the Commanding Officer at completion of the dive.

QE 2 Investigation
DIVE INVESTIGATION REPORT

DATE: 17 AUGUST 92 DN: 230

PERSONNEL:

DIVEMASTER\TENDER- ENS. BRENNAN DIVERS- LT SCHATGEN

COXSWAIN\TENDER- J. BRAWLEY - ENS ILLG

VISIBILITY: 25 FEET CURRENT: <.5 KNOT

MAXIMUM DEPTH: 43 FEET BOTTOM TIME: 38 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITION

HDAPS POSITION: FIX 395

EASTING: 181230.3 NORTHING: 263142.5

LATITUDE: 41°-22'-09.405"N LONGITUDE: 070°-57'-36.155"W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.6 METERS

TIME OF READING: 1515Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: ~~-1.1~~ METERS

LEAST DEPTH DETERMINED @MLLW 10.⁷ METERS

NARRATIVE REPORT: The object of this dive was a search along a ground line run between two dive buoys in the direction of the track line of the Queen Elizabeth 2 (240°). Divers descended on the northern-most dive buoy onto Red Rock 2. While there, they obtained a pneumatic depth gauge least depth of 11.6 meters (uncorrected), measurements of 8' x 10' on Red Rock 2, and additional paint and metal shaving samples. The divers continued southward along the ground line for approximately 70 meters with a visual search of 5 to 10 meters either side of the ground line. Along this line approximately 6-8 more boulders were found which appeared to receive glancing blows by the QE 2. In addition, one boulder near the end of the ground line was found which had been tumbled, evident by the exposed algae line and chipped edges.

* Note-a corrected shoaler depth of 10.1 meters @ MLLW was recorded by echosounder for this feature.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 17 Aug 92					DN 230				
AWOIS Item No. QE2					Survey No.				
Pneumatic Depth Gauge									
<input checked="" type="checkbox"/> 0 - 21 M s/n 201637 12					0 - 42 M s/n 8606822				
Time of readings 1515Z					Tide Corrector -1.1-0.9				
Reading No. 1 11.6					<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge 10.5⁷ metres </div>				
Reading No. 2 11.6									
Reading No. 3 11.6									
Average Reading 11.6m									
Dive Buoy Position Information									
Range of D.P.'s 387-395									
Fix No.	387	388	389	390	391	392	393	394	395
Raw Depth	11.4	10.8	10.6	10.7	10.2	10.3	9.7	9.6	11.6
Corrected	12.5	12.1	12.1	12.1	11.4	11.3	11.0	11.0	10.5
D.P. Selected Least Depth					Fix 395				
Easting 181230.3					Lat 41-22-09.405" N				
Northing 263142.5					Lon 070-57-36.155" W				
Loran-C Position on Dive Buoy									
Chain									
SNR									
Master									

REMARKS:

QE 2 Investigation
DIVE INVESTIGATION REPORT

DATE: 17 AUGUST 92 DN: 230 DIVE NUMBER: 2

PERSONNEL:

DIVEMASTER\TENDER- ENS. BRENNAN DIVERS- LT SCHATGEN

COXSWAIN\TENDER- J. BRAWLEY - ENS ILLG

VISIBILITY: 15 FEET CURRENT: 1.5 KNOT

MAXIMUM DEPTH: 15 METERS BOTTOM TIME: 32 MIN.

NARRATIVE REPORT: The objective of this dive was a circle search around a dive buoy dropped in the location of a boulder. This boulder was initially located by echosounder, however a good position was not available. Upon completing three separate circle searches (one at 10, 20, and 30 meters) no rock shoaler than 37 feet by diver's depth gauge was encountered.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 1

DATE: 31 MARCH 93 DN: 090

PERSONNEL:

DIVEMASTER\TENDER- LT NIICHEL DIVERS- LTJG ILLG

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 10-15 FEET CURRENT: 1.5 KNOTS NW

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 32 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITION

HDAPS POSITION: FIX 1110

EASTING: ~~181223.3~~

(Original Fix #10) / 1110
NORTHING: 263145.4

LATITUDE: 41°-22'-09.³¹~~500~~"N

LONGITUDE: 070°-57'-36.³²~~456~~"W <

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.38 METERS

TIME OF READING: 1646Z ✓

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

^{smooth}
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.7 METERS

LEAST DEPTH DETERMINED @MLLW 10.7 METERS
(35.1 Feet) ✓

NARRATIVE REPORT: The objective of this dive investigation was to again locate the submerged boulder referred to as Red Rock 2. Once it was located, it's dimensions were to be measured and a least depth determined by use of a pneumatic depth gauge. If time allowed, a search along a previously laid ground line was to be conducted in an attempt to identify boulders showing signs of impact with the QE2.

The ground line was approximately 20 meters long. It's beginning was at Red Rock 2 and it ran due North where it was fixed to another anchor. This ground line was intended to serve as a point of reference for conducting searches North of Red Rock 2. Searches were to be conducted out to 10 meters on both sides, to the East and West, of the ground line.

Weather conditions for this dive were outstanding. It was a clear, calm day and the sea surface was unusually flat especially considering the time of year. Conditions below the surface were

not ideal. There was a fairly strong current estimated at 1.5 knots flowing to the Northwest. This limited the visibility to 10-15 feet.

Upon entering the water the divers descended the Southern buoy line and had Red Rock 2 in sight as soon as they reached the bottom. The anchors for the buoy were no more than three feet away from the edge of that boulder. The divers spent some time investigating the immediate vicinity while personnel in the dive launch deployed the 20 meter ground line between the two dive buoys previously deployed by NOAA Ship RUDE. After a short while the divers signalled the dive launch by giving three sharp tugs on the dive buoy on Red Rock 2. Personnel on the surface then sent down the orifice end of the pneumatic depth gauge hose. Three consecutive readings on the shoalest point of the rock were obtained by this method.

After tenders in the dive launch recovered the hose they sent down a bag of equipment for conducting further investigations. Among this equipment was a fiberglass measuring tape marked in both feet and meters. The divers measured Red Rock 2 and found it had a girth of 43' 2", a height of 5' 0" and a surface of 8' 2" by 10' 4". These measurements were recorded on a dive slate.

After completing these activities the divers were low on air and terminated the dive. After being recovered by the dive launch the divers reported their findings to the Commanding Officer and were recorded aboard the launch on a dive operations summary sheet.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 31 Mar 93		DN 090	
AWOIS Item No. QE2		Survey No. FE 37925	
Pneumatic Depth Gauge			
<input checked="" type="checkbox"/>	0 - 21 M s/n 201637 12		<input type="checkbox"/>
		0 - 42 M s/n 8606822	
Time of readings 1646 UTC		Tide Corrector -0.7	
Reading No. 1 11.4 (37.2)		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 10.7 m (35.1 ft) </div>	
Reading No. 2 11.4 (37.4)			
Reading No. 3 11.35 (37.4)			
Average Reading 11.38 ✓			
Corrected Least Depth by Pneumatic Gauge			
Dive Buoy Position Information			
Range of D.P.'s			
Fix No.	5	6	7
Raw Depth	11.1	10.8	11.3
Corrected	12.3	12.1	12.6
← Reject →			
D.P. Selected Least Depth			
Use DP 10 with new adjusted position as DP 1110. NSP			
Easting	181223.3 ✓		Lat 41° 22' 09.630"
Northing	263149.4 ✓		Lon 070° 57' 36.455"
Loran-C Position on Dive Buoy			
Chain	N/A		
SNR			
Master			

11
 10.1
 11.5
 Reject
 } DP 10

REMARKS: Position of DP 1110:

Easting **181223.3** ✓ Lat **41° 22' 09.500"**
 Northing **263145.4** Lon **070° 57' 36.456"**

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 2

DATE: 31 MARCH 93 DN: 090

PERSONNEL:

DIVEMASTER\TENDER- LT NIICHEL DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 10-15 FEET CURRENT: 1.0 KNOTS NW

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 35 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITION

HDAPS POSITION: NOTE: NO POSITIONS WERE OBTAINED FOR THIS DIVE

EASTING: XXXXXX.Z

NORTHING: XXXXXX.Z

LATITUDE: ^{41° 22' 09.54"}
~~XX°-XX'-XX.XXX"N~~

LONGITUDE: ^{70° 57' 36.48"}
~~XXX°-XX'-XX.XXX"W~~

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.70 METERS

TIME OF READING: 1844Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

^{smooth}
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.8 METERS

LEAST DEPTH DETERMINED @MLLW 10.90 METERS
(35.76 Feet)

NARRATIVE REPORT: Dive 2 continued the work begun on the first dive of day 090; specifically, to investigate a 10 meter swath either side of the previously laid ground line and to acquire a least depth on the rock labeled "Impact 2" in the AUSS investigation.

After descending down the southern buoy line onto Red Rock 2 (Impact 5) an initial run of the ground line was made to insure it was properly laid. On this first run towards the northern buoy approximately one-third of the way, the dive team swam across what it believes to be "Impact 4" and "Impact 3". These two rocks roughly matched the dimensions of the Impact 3 and 4 rocks, and were oriented in the same manner as described in the AUSS Investigation. In addition both rocks had large smears which appeared to be bottom paint and were still devoid of vegetation. It should be noted that the ground line should have passed to the east of these rocks by several meters, however due to the current and excess slack in the ground line it was blown

off the originally intended base line. The area surrounding these boulders (as well as the entire site) was covered with small cobbles. There were small patches on the bottom devoid of boulders or cobbles and a very dense, stiff plastic like clay could be seen.

Upon reaching the northern buoy (approximately 20 meters north of Red Rock 2) the ground line was drawn tight and as straight as possible. A second line was then attached, via a clip, to the ground line and stretched approximately 90° (perpendicular) to the eastern side of the ground line out to a measured 10 meters. LT Niichel was located at the 10 meter mark and ENS Brennan was located between LT Niichel and the ground line at 5 meters. The pair of divers then swam back south to Red Rock 2. No rocks were observed on this pass which matched the description of "Impact 2" in the AUSS Investigation. Another radial search was conducted with LT Niichel as the anchor man situated at Red Rock 2 and ENS Brennan on the free end of the line. This search was conducted twice, at 5 and 10 meters, from due south of Red Rock 2 east to the ground line. This search failed to yield any rock matching the description of "Impact 2".

With air running short, it was decided to get a least depth on the Impact 4 boulder since it proved to be the shoalest between Impacts 3 and 4 as evident by diver's depth gage. Upon setting up on Impact 4 boulder, a pelican float was deployed to the surface. The dive tender on the surface then returned the orifice end of the pneumo hose down the pelican float's line. After finishing the pneumo reading the divers returned to the surface, completing dive 2.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 31 MAR 93	DN 090
AWOIS Item No.	Survey No.
Pneumatic Depth Gauge	
X 0 - 21 M s/n 201637 12	0 - 42 M s/n 8606822
Time of readings 1844UTC	Tide Corrector -0.8
Reading No. 1 11.7	Corrected Least Depth by Pneumatic Gauge <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> 10.9 (35.74) </div>
Reading No. 2 11.7	
Reading No. 3 11.7	
Average Reading 11.7	
Dive Buoy Position Information	
Range of D.P.'s NO DPS TAKEN FOR THIS	
Fix No.	DIVE. A DRIFT SEARCH WAS DONE
Raw Depth	IN THE AREA.
Corrected	FIX # 34 → 40
D.P. Selected Least Depth	
Easting	Lat
Northing	Lon
Loran-C Position on Dive Buoy	
Chain	
SNR	
Master	

REMARKS:

NOAA SHIP RUDE DIVE OPERATIONS

DATE		March 31, 1993 (DN090)						
SUBJECT OF INVESTIGATION		QE2 Grounding Site						
Relative Location of Dive		South of Cuttyhunk Island						
LAT		LON						
CONTACT CHAMBER (203) 449-3676		✓		Chief Sharpe				
CONTACT US COAST GUARD		✓						
Expected Max. Depth								
Dive No. 1 > 40'		Dive No. 2 ~ 45'		Dive No. 3				
Time of High Tide (Local)								
Divers	Surface Interval	RNT	Pressure In	Pressure Out	Time In	Time Out	Bottom Time	Max Depth
Niichel								
Dive #1 {	Illg		2450	700	1121	1153	32	45'
	Brennan		3100	1200	1121	1153	32	45'
Dive #2 {	Niichel		3000	500	1315	1350	35	
	Illg							
	Brennan	1:15	32	2800	500	1315	1350	35

Diver's Remarks:

Dive #1: RR2 Girth 43' 2", Height 5' 0", Top 8' 2", 10' 4"
LD by pneumo 37.4'

Dive #2: Suspected Rock was #4 LD 38.4' by pneumo
Divers think they found #3 and #4 and perhaps extending the search further East will uncover #2.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 1

DATE: 09 APRIL 93 DN: 099

PERSONNEL:

DIVEMASTER\TENDER-LTJG ILLG DIVERS-LT NIICHEL

COXSWAIN\TENDER-J. BRAWLEY -ENS BRENNAN

VISIBILITY: <10 FEET CURRENT: 2 - 2.5 KNOTS SE

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 23 MIN.

NARRATIVE REPORT: The object of this dive was to search for the rock described as Impact 6 in the AUSS investigation. The dive began by descending down a buoy line which was dropped on a 36 foot sounding found during last years survey. This 36 foot sounding (position: 41°-22'07.803" N, 070°-57'-37.821" W) plotted approximately 6 meters to the north west of the AUSS location of Impact 6 (position: 41°-22'-07.68" N, 070°-57'-37.62" W) and was thought to possibly be one in the same.

Upon descending the buoy line, LT Niichel remained stationary on a large rock and tended the center of the circle search. ENS Brennan extended the circle search line out to a measured 5 meters and completed one revolution with no positive results. A 10 meter radius search and a partial 15 meter radius search was completed. The 15 meter search covered approximately three quarters of the compass quadrants, starting at 270° and swimming through to 180° magnetic. Again, nothing was found on these circle searches. The third search at 15 meters was not completed due to low air and strong currents.

Over the course of the circle searches that were completed, numerous boulders were encountered lying on a rocky, gravel bottom, and were at depths between 40 and 42 feet by divers depth gauge. None of these rocks showed any of the signs of impact seen on the other boulders (i.e. lack of marine growth, smears of bottom paint) nor did any match the sketches seen in the AUSS investigation. The average boulder rose approximately 3 to 4 feet off the bottom with the largest rising approximately 5 to 6 feet off the bottom. An intense echo-sounder investigation around the Impact 6 position revealed a least depth of about 42 feet as opposed to the 30 foot least depth reported in the AUSS investigation.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 2

DATE: 09 APRIL 93 DN: 099

PERSONNEL:

DIVEMASTER\TENDER-LTJG ILLG

DIVERS-LT NIICHEL

COXSWAIN\TENDER-J. BRAWLEY

-ENS BRENNAN

VISIBILITY: >10 FEET

CURRENT: 2 KNOTS SE

MAXIMUM DEPTH: 45 FEET

BOTTOM TIME: 27 MIN.

NARRATIVE REPORT: The objective of this dive investigation was to again locate the submerged boulder referred to as Red Rock 2. Then use it as a base from which to conduct a radial search for the rock referred to as AUSS Impact 2. One diver would be the anchor at Red Rock 2 and the other was to begin due south of Red Rock 2 and swim east until he reached the ground line, completing a semicircle east of the north-south ground line. After locating the rock referred to as Impact 2, it's dimensions were to be measured and a least depth determined by use of a pneumatic depth gauge.

Red Rock 2 was easily located and the first semicircle was conducted at a distance of five meters from south to north. Upon reaching the ground line the search line was extended to 10 meters and a semicircle search was conducted in the opposite direction. This search located a rock which was similar to the discription of Impact 2 but considerably smaller, with no sign of impact. Mature marine growth covered this entire rock, unlike Red Rock 2 and Impact 3 and 4 Rocks which are still easily identifiable by their lack of marine growth in the impact area. Diver depth gage on this particular rock was 40 feet. Having failed to locate the rock referred to as Impact 2, the divers moved north along the ground line five meters, traded places and conducted a second set of semicircle searches at five and ten meters from the ground line. This second search also failed to locate the rock referred to as Impact 2.

Weather conditions for this dive were good. It was partly cloudy, with light southerly winds (5-10 knots), the sea surface had a slight chop and a 2 foot southerly swell. Conditions below the surface were less than ideal. There was a fairly strong current estimated at 2 knots flowing to the Southeast and the swell action was considerable even at depth. The visibility was generally 10 feet or less.

After completing these searches the divers were low on air and terminated the dive. After being recovered by the dive launch the divers reported their findings to the Commanding Officer and were recorded aboard the launch on a dive operations summary sheet.

NOAA SHIP RUDE DIVE OPERATIONS

DATE 9 April 93								
SUBJECT OF INVESTIGATION QEA Grounding Site								
Relative Location of Dive 2.5 NM South of Cutty Hunk Island								
LAT				LON				
CONTACT CHAMBER (203) 449-3676					✓			
CONTACT US COAST GUARD					✓			
Expected Max. Depth								
Dive No. 1 45			Dive No. 2 45			Dive No. 3 40		
Time of High Tide (Local)								
Divers	Surface Interval	RNT	Pressure In Out		Time In Out		Bottom Time	Max Depth
Dive #1 { Niichel Illg Brennan			2900	900	1100	1123	23	45
	Loafing							
			2900	700	1100	1123	23	45
Niichel	29	23	2900	500	1152		24	
Illg	still loafing							
Brennan	29	23	2900	1000	1152		24	

Diver's Remarks:

Dive #1: Impact #6 completed 5, 10 meter circle searches and a partial 15 meter search with negative results
 0-70' pneumo
 0-140' pneumo

Dive #2 - nothing found

Dive #3 Niichel 3000 1323 1328 Aborted
 Brennan 3000 1323 1330

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 1

DATE: 15 APRIL 93 DN: 105

PERSONNEL:

DIVEMASTER\TENDER- ST WILLIAMS DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 20-25 FEET CURRENT: <1.0 KNOTS SW

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 25 MIN.

METHOD OF POSITION DETERMINATION: DETACHED POSITION

HDAPS POSITION: FIX 76

EASTING: 181167.1 ✓ NORTHING: 263098.8 ✓

LATITUDE: 41°-22'-07.997"N LONGITUDE: 070°-57'-38.883"W

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: ERROR IN GAGE

ECHO SOUNDER LEAST DEPTH: 11.2 METERS

TIME OF READING: 1456Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

PREDICTED TIDAL ZONE CORRECTOR: -0.2 METERS

LEAST DEPTH DETERMINED @MLLW (echo sounder) 11.0 METERS
(36.1 Feet)

NARRATIVE REPORT: The objective of this dive investigation was to swim a ground line laid between the following points:

RR 2 (41°-22'-09.300" N, 070°-57'-36.600" W)
 (E-181226.9, N-263139.2)
36' (41°-22'-07.886" N, 070°-57'-38.636" W)
 (E-181172.9, N-263095.4)

This ground line was laid approximately 50 meters from Red Rock 2 (RR 2) at 220° along the crest of a rocky shoal to the position of a 36 foot depth found during last August's investigation. It was hoped that the AUSS Impact 6 would be found while swimming this ground line along the shoal. Buoys were dropped at the terminal ends of the ground line by the RUDE and the actual ground line itself was strung between these two buoys by the dive boat.

Once the ground line was laid, the divers descended the northern buoy and proceeded south with the current, LT Niichel swam 5 meters to the east of the ground line and ENS Brennan swam 5 meters to the west of the ground line.

Approximately three quarters of the way along the line ENS Brennan found a medium sized boulder (approximately 1 meter in diameter) which had been tumbled as evident by the marine growth which was on the bottom of the boulder as opposed to the top. Seven meters further down the line was a large boulder (rising approximately 2 meters off the bottom) which fit the description of Impact 6. This boulder was higher on the northern end and showed signs of abrasion on the top as well as bottom paint smears. The southern end of the boulder had a face which appeared to have been sheared off, as it did not follow the natural contour the boulder. There were some angular pieces of rock lying at the base of this fracture, however it was not readily apparent whether these rocks were the the pieces sheared from the Impact 6 boulder.

Upon completing the inspection of Impact 6R (Impact 6R will be used to describe the position and depth of the Impact 6 boulder as found by the RUDE), the divers continued on with the ground line search. One other boulder was found to the south-east of Impact 6R which was substantially larger than Impact 6R, however showed no signs of impact or abrasion.

When the entire length of the ground line had been swam, the divers moved the dive buoy marking the southern end of the line to the position of Impact 6R and signaled the dive boat to send down the pneumo hose. A pneumatic depth gage reading was taken on Impact 6R as well as a detached position. (NOTE: The depth reading obtained on this dive was later found to be in error due to a gage malfunction. The pneumatic depth gage will be sent out for repair and recalibration and a second dive on Impact 6R will be planned for the near future to confirm a least depth on this boulder. An approximate depth of 11.0 meters from the echo sounder will be used at this time, until a second dive is completed) Upon completing the pneumo reading, dive 1 was completed.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 15 APRIL 93			DN 105		
AWOIS Item No. QE JL			Survey No.		
Pneumatic Depth Gauge					
0 - 21 M s/n 201637 12		✓ 0 - 42 M s/n 8606822			
Time of readings 1456			Tide Corrector - .2		
Reading No. 1 12.5			<div style="border: 1px solid black; padding: 10px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge 12.3 </div>		
Reading No. 2 12.5					
Reading No. 3 12.5					
Average Reading 12.5 ✓					
Dive Buoy Position Information					
Range of D.P.'s					
Fix No.	76	77	78		
Raw Depth	9.4	10.2	10.2		
Corrected	11.2	12.1	12.1		
NSPED NSPED					
D.P. Selected Least Depth					
Easting 181167.1			Lat 41:22:07.997		
Northing 263098.8			Lon 070:57:38.883		
Loran-C Position on Dive Buoy					
Chain					
SNR					
Master					

REMARKS:

LEAST DEPTH OF IMPACT AREA # 6
 USE FIX # 76 (CORRECTED FOR LD)
 Pneumo gauge appeared to be malfunctioning, (like before on
 diving depth)

radius. With LT Nichell in the center, ENS Brennan swam three consecutive search radii in 10 meter increments out to 30 meters without finding Impact 2.

Conditions being good and an adequate air supply remaining, the divers decided to relocate the Impact 3 and 4 boulders. Upon locating the Impact 4 boulder the divers measured the distance between RR 2 and Impact 4 and found them to lie approximately 10 meters apart, which is roughly the same distance apart that Impact 4 and Impact 2 should lie, which helped to confirm that Impact 2 was not in the position reported in the AUSS investigation. With this in mind, the divers decided to investigate further south of RR 2 under the assumption that RR 2 might have been mistaken in the AUSS survey for Impact 2 (Which would in turn place Impact 5 south-west of the *assumed* Impact 2). After swimming less than 10 meters in a south-westerly direction the divers came upon a large boulder which fit the description of Impact 2 as described in the AUSS investigation. This boulder rose approximately 6-8 feet off the bottom and was roughly 12 feet along its major axis, (Which was oriented in a north-north-east, south-south-west direction) and 6 feet along its minor axis.

The dive buoy was moved from RR 2 to the Impact 2R (Impact 2R will represent the position and depth of the Impact 2 boulder, as found by the RUDE) boulder and a pneumatic depth gage reading was taken. (NOTE: due to the problems encountered with the 0-21 M gage on the first dive, the 0-42 M gage was used for Dive #2) Once the pneumo reading was completed the divers used the circle search line to measure the distance between RR 2 and Impact 2R. This distance measured approximately 11 meters. After completing this measurement the divers reunited and ascended to the surface, completing dive 2.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 15 APRIL 93		DN 105	
AWOIS Item No. QE II		Survey No.	
Pneumatic Depth Gauge			
✓ 0 - 21 M s/n 201637 12		0 - 42 M s/n 8606822	
Time of readings 1651		Tide Corrector -.5	
Reading No. 1 11.2		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Corrected Least Depth by Pneumatic Gauge 10.7 </div>	
Reading No. 2 11.2			
Reading No. 3 11.2			
Average Reading 11.2			
Dive Buoy Position Information			
Range of D.P.'s			
Fix No.	85	86	87
Raw Depth	10.8	11.3	11.3
Corrected	12.5	12.9	12.9
NSPED ← NSPED X D.P. Selected Least Depth			
Easting 181203.7		Lat 41:22:09.362	
Northing 263139.2		Lon 070:57:37.300	
Loran-C Position on Dive Buoy			
Chain			
SNR			
Master			

REMARKS: USE POSITION OF FIX # 85 AND TIME OF DIVE
 ENTER IN MANUAL DATA ENTRY NEW FIX # 1113
 THIS IS IMPACT AREA # 2.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 1

DATE: 18 MAY 93 DN: 138

PERSONNEL:

DIVEMASTER\TENDER- ST WILLIAMS DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 20-30 FEET CURRENT: < 1.0 KNOT WSW

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 12 MIN.

METHOD OF POSITION DETERMINATION: NONE TAKEN

HDAPS POSITION: N/A 2001

EASTING:

NORTHING:

LATITUDE: $41^{\circ} 22' 12.12''$

LONGITUDE: $70^{\circ} 57' 31.11''$

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.00 METERS

TIME OF READING: 1446Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.2^2 METERS

LEAST DEPTH DETERMINED @MLLW (0 - 42 M) 10.8^8 METERS
(35.8^4 Feet)

NARRATIVE REPORT: The object of this dive was to revisit Red Rock 1 (RR 1) and obtain an updated pneumo reading for comparison with last year, and check the impact sight for signs of movement of the boulder.

This dive began by descending a buoy line dropped on the site by the RUDE. The boulder was easily found within 15 feet of the buoy anchors. Upon locating the boulder the divers signaled the dive tender on the surface to lower the orifice of the pneumo gauge. The least depth readings were taken and the orifice returned to the surface.

Through a close inspection of the boulder, it was apparent that some movement had occurred as evidenced by the exposed clay which underlies the layer of gravel covering the entire sea floor in this area. The area of exposed clay was found around the north-northeast side of the boulder which would indicate movement in a

— south-southwesterly direction (or along the direction of the ship's track) and measured approximately 6-8 inches. Some vertical displacement was also evident by the way the clay had "welled up" as though it were displaced by the downward movement of the boulder. The amount of this downward movement was hard to quantify, however judging by the displaced clay it would be estimated at about 2-3 inches.

It should be mentioned that this underlying layer of clay was a very dense plastic clay which would preclude any substantial downward motion of the boulders which lie above it.

Upon completing the least depth measurement and the associated investigations of the boulder, the divers ascended to the surface completing dive 1.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 2

DATE: 18 MAY 93 DN: 138

PERSONNEL:

DIVEMASTER\TENDER- ST WILLIAMS DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 20-30 FEET CURRENT: < 1.0 KNOT WSW

MAXIMUM DEPTH: 40 FEET BOTTOM TIME: 15 MIN.

METHOD OF POSITION DETERMINATION: NONE TAKEN

HDAPS POSITION: N/A 2006

EASTING: NORTHING:

LATITUDE: $41^{\circ} 22' 12.12''$ ^{08.01"} LONGITUDE: $70^{\circ} 57' 31.4''$ ^{38.89"}

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 10.40 METERS

TIME OF READING: 1507Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

^{Smooth}
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.1² METERS

LEAST DEPTH DETERMINED @MLLW (0 - 42 M) 10.1² METERS
(33.8⁴ Feet)

NARRATIVE REPORT: The object of this dive was to revisit Impact 6 and acquire a least depth and take measurements of this boulder.

This dive began with divers Niichel and Brennan descending a buoy line previously dropped by the RUDE. Impact 6 was found roughly within 15-20 feet of the bouy anchors. Upon locating the boulder the dive tender was signaled to lower the pneumo gage orifice. The divers completed the least depth reading and returned the orifice to the surface. Measurements of the boulder were then recorded. Impact 6 measured 13'L x 8'W x 5'H. Once the least depth and size measurements were completed the divers ascended to the surface completing dive 2.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 3

DATE: 18 MAY 93 DN: 138

PERSONNEL:

DIVEMASTER\TENDER- ST WILLIAMS DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 15-20 FEET CURRENT: 1.0 KNOT WSW

MAXIMUM DEPTH: 45 FEET BOTTOM TIME: 40 MIN.

METHOD OF POSITION DETERMINATION: NO POSITIONS RECORDED

HDAPS POSITION: N/A

EASTING: NORTHING:

LATITUDE: LONGITUDE:

Least Depth 1: Impact 3

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.20 METERS

TIME OF READING: 1556Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.1² METERS

LEAST DEPTH DETERMINED @MLLW (0 - 42 M) 11.1² METERS
(36.1₁ Feet)

Least Depth 2: Impact 2

AVERAGE LEAST DEPTH BY PNEUMATIC DEPTH GAUGE: 11.10 METERS

TIME OF READING: 1621Z

PNEUMATIC DEPTH GAUGE CORRECTOR: 0.0

Smooth
~~PREDICTED~~ TIDAL ZONE CORRECTOR: -0.1² METERS

LEAST DEPTH DETERMINED @MLLW (0 - 42 M) 11.0 METERS
(36.1 Feet)
35.8

NARRATIVE REPORT: This dive had two objectives; 1) obtain a least depth and dimensions for the Impact 2R (Impact 2 as found by RUDE) boulder and 2) obtain a least depth on Impact 3.

This dive began by descending a buoy line dropped on Red Rock 2 (RR 2) by the RUDE. Once on the bottom Ens. Brennan swam with the zero point of a meter tape out to ten meters in the direction of Impact 3 while LT Niichel held the meter tape reel on RR 2. Upon finding Impact 3 Ens. Brennan signaled LT. Niichel to bring a second dive buoy. Once the dive buoy was positioned on Impact 3, the divers gave several sharp tugs on the buoy line signaling the dive tenders to send down the pneumo hose. Once the orifice reached the divers, a least depth was obtained and the hose was returned to the surface.

The divers then returned to RR 2, which served as a point of reference. Ens. Brennan again swam out to ten meters as measured on the meter tape, this time in the direction of Impact 2R. Upon reaching the boulder LT Niichel was signaled to join ENS Brennan and a pneumo least depth was taken at that position. After finishing the pneumo reading, measurements were taken on the Impact 2R boulder. It measured 10'L x 8'W x 4'H. Once these measurements were complete the divers ascended to the surface, completing dive 3.

QE 2 Investigation
DIVE INVESTIGATION REPORT
Dive 4

DATE: 18 MAY 93 DN: 138

PERSONNEL:

DIVEMASTER\TENDER- ST WILLIAMS DIVERS- LT NIICHEL

COXSWAIN\TENDER- J. BRAWLEY - ENS BRENNAN

VISIBILITY: 15-20 FEET CURRENT: 1.5 KNOT WSW

MAXIMUM DEPTH: 40 FEET BOTTOM TIME: 26 MIN.

METHOD OF POSITION DETERMINATION: MEASURED (ANGLE & DISTANCE)

HDAPS POSITION: N/A

EASTING: 181213.95 NORTHING: 263140.33

LATITUDE: 41°-22'-09.³⁵~~37~~" E LONGITUDE: 070°-57'-36.⁸⁷~~859~~" W

NARRATIVE REPORT: Dive four completed work intended for dive 3. This dive's objectives were to measure the distance between RR 2 and Impact 2R and take a series of bearings along an established line between the two boulders both above and below the water.

This dive started with divers Niichel and Brennan descending onto RR 2. Once on the bottom ENS Brennan swam with the measured mark of a meter tape out to Impact 2R and LT Niichel remained on RR 2 with the zero mark at the center of the boulder. The distance (center to center) between these two boulders was 13 meters.

With the distance measurements complete, the two ends of the fiberglass tape were secured to the boulders and a series of sighting from RR 2 to Impact 2R were taken along the line of the stretched tape with both diver's dive compasses. The average reading observed was 265° M and was corrected for 10° E compass error to 275° T. Once these measurements were complete, the divers ascended to the surface, completing dive 4.

The range and azimuth measured on this dive were broken down into a δ east and δ north value. These values were in turn applied to the position for RR 2 to arrive at a calculated position for Impact 2R. These values are listed above.

NOAA SHIP RUDE
LEAST DEPTH DIVE OPERATIONS

Date 18 MAY 93				DN 138				
AWOIS Item No.				Survey No. GE II				
Pneumatic Depth Gauge								
/ 0 - 21 M s/n 201637 12				0 - 42 M s/n 8606822				
Time of readings 1621 UTC				Tide Corrector -0.1				
Reading No. 1 11.1				Corrected Least Depth by Pneumatic Gauge <div style="border: 1px solid black; padding: 5px; display: inline-block;">11.0</div>				
Reading No. 2 11.1								
Reading No. 3 11.1								
Average Reading 11.1 /								
Dive Buoy Position Information								
Range of D.P.'s								
Fix No.	88	89	90	91	92	93	94	95
Raw Depth	12.6	11.4	11.7	11.6	11.1	10.5	10.4	9.1
Corrected	14.6	13.5	13.5	13.3	13.3	12.6	12.4	12.2
D.P. Selected Least Depth								
Easting 181202.5				Lat 041:22:09.325				
Northing 263139.9				Lon 070:57:37.352				
Loran-C Position on Dive Buoy								
Chain								
SNR								
Master								

REMARKS: FIX 95 NSPDS RE-ENTERED IN MANUAL DATA ENTRY AS
 FIX # 1117 FOR A CHANGE IN POSITION. BUOY WAS 5M ← SHIP HIX.
 PLUS TIME OF DIVE WAS USED. 075'

NOAA SHIP RUDE DIVE OPERATIONS

DATE								
SUBJECT OF INVESTIGATION <i>DEEP SIGHT; GROUND LINE SEARCH FOR IMPACT &</i>								
Relative Location of Dive <i>3 NM SE. OF CATTY HUNK</i>								
LAT			LON					
CONTACT CAMBER (203) 449-3676								
CONTACT US COAST GUARD								
Expected Max. Depth								
<u>Dive No. 1</u>			<u>Dive No. 2</u>			Dive No. 3		
Time of High Tide (Local)								
Divers	Surface Interval	RNT	Pressure		Time		Bottom Time	Max Depth
			In	Out	In	Out		
<i>Nichols</i>			<i>2950</i>	<i>750</i>	<i>1025</i>	<i>1100</i>	<i>35</i>	<i>45</i>
<i>BRENNAN</i>			<i>2900</i>	<i>500</i>	<i>1025</i>	<i>1100</i>	<i>35</i>	<i>45</i>
<i>Nichols</i>			<i>3000</i>	<i>1000</i>	<i>1228</i>	<i>1257</i>	<i>29</i>	<i>45</i>
<i>BRENNAN</i>			<i>2900</i>	<i>500</i>	<i>1228</i>	<i>1257</i>	<i>29</i>	<i>45</i>

Divers Remarks:

APPENDIX VII. APPROVAL SHEET

LETTER OF APPROVAL

REGISTRY NO. FE-379SS

Field operations contributing to the accomplishment of this survey were conducted under my supervision with frequent personal checks of progress and adequacy. This report and field sheets have been closely reviewed and are considered complete and adequate for charting.



Nicholas E. Perugini, LCDR NOAA
Commanding Officer
NOAA Ship RUDE

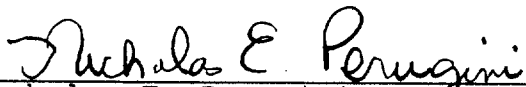
LETTER OF APPROVAL

REGISTRY NO FE-379SS

Additional SURVEY WORK - 1993

Field operations contributing to the accomplishment of this survey were conducted under my supervision with frequent personal checks of progress and adequacy. This report and field sheets have been closely reviewed and are considered complete and adequate for charting.

Final data processing and this supplemental descriptive report were conducted at the Atlantic Hydrographic Section, Norfolk Va.



Nicholas E. Perugini
Nicholas E. Perugini, LCDR, NOAA
Commanding Officer
NOAA Ship RUDE

and Chief, Atlantic Hydrographic Section
effective June 18, 1993



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of Ocean and Earth Sciences
Rockville, Maryland 20852

TIDE NOTE FOR HYDROGRAPHIC SURVEY

DATE: October 5, 1992

MARINE CENTER: Atlantic

OPR: B616-RU-92

HYDROGRAPHIC SHEET: FE-379SS

LOCALITY: Massachusetts, Rhode Island Sound, Two point Five
Nautical Miles South Southwest of Cuttyhunk Island

TIME PERIOD: August 10 - August 20, 1992

TIDE STATION USED: 845-0768 Sakonnet Yacht Club, Rhode Island
Lat. $41^{\circ} 27.9'N$ Lon. $71^{\circ} 11.6'W$


PLANE OF REFERENCE (MEAN LOWER LOW WATER): 8.13 ft.

HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 3.3 ft.

REMARKS: RECOMMENDED ZONING

Apply a +18 minute time correction and a x0.90 range ratio to
Sakonnet Yacht Club, Rhode Island (845-0768).

Note: Times are tabulated in Eastern Standard Time.


CHIEF, DATUMS SECTION





National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of Ocean and Earth Sciences
Silver Spring, Maryland 20910

TIDE NOTE FOR HYDROGRAPHIC SURVEY

DATE: September 21, 1993

MARINE CENTER: Atlantic

OPR: B616-RU-93

HYDROGRAPHIC SHEET: FE-379SS

LOCALITY: Massachusetts, Rhode Island Sound, Two point Five
Nautical Miles South Southwest of Cuttyhunk Island

TIME PERIOD: March 31 - May 18, 1993

TIDE STATION USED: 845-0768 Sakonnet Yacht Club, Rhode Island

Lat. $41^{\circ} 27.9'N$ Lon. $71^{\circ} 11.6'W$

PLANE OF REFERENCE (MEAN LOWER LOW WATER): 8.15 ft.

HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 3.4 ft.

TIDE STATION USED: 845-2660 Newport, Rhode Island

Lat. $41^{\circ} 30.3'N$ Lon. $71^{\circ} 19.6'W$

PLANE OF REFERENCE (MEAN LOWER LOW WATER): 1.67 ft.

HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 3.7 ft.

REMARKS: RECOMMENDED ZONING

Apply a +18 minute time correction and a x0.90 range ratio to Sakonnet Yacht Club, Rhode Island (845-0768).

When data for Sakonnet Yacht Club, Rhode Island are not available, apply a +22 minute time correction and a x0.82 range ratio to Newport, Rhode Island (845-2660).

Note: Times are tabulated in Eastern Standard Time.

William M. Wilson
ACTING CHIEF, DATUMS SECTION



LETTER TRANSMITTING DATA

N/CG244-5-94

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY
(Check):

- ORDINARY MAIL AIR MAIL

 REGISTERED MAIL EXPRESS

 GBL (Give number) _____

TO:

Chief, Data Control Section, N/CG243
NOAA/National Ocean Service
Station 6813, SSMC3
1315 East-West Highway
Silver Springs, Maryland 20910

DATE FORWARDED

January 21, 1994

NUMBER OF PACKAGES

1(one) box

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be returned as a receipt. This form should not be used for correspondence or transmitting accounting documents.

FE-379SS

Massachusetts, Rhode Island Sound, 2.5 NM SSW of Cuttyhunk Island

- box 1 Envelope containing the Original Descriptive Report w/ Page size Smooth Sheet
- 1 Envelope containing Miscellaneous Data removed from the original Descriptive Report
- 1 Cahier with final Sounding, Position, Control and L-file Printouts
- 1 Accordion file containing fathograms, raw data printouts and sonargrams for the following days (1992): #223, 224*, 225, 226*, 227*, 228*, 230, 232* and 233*
and field "Seperates Report"
- 1 Accordion file containing fathograms, raw data printouts for the following days (1993): 090, 099, 105 and 13899, 105 and 138
- * no sonargram

FROM: (Signature)

Robert R. Hill Jr.

RECEIVED THE ABOVE
(Name, Division, Date)

Return receipted copy to:

Atlantic Hydrographic Section
N/CG2441
439 West York Street
Norfolk, VA 23510

01/20/94

HYDROGRAPHIC SURVEY STATISTICS
REGISTRY NUMBER: FE-379SS

NUMBER OF CONTROL STATIONS		1
NUMBER OF POSITIONS		567
NUMBER OF SOUNDINGS		3343
	TIME-HOURS	DATE COMPLETED
PREPROCESSING EXAMINATION	384	/ /
VERIFICATION OF FIELD DATA	432	03/12/93
ELECTRONIC DATA PROCESSING	94	
QUALITY CONTROL CHECKS	110	
EVALUATION AND ANALYSIS	130	03/15/93
FINAL INSPECTION	12	01/06/94
TOTAL TIME	1162	
ATLANTIC HYDROGRAPHIC SECTION APPROVAL		01/19/94

COAST AND GEODETIC SURVEY
ATLANTIC HYDROGRAPHIC SECTION
EVALUATION REPORT

SURVEY NO.: FE-379SS

FIELD NO.: RU-20-8-92

Massachusetts, Rhode Island Sound, 2.5 NM SSW of Cuttyhunk
Island

SURVEYED: August 10, 1992 through May 18, 1993

SCALE: 1:20,000

PROJECT NO.: OPR-B616-RU-92

SOUNDINGS: EG&G Model 260 Side Scan Sonar, Pneumatic Depth
Gauge, and RAYTHEON DSF 6000N Fathometer

CONTROL: ASHTECH Satellite Receiver/MAGNAVOX MX50R
Radiobeacon Receiver Differential Global Positioning
System (DGPS), and MOTOROLA Falcon 484 Mini-Ranger
(DGPS Performance Check)

Chief of Party.....N. E. Perugini

Surveyed by.....P. L. Schattgen
.....J. A. Illg
.....R. T. Brennan
.....D. E. Williams

Automated Plots by.....XYNETICS 1201 Plotter (AHS)

1. INTRODUCTION

a. This is primarily a side scan sonar survey. A RAYTHEON DSF-6000N fathometer was operated concurrently with the side scan sonar. Fathometer developments were conducted to search for features found on the sonargrams. Position data acquired during fathometer developments was used to position features and to determine significance and, in some cases, the least depth of the feature. In cases where the side scan sonar was used to determine the estimated depth of a feature, depths were estimated by scaling heights off the bottom from side scan sonar records. Positions of features located using side scan sonar were determined by computing offsets from the vessel track. The hydrography acquired during survey operations is considered suitable for charting.

b. The area surveyed is very rocky. Cartographic limitations prohibit labeling all rocks in the area surveyed. The features labeled 'Rk' on the smooth plot are considered the most significant features identified using the survey records. The bottom characteristic "rky" is used liberally on the smooth plot to alert the chart compiler to the nature of the bottom in the area surveyed.

c. One page size smooth plot with accompanying overlays was generated during office processing. The smooth plot and an overlay identifying two of six apparent impact rocks, "Red Rock 1" and "Red Rock 2", are appended to this report. All other plots are filed with the field records.

d. "Red Rock 1" and "Red Rock 2" are the two apparent major impact rocks struck by the passenger vessel Royal Mail Ship (RMS) QUEEN ELIZABETH 2. These designations were made by the hydrographer for field identification purposes only. These names are not approved geographic names.

e. Survey scale is 1:20,000; all data is plotted at 1:10,000 scale for clarity.

f. Corrections and notes made by the evaluator and/or the inspector to the Descriptive Report are in red ink.

2. CONTROL AND SHORELINE

a. Control is adequately discussed in Section H. and I. of the Descriptive Report and the Addendum to.

Horizontal control used for this survey during data acquisition is based upon the North American Datum of 1983 (NAD 83). Office processing of this survey is based on these values. The smooth sheet has been annotated with ticks showing the computed mean shift between the North American Datum of 1983 (NAD 83) and the North American Datum of 1927 (NAD 27).

To place the smooth plots on the NAD 27 move the projection lines 0.389 seconds (1.20 mm at the scale of 1:10,000, or 0.60 mm at the scale of 1:20,000) north in latitude and 1.873 seconds (4.35 mm at the a scale of 1:10,000, or 2.18 mm at the scale of 1:20,000) east in longitude.

b. There is no shoreline within the limits of this survey.

3. HYDROGRAPHY

a. Where crossings occur there is adequate agreement.

b. The standard depth curves are drawn in their entirety on the smooth plot. A brown 12 meter depth curve was drawn to better define the rock shoal which is the central focus of this investigation.

c. The investigation of features and least depths is considered adequate on the shoal where the grounding occurred.

4. CONDITION OF SURVEY

The smooth plots and accompanying overlays, survey records, and reports adequately conform to the requirements of the HYDROGRAPHIC MANUAL, FIELD PROCEDURES MANUAL, and SIDE SCAN SONAR MANUAL.

5. JUNCTIONS

There are no junctional requirements for this survey.

6. COMPARISON WITH PRIOR SURVEYS

H-1788 (1887) 1:40,000
 H-6445 (1939) 1:40,000
H-8905 (1966) 1:20,000

These three prior surveys cover the present survey in its entirety.

Prior survey H-1788 (1887) was not available for comparison. A charted 46-ft depth (14 m), in Latitude $41^{\circ}22'22.4''N$, Longitude $70^{\circ}57'17.6''W$, originating with this prior survey was brought forward to prior surveys H-8905 (1966) and H-6445 (1939). The present survey depths in this area range from 41 feet (12⁵ m) to 36 feet (11² m). It is recommended that the area be charted as shown on the present survey.

Prior surveys H-6445 (1939) and H-8905 (1966) are the most recent prior surveys common to the present survey. Present and prior hydrography generally agree quite well, with depths vary ± 1 to 2 feet ($\pm 0^3$ to 0^6 m). A charted 49-ft depth (14⁹ m), in Latitude $41^{\circ}22'32.4''N$, Longitude $70^{\circ}57'26.7''W$, originating with prior survey H-6445 (1939) has been brought forward from the prior survey to supplement the present survey. This sounding was brought forward because it is at the edge of the present survey and only a few meters off the vessel track. Because of the small offset from the vessel track, this depth could have been missed by both echosounder and side scan sonar.

Except as noted above, the present survey is adequate to supersede the prior surveys within the common area.

7. COMPARISON WITH CHART 13218 (31st Edition, Jan. 11, 1992)

a. Hydrography

The charted hydrography originates with the previously discussed prior surveys. The previously addressed prior surveys require no further consideration. Charting recommendations for AWOIS Item #8297 are adequately discussed in section N. page 21 of the Descriptive Report. The present survey is adequate to supersede the charted hydrography within the common area with the exception discussed in section 6. of this report. AWOIS Item #8297 is considered resolved.

Chart 13218 is an 1:80,000 scale chart and is the largest scale chart common to the present survey and only five charted soundings are within the common area. Five significant rocks were discovered in the survey area. Due to scale considerations, four were deemed appropriate for charting:

<u>FEATURE</u>	<u>SOUNDING</u> <u>m / ft</u>	<u>LATITUDE (N)</u>	<u>LONGITUDE (W)</u>	
Rk	9 ⁶ / 31	41°22'13.57"	70°57'19.19"	# 8297
Rk*	10 ² / 33	41°22'09.31"	70°57'36.32"	
Rk**	14 ¹ / 46	41°22'30.80"	70°57'18.20"	# 8856
Rk**	14 ⁵ / 47	41°22'31.20"	70°58'28.90"	# 8857

* "Red Rock 2" is one of two apparent major impact rocks struck by the passenger vessel Royal Mail Ship (RMS) QUEEN ELIZABETH 2. This designation was made by the hydrographer for field identification purposes only. This name is not an approved geographic name.

** The depths on these features were determined by side scan sonar. Estimated depths were determined by scaling heights off the bottom from side scan sonar records. Positions of features located using side scan sonar were determined by computing offsets from the vessel track.

In addition to charting the shoalest and most critical depths, it is recommended that a 36-foot supplemental curve be applied to the chart in the common area of this survey to focus the mariner's attention to this rocky shoal.

b. Aids to Navigation

No fixed or floating aids to navigation are common to the investigations of this field examination.

8. COMPLIANCE WITH INSTRUCTIONS


This survey adequately complies with the Project Instructions.

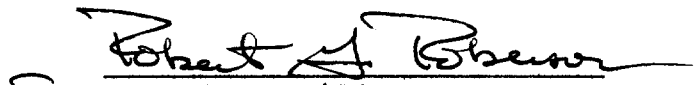
9. ADDITIONAL FIELD WORK

This is an adequate side scan sonar survey. Due to the nature of this survey, basic hydrographic requirements were met only in the immediate area of the QE2 grounding. This area can be defined as a 300 meter radius about the following position:

41° 22' 11.04" N
70° 57' 29.27" W

Outside this area, the hydrography should be considered reconnaissance and supplemental. During the initial search for the grounding site, numerous rocky features were noted while running side scan sonar lines outside of the described circle. This area is appropriately scheduled for a basic survey in 1994. It is recommended that the two rocks mentioned as being scaled from side scan sonar records in section 7a of this report be assigned as AWOIS items.


Maxine Fetterly
Cartographic Technician
Verification of Field Data


Robert R. Hill Jr.
Cartographer
Evaluation and Analysis

APPROVAL SHEET
FE-379SS

Initial Approvals:

The completed survey has been inspected with regard to survey coverage, delineation of depth curves, development of critical depths, cartographic symbolization, and verification or disproval of charted data. The digital data have been completed and all revisions and additions made to the smooth sheet during survey processing have been entered in the magnetic tape record for this survey. Final control, position, and sounding printouts of the survey have been made. The survey records and digital data comply with NOS requirements except where noted in the Evaluation Report.

Leroy G. Cram Date: 01/11/94 Leroy G. Cram
Chief, Hydrographic Processing Team B Atlantic
Hydrographic Section

I have reviewed the smooth sheet, accompanying data, and reports. This survey and accompanying digital data meet or exceed NOS requirements and standards for products in support of nautical charting except where noted in the Evaluation Report.

Nicholas E. Perugini Date: 01/19/94
Nicholas E. Perugini, LCDR, NOAA
Chief, Atlantic Hydrographic Section

Final Approval:

Approved: J. Austin Yeager Date: 2/3/94 J. Austin
Yeager Rear Admiral, NOAA
Director, Coast and Geodetic Survey

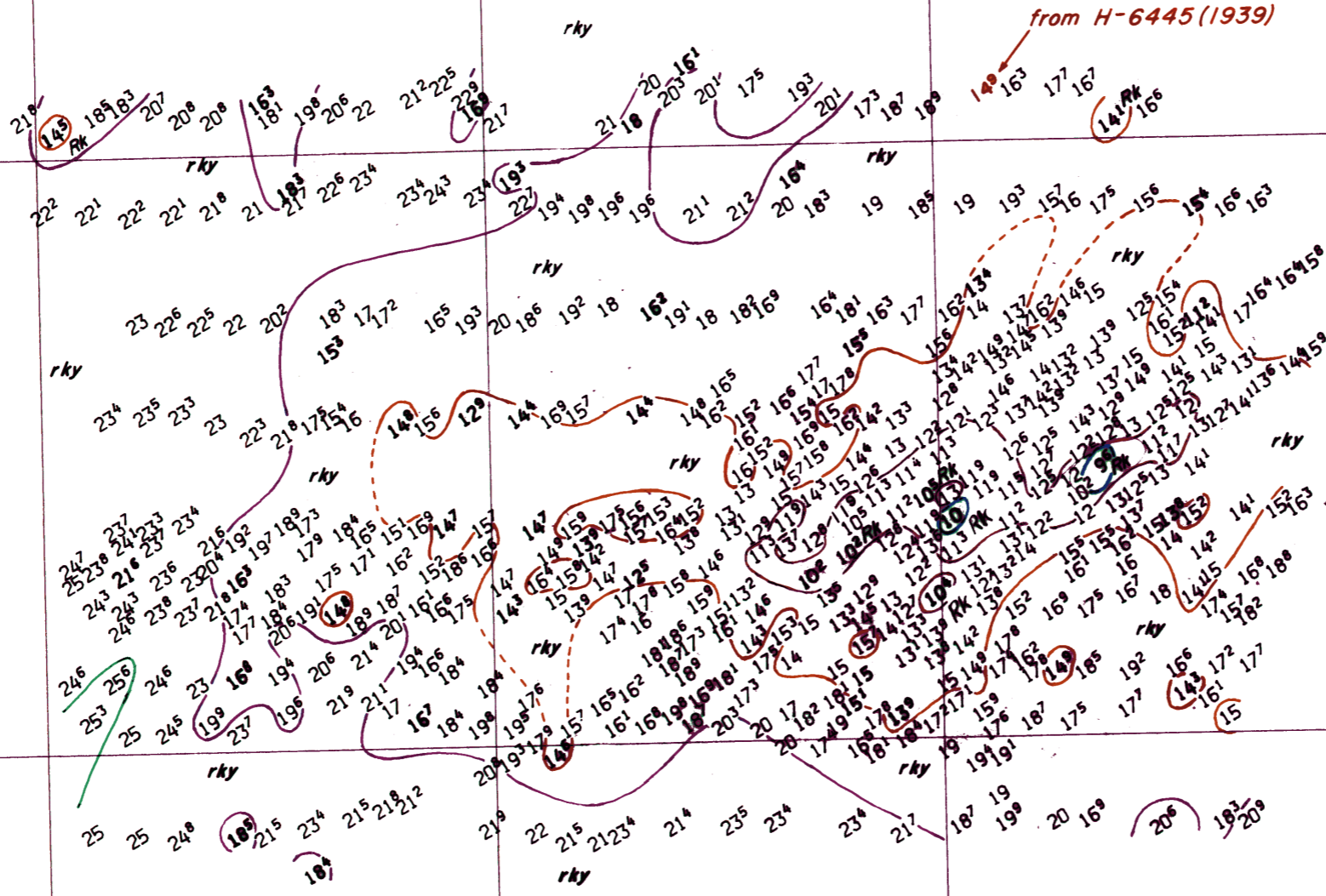
70° 58' 30"

70° 58' 00"

70° 57' 30"

70° 57' 00"

70° 56' 30"



41° 22' 30"

41° 22' 00"

FE-379SS
 MASSACHUSETTS
 RHODE ISLAND SOUND
 2.5 NM SSW OF CUTTYHUNK ISLAND
 DATE OF SURVEY: 10 AUG 1992 TO 18 MAY 1993
 SCALE: 1:10000
 SOUNDINGS IN METERS AT MLLW
 HORIZONTAL DATUM: NAD 1983
 SHEET 1 OF 2
 AVOIS ITEM NUMBER 8297

70° 58' 30"
 41° 21' 30"
 NAD 27
 XYNETICS 1201
 ✓ 3/12/93 MBH

41° 21' 30"

70° 58' 30"

70° 58' 00"

70° 57' 30"

70° 57' 00"

70° 56' 30"

41° 22' 30"

10PRK — Red Rock 1
10PRK — Red Rock 2

41° 22' 00"

FE-379SS
OVERLAY TO ACCOMPANY
SHEET 2 OF 2

70° 58' 30"

41° 21' 30"

NAD 27
XYNETICS 1201
✓ 3/12/93 MBH

41° 21' 30"

+

