AD-A167 743 SAN NICOLAS ISLAND BARGE LANDING SITE SURVEY(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE DIV NOV 78 CHES/NAVFAC-FPO-1-79(3) 4000TR-85-86 1/1

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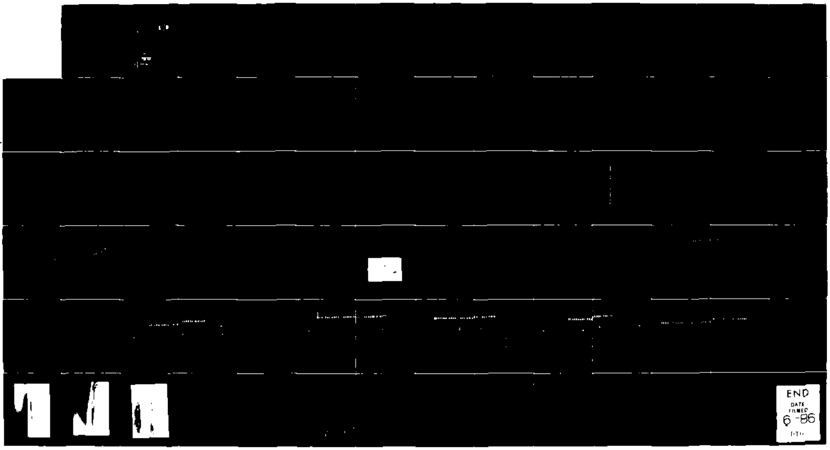

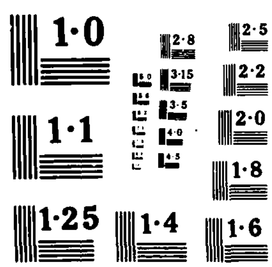
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SAN NICOLAS ISLAND
BARGE LANDING SITE SURVEY

FPO-1-79(3)
NOVEMBER 1978

OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

FPO-1P:pw
11010
[illegible]

From: Commanding Officer, Chesapeake Division
Naval Facilities Engineering Command
To: Commander, Pacific Missile Test Center
Point Mugu, CA 93042
Attn: Code 6230

Subj: San Nicolas Island Survey

Ref: (a) PMTC Work Request #N6312678WR62010

Encl: (1) Final Report: San Nicolas Island Barge Landing Site Survey, FPO-1-79(3), November 1978
(2) Revisions, pages 25 and 47

1. In response to reference (a), this Command has executed a survey of the YFU landing site at San Nicolas Island. Enclosure (1) has been prepared using results from the survey and is herewith submitted as the final report and fulfillment of the subject tasking. Enclosure (2) contains corrected sheets for revision of two previously transmitted final reports.

2. The survey has identified the boundaries of the best landing approach to NAVFAC Beach. Included within the final report are recommendations for further improvements for barge access.

3. This Command regrets the delay in submittal of the report. Additional analysis and preparation of survey data were required to provide the desired accuracy and coverage to meet the project objectives.

J. A. STAMM
By direction

Copy to:
CEL
Attn: J. Wadsworth, Code L42 (Encl (1) only)
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Report 15 Jan 7[9]
pp 1 of 2

From GEB
To: Knight, Gregory & Escowitz

Please note Ling's inputs on this for any future update to this report

15 Jan 79

Chuck,

San Nicolas Isl Barge Landing Site Survey, comments on

① p. 20 & 21 # 4.1 refers to Block Diagram per title of Fig. 6, however, fig. 6 is not a "block" diagram. Fig 6 is an operational drawing showing relative physical position of survey system components.

② p. 31. I can't readily see the 7 locations discussed on p. 31 ff when I examine the referenced Fig. 4. Just found it. I think that figure 13 is the drawing to which one should be directed in line 2 of 2nd ¶ of p. 31.

(3) Have problems w/ bathymetry charts - no contour identification, i.e. meters, feet, fathom etc. Fig. 3, 4, and big charts in appendix. Text indicates feet, however, when appendix is separated from text, the measure is lost.

(4) Fig. 13 refers to non-existing contour intervals. Fig. 3 doesn't discuss "its" contours and is not very legible.

I quit reading. These are some quick observations. We may receive requests for clarification of contents of the report.

[signature]

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A bathymetric survey of the YFU landing site area on San Nicolas Island, California, has shown that a narrow channel of sufficient width and clear of bottom obstacles exists into the beach to permit safe operation of the vessel under wind and sea conditions which are tolerable during cargo (Con't)

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transfers. Obstacles on both sides of the channel have been identified and charted. The geology suggests that the clear channel has no hidden rocky features which may become exposed as the beach sand is removed by storm seas. Probing at the beach area confirms this hypothesis.

A recommendation is made to install a new set of approach markers to the beach to identify a dog leg track close to the center to the center of the newly charted channel. A secondary recommendation is to pursue bathymetric surveys of adjacent beach sites in order to find a wider approach channel to the beach, if such exists.

FPO-1-79(3)

SAN NICOLAS ISLAND

BARGE LANDING SITE SURVEY

Prepared By

Ocean Engineering and Construction Project Office
Chesapeake Division

November 1978

Prepared For

Pacific Missile Test Center
Point Mugu, California

ABSTRACT

A bathymetric survey of the YFU landing site area on San Nicolas Island, California, has shown that a narrow channel of sufficient width and clear of bottom obstacles exists into the beach to permit safe operation of the vessel under wind and sea conditions which are tolerable during cargo transfers. Obstacles on both sides of the channel have been identified and charted. The geology suggests that the clear channel has no hidden rocky features which may become exposed as the beach sand is removed by storm seas. Probing at the beach area confirms this hypothesis.

A recommendation is made to install a new set of approach markers to the beach to identify a dog leg track close to the center of the newly charted channel. A secondary recommendation is to pursue bathymetric surveys of adjacent beach sites in order to find a wider approach channel to the beach, if such exists.

FOREWORD

The bathymetric survey was carried out by personnel of the Ocean Engineering and Construction Project Office of the Chesapeake Division, Naval Facilities Engineering Command under COM PMTC Work Request N63126-78-WR62010, with logistic support from the Pacific Missile Test Center at Point Mugu, CA, and at San Nicolas Island. The diver observations were undertaken by the divers from the Underwater Construction Team Two, Construction Battalion Center, Port Hueneme, CA. Material from an earlier survey conducted by the Civil Engineering Laboratory at Port Hueneme is incorporated into this study. Data analysis and bathymetric contouring was carried out by personnel of the Ocean Engineering and Construction Project Office, and of the Naval Oceanographic R&D Center at Bay St. Louis, MI.

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1.0 INTRODUCTION

A bathymetric survey of the YFU landing site on San Nicolas Island was undertaken in order to identify the location and the extent of various submarine obstacles which might affect the safety of the YFU-supported supply operation. The results of the survey indicate that a clear channel of sufficient width into the beach does exist for the safe conduct of the YFU supply craft. The clear channel is bordered on both sides by submerged rocky features and on one side by partially exposed ridges. The accurate charting of these features will permit continued safety of operations within tolerable wind and sea conditions, and should prove no hindrance, in spite of the narrow channel width.

1.1 Description and Location

San Nicolas is the outermost island of the eight Channel Islands which extend for 130 miles along a northwesterly line off California from San Diego to Point Conception. It is one of three islands set aside as a military reservation and is off limits to public access. A 3-mile zone surrounding the island is designated as a naval restricted area. The island is 9 miles long and 3 miles wide, oriented in a northwesterly direction corresponding to the line of the Channel Islands, and the line of the California coast south of Point Conception.

Logistic support for the military establishments on San Nicolas Island is provided by sea, from Port Hueneme, some 55 miles distant, and by air, into a landing strip built during World War II. The major cargo route is by sea. An LCU-1610 type amphibious utility landing craft, redesignated as a YFU, is used for the marine supply operation. The YFU has an overall length of 136 feet, a beam of 29 feet, and a draft of 4 feet forward and 7 feet aft. Light displacement is 193 tons, and fully loaded displacement is 374 tons, giving the aforementioned drafts. The YFU is fitted with a bow ramp to permit discharge of cargo onto the beach, and a stern gate to permit through passage of vehicles. (The latter feature is not used in this application.) At initial landing, approximately 10 feet of the hull is run up onto the sand, and the vessel is restrained from broaching by an offshore mooring.

The location of San Nicolas Island is shown in Figure 1. The island offers no protection from the heavy sea conditions owing its shape and orientation, and hence restricts the YFU landing operation to reasonably calm or at most, moderate wind and sea conditions. The specific site for the YFU landings, and hence, the site of this bathymetric survey, is shown in Figure 2.

1.2 Objectives

The principal objective of this investigation was to assure the continued safe operation of the YFU supply route to San Nicolas Island by identifying potential obstacles in the marine access route. This task

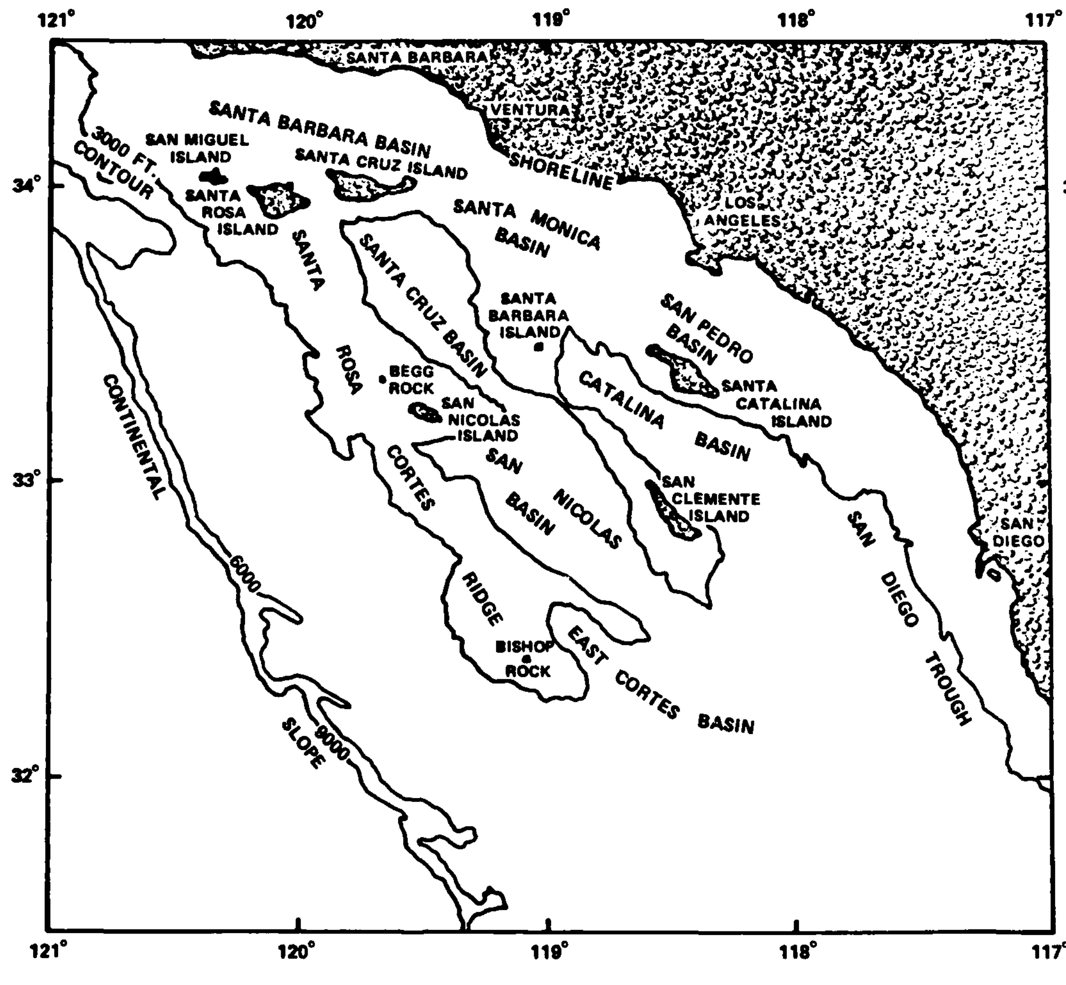


Figure 1. Channel Islands/San Nicolas Area Chart

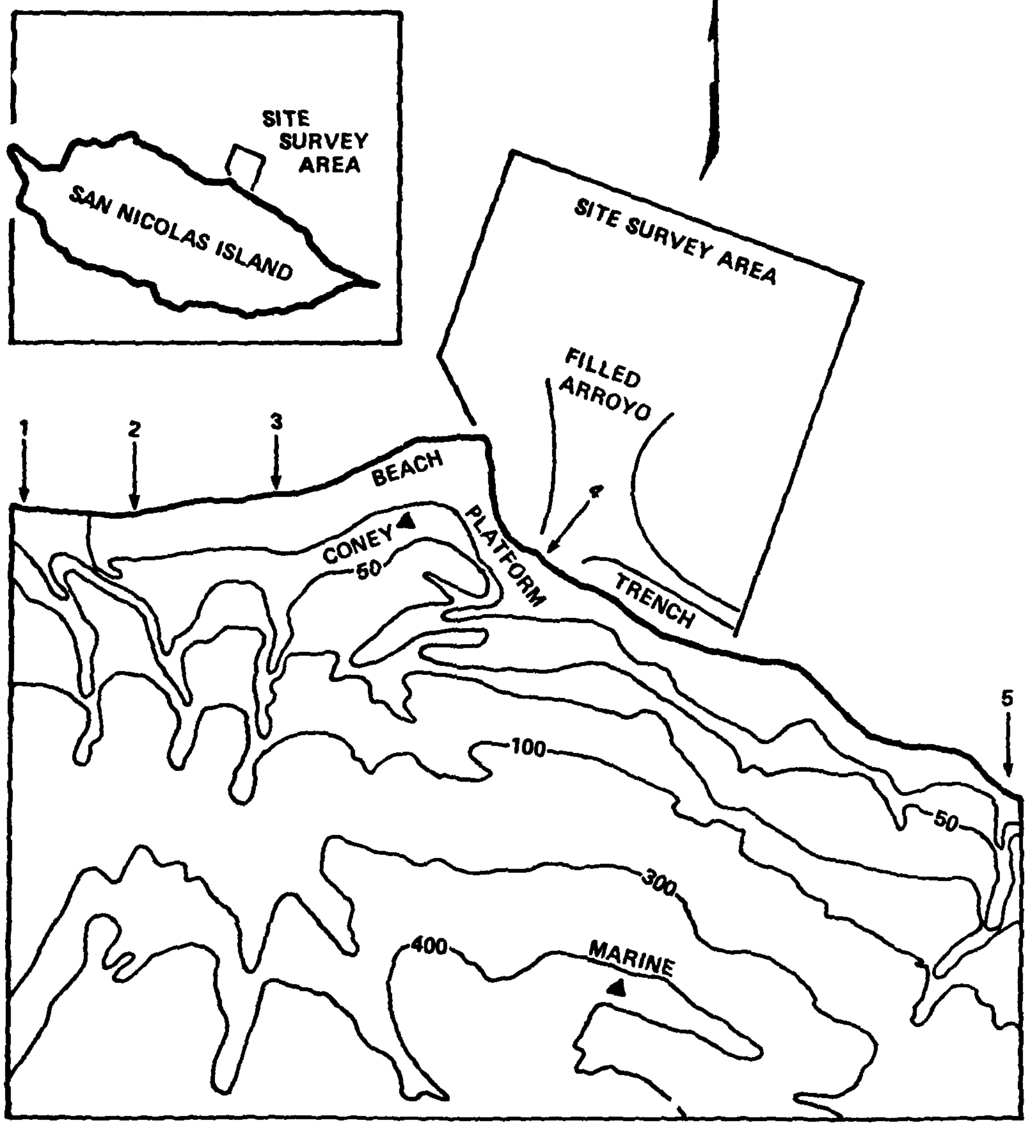


Figure 2. Location Of The Survey Area, San Nicolas Island (Showing Ancient Onshore Arroyos (numbered 1 through 5) and the Later Beach Platform (a late Pleistocene marine terrace)

was achieved by means of the following objectives:

- carry out a bathymetric survey of the landing site area with sufficient accuracy to provide a chart suitable for navigation and maneuvering within that area;

- identify distinct features on the bottom by diver observation, and plot their physical extent (features include rock outcroppings, ridges, holes, or any other feature different from the relatively smooth bottom);

- probe the shallow sandy areas for rocky features hidden at a small distance beneath the sand surface;

- interpret the bathymetry in terms of the geology of the island coast in order to assess the potential for future difficulty in landing due to beach erosion.

All objectives were met in the course of this investigation.

2.0 SUMMARY AND RECOMMENDATION

Submarine features identified during the course of the bathymetric survey of the YFU landing site on San Nicolas Island correspond directly to extensions of the visible landform ashore, and correlate with the geology of the Island. Essentially, a large ancient arroyo, which currently is the path of the road access to the beach from the mesa, continues out into the seabed. It is seen in the onshore contours in Figure 2, and its projection seaward is indicated. It is filled with sand in the beach area and in the offshore area. In the near shore, the sand exists to a depth of 4 to 6 feet in a loose condition, underlain by a somewhat consolidated material which stopped the diver's probing tool, but was not investigated further. The entire submarine feature, which represents a safe but narrow access route for the YFU, is shown in the bathymetric chart of Figure 3 (and the fold-out at the end of this report). It maintains a distinctive canyon like bathymetry, on a small scale, from the shore to the outer edge of the site survey area. The channel using this route is not straight. It has a small offset in direction some 800 feet from shore.

The steeply folded sandstone and siltstone rock formation visible on shore dipping downwards from the southeast to the northwest continues in the marine environment. Ridges are exposed above the low water east of the YFU landing beach. They dip northwestwards to present what appears to be isolated rocky features on the bottom west of the YFU landing beach. These features are actually prominences of the sub-bottom ridges. The aforementioned YFU access route via an ancient arroyo, eroded during a time of lower sea level, and now ponded with sand, lies between the rocky bottom features. All are visible in the bathymetric chart of Figure 3, the fold-out in the Appendix, and are further identified in the descriptive chart of Figure 4. The depths indicated in Figure 4 are minimum water depths at Mean Lower Low Water. The bathymetric chart is suitable for navigation and uses the Mean Lower Low Water (MLLW) as the chart datum. The tidal range at this site is almost 5 feet, with the mean tidal level 2.5 feet above the chart datum.

Accuracy of the bathymetric survey operation was $\pm$ 10 feet in location on the sea surface, as determined from the two USGS benchmarks shown on the charts, and less that $\pm$ 1 foot in depth, corrected for the chart datum. Latitude and longitude were determined independently by the Defense Mapping Agency according to the positions of the USGS benchmarks. The shoreline indicated in the charts was that of the year 1956, as provided by the Defense Mapping Agency, and has notably receded a few feet to date.

On the basis of this survey data, it is recommended that the range markers used in the approach of the YFU to the beach be replaced by a new set of markers, perhaps four, to establish a line close to the center of the submerged arroyo as shown in Figure 4. This alignment, with its dog leg offset, offers a safer distance for the YFU from the submerged obstructions.

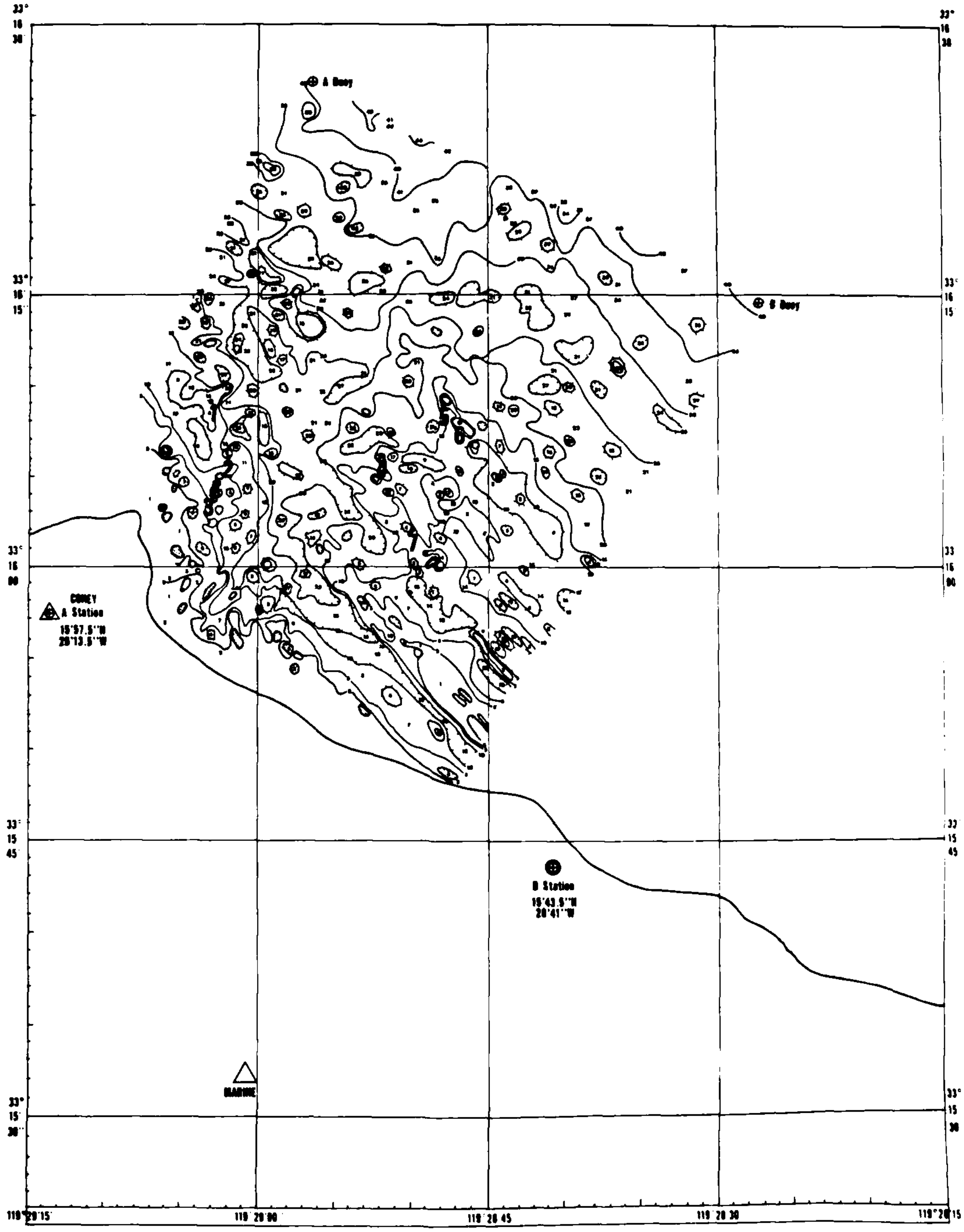


Figure 3. Depth Contour Chart - (Composite, Small)

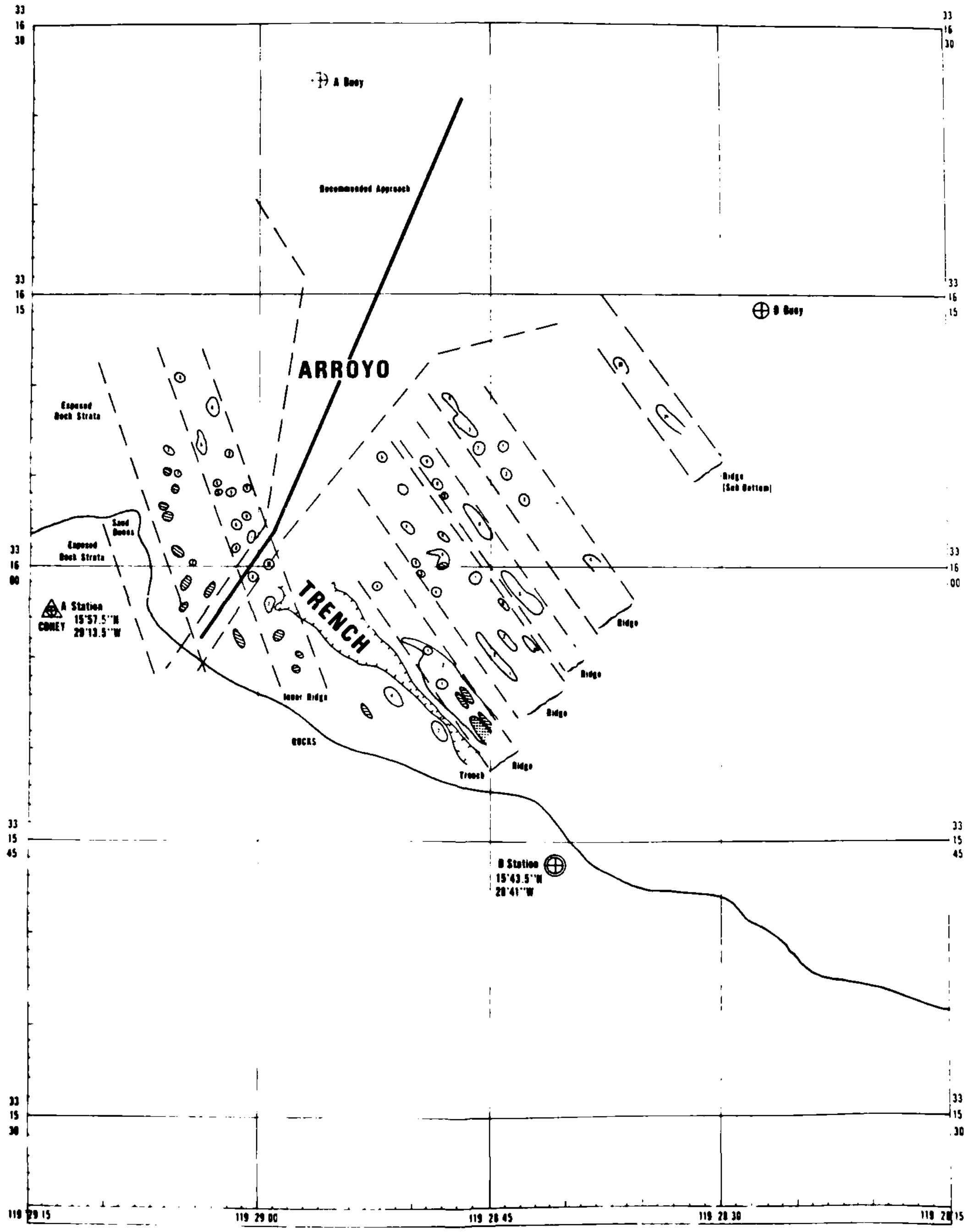


Figure 4. Rocky Feature Locations, With Minimum Depths

A secondary recommendation is to pursue additional bathymetric surveys at sites along the beaches adjacent to the present YFU landing site beach. The intent would be to locate a wider access route to the beach without the constrained maneuvering area nearshore. The coastal geology indicates that the same pattern of arroyos eroding the ancient landform existed at many places along the coast, followed by the erosion and deposition of the marine terraces. It is possible that one of these sites may offer a wider access channel to the beach than that of the current site.

3.0 THE PHYSICAL SETTING

The difficulties encountered in bringing the YFU supply craft into the beach at San Nicolas Island are the consequence of several facets of the environment, ranging from geologic processes occurring over millions of years, to wind and wave con tions which are of the current moment. Those facets of the environment which have an impact on the YFU operation are described in the following sections.

3.1 *Geology*

All of San Nicolas Island is a complex faulted anticline oriented along the major axis of the island, southeast to northwest. The exposed sedimentary rock consists almost entirely of alternating sandstone and siltstone beds. Individual layers are only a few inches in thickness, laid down as turbidites in the middle to late Eocene. (Table I is a chronology of the geologic ages pertinent to this study.) Steep uplifting occurred in the mid-Miocene, with some continued uplift to the present time. Wind and water erosion have left the entire exposed Tertiary section deeply cut with arroyos. There is no evidence that any substantially enduring streams ever existed on San Nicolas. A complex of five arroyos in the vicinity of the YFU landing site is shown in Figure 2. In particular, the arroyo numbered 4 is the one of interest, in that it affects the bathymetry and submarine geology of the survey area.

During various Pleistocene sea level regressions, erosion features such as arroyos extended into areas that are now a part of the underwater shelves surrounding the Island. These shelves are later Pleistocene wave erosion features, covered with unconsolidated marine terrace deposits which have formed unconformably over the Eocene rocks. Only two of some twenty shelves are of interest at the YFU landing site, the beach platform, and the nearshore platform.

The entire YFU landing site survey area offshore is characterized as a single marine terrace unit with a seaward slope of 0.6 degrees. Although the individual marine terraces in general, considered as a unit, are relatively flat, much local irregularity exists. These are the features due to differential erosion by wind and water at times of eustatic lower stands of sea level. The differential erosion derives from the interbedding of the softer siltstones with the more resistant sandstones. (Conversely, however, Brackett (1975) has found a cementitious siltstone at the YFU survey area with a compressive strength of 15,000 psi, interbedded with a soft sandstone having a compressive strength of only 600 psi. Nevertheless, the mechanism of differential erosion is still valid.) The course of an arroyo across the uplifted and folded bedding planes is at an angle to the bedding plane normal which is related to the ratio of the individual interbedded material strengths. The arroyo of interest, numbered 4 in Figure 2, has cut at an angle across the sandstone and siltstone strata from the mesa to a place at sea beyond the survey area. The marine terrace deposits of

TABLE I: SAN NICOLAS ISLAND

GEOLOGIC TIME SCALE

ERA	PERIOD	EPOCH	YEARS BEFORE THE PRESENT	EVENT
				- Vegetatian - Grasses & Shrubs, Active Sand Dunes - Native Indian Inhabitants
	Quaternary	Holocene (Recent)	11,000	- Dense Vegetation Including Trees
		Pleistocene (Glacial)	------	- Formation of Marine Terraces. Erosion of Arroyos
			500,000 to 2,000,000	
Cenozoic		Pliocene	13,000,000	
		Miocene	25,000,000	- Island Uplift
	Tertiary	Oligocene	36,000,000	
		Eocene	---------- 58,000,000	- Sandstone and Siltstone Beds Laid Down on Sea Floor by Turbidity Currents
		Paleocene	63,000,000	
Mesozoic			230,000,000	
Paleozoic			600,000,000	
Precambrian			4,500,000,000	

the beach platform and the nearshore platform have covered the arroyo, but evidence of its existence remains in the bathymetry.

The strike of the arroyo is almost normal to the local shoreline, but crosses the folded bedding planes of the sedimentary strata roughly 60 degrees off normal (30 degrees from the bedding plane). On both terraces, the arroyo is covered in the upper layers with sand and unconsolidated material underlying the sand, as determined by actual probing.

The northwesterly strike and dip of the cleavage planes of the sedimentary strata visible in the landform behind the YFU landing beach are repeated at successively lower levels going seaward. The two marine terraces (the beach platform and the nearshore marine platform) and the ponded arroyo hide the continuity of the visible landform going seaward, however, there is sufficient evidence to indicate such continuity. The prominent outcroppings of ridges in the eastern site area, and apparently isolated rock outcroppings in the western site area are the visible evidence of the continued landform. As shown in Figure 4, the eastern ridges, of which the nearshore units are visible above water at low tide, parallel the cliffs on shore. Going north westwards, the same features dip so that only the prominences appear above the marine terrace level, thus giving the appearance of isolated features. From this interpretation of the geology, the preferred access route for the YFU to the beach would be over the sand-filled and submerged arroyo.

A secondary recommendation of this study for additional site surveys to locate a wider channel, without an offset in its course, is based on this same interpretation of the coastal geology. The ancient arroyos ponded over with the late Pleistocene marine terraces are numerous along the coast. Several are shown in the chart of Figure 2, and many more in the geologic map of Vedder and Norris (1963), from which Figure 2 was serived. Initially, one should investigate the potential of the adjacent beaches to the current YFU landing site beach, particularly the areas in front of the arroyos numbered 1, 2, and 3. Although less protected than the currentsite, the potential of a better channel may take precedence. The site in front of the arroyo numbered 5 in Figure 2 is similarly less protected at the beach line, but may offer a superior advantage in access.

A general study of the geology of San Nicolas Island has been reported by Vedder and Norris (1963), and extensive observations are reported in numerous theses for M.S. and Ph.D. at the University of California, notably Kemnitzer, L. E. (1933), Norris, R. M. (1951), Uchupi, E. (1954), and Hoskins, C. W. (1957).

3.2 Beach Littoral Drift

Since there is no protection from the large waves over most of San Nicolas Island, the beach zones are characterized by frequent removal of substantial quantities of sand, which are later returned to the beach. Revelle and Shepard (1939) have studied this type of periodic changes on the California beaches. They have determined that the sand is carried only a short distance seaward by the heavy surf action, which cuts back and steepens the foreshore, and then the sand is returned by the calmer wave conditions following. There is also a significant transport of sand along the shore, evident on San Nicolas by the presence of an actively renewed sand spit at the southeastern end of the island. This transport is independent of the aforementioned beach process. The alongshore littoral transport is very small compared to the periodic sand removal and return when the latter process is active. However, the persistent alongshore current does influence the ponding of sand around ridges and other submerged rocky features. The current is towards the southeast along the shore, and tends to clear sand from the impact side of submerged features, and deposit sand on the lee side.

The low water berm is a prominent feature of the beach in that it presents a 1 to 2 foot steep rise of the sand at the point at which the YFU would lower its bow ramp. The shoreline at this point is actively receding. (The storm waves cut into the higher marine terrace which is the beach platform.) The chart of Figure 3 indicates the shore line as it existed in 1956. The present day shoreline was not charted specifically, but it can be surmised from the depth contours. It is several feet inland of the 1956 position in the sandy areas, about the same in the rocky areas. A distinct advantage of a YFU access route over the ancient arroyo submerged beneath the sands of the marine terrace is that the continual cutting back of the foreshore by the wave action is not likely to expose any outcroppings of the sandstone and siltstone ridges through which the arroyo was originally cut. Thus, the continued safety of the YFU hull can be relied on.

3.3 Tides

The tidal variation at San Nicolas Island is characterized as mixed, or semi-diurnal, with a substantial diurnal inequality. The largest inequality is in the height above datum of the successive low waters. A typical tidal chart through the lunar cycle is shown in Figure 5, which is the data for the time of the survey. The tide reference station for San Nicolas Island is the outer harbor of Los Angeles. San Nicolas tides occur 9 minutes later than the reference station for high water, 19 minutes later for low water, with a tidal range equal to 91% of that indicated for the reference station.

The chart datum is the Mean Lower Low Water (MLLW) which is the average of the lower of the two daily low tides. This is not the least water to cover any submerged features. Meteorological effects (such as wind stress) can lower the water level below the expected level at any tide. The extremes of the low water, the low water springs, occur regularly. On the average, excluding meteorological effects, the expected mean tide level is 2.5 feet above the chart datum. The difference in height between mean high water and mean low water, or the mean tidal range, is 3.3 feet. The diurnal range, which is the difference in height between mean higher high water and mean lower low water, is 4.9 feet. During difficult wind and sea conditions when the YFU supply route must be scheduled, added maneuvering room can be achieved by taking advantage of the tidal diurnal inequality. During 4 or 5 days each fortnight, one of the low waters is at least 2 feet above the MLLW datum.

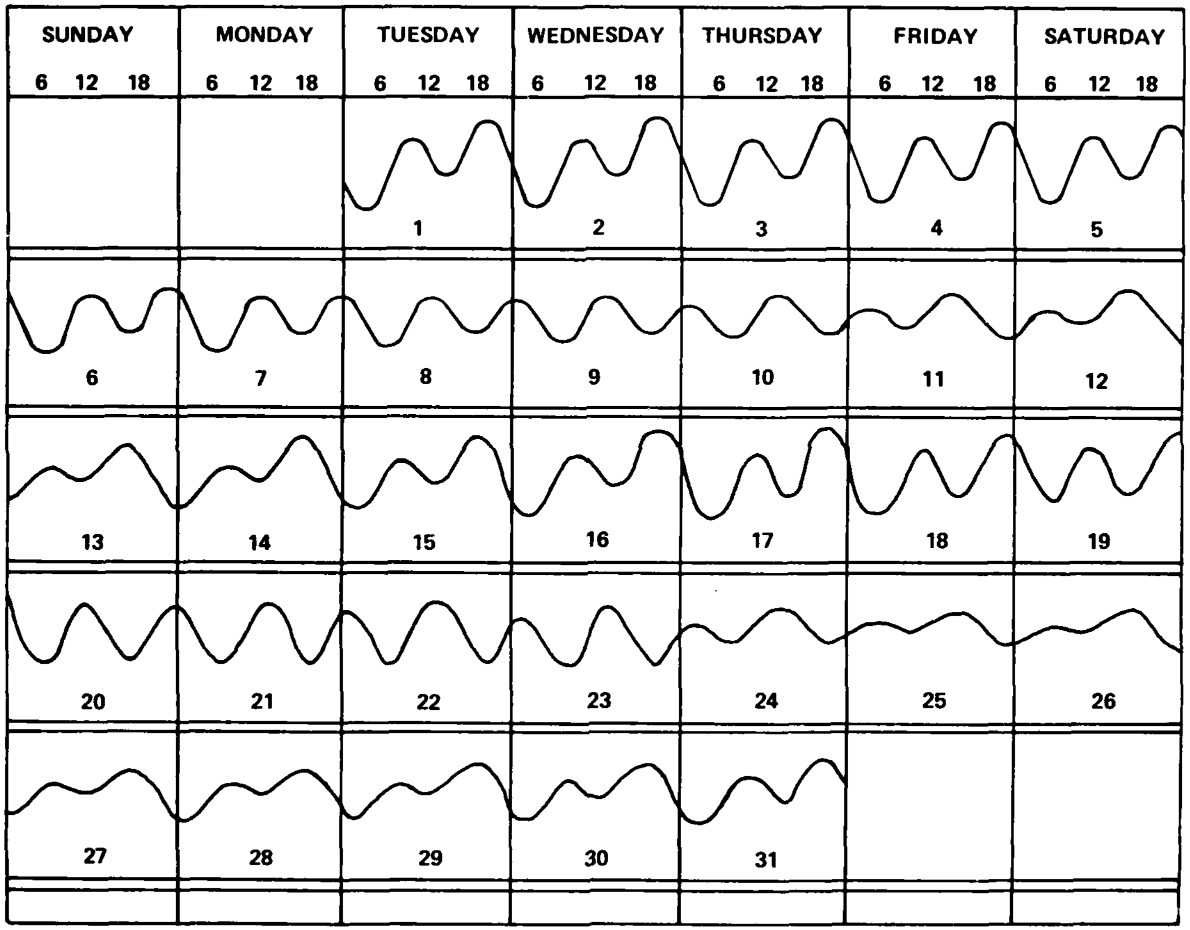


Figure 5: Typical Monthly Tidal Variation; (Specifically for San Nicolas Island for August 1978).

TABLE II

Times and Heights above MLLW datum for the northeast coast of San Nicolas Island (33° 16' N, 119° 30' W) high and low tides during the survey interval.

DATE AUG 1978	TIME PST	HEIGHT FEET	TIME PST	HEIGHT FEET
14	0025	0.1	0642	3.5
14	1136	2.0	1749	5.6
15	0111	-0.4	0726	3.8
15	1238	1.7	1842	6.0
16	0155	-0.7	0806	4.2
16	1329	1.5	1932	6.3
17	0236	-0.9	0847	4.6
17	1419	1.1	2018	6.3
18	0316	-0.9	0924	4.7
18	1507	0.9	2104	6.1
19	0356	-0.7	1004	4.9
19	1555	0.8	2152	5.7
20	0433	-0.4	1042	5.0
20	1648	0.8	2241	5.2
21	0513	0.2	1124	4.9
21	1742	0.9	2331	4.6
22	0552	0.7	1209	4.8
22	1845	1.1	-	-

This offers 14 to 16 hours of added water depth for the offloading operation.

The actual tidal heights during the survey operation are given in Table II. Interpolation was made using the cosine characteristic shape for the individual tidal components between extremes, as shown in Figure 5.

3.4 Wind and Waves

The predominant wave direction at San Nicolas Island is from the northwest. No intervening land offers a fetch limitation to limit the build-up of the local waves, or block the distant swell. Although the general wave direction is parallel to the San Nicolas coast, diffraction effects turn the waves towards the beach in the YFU site survey area. Most of the higher waves during YFU operations are wind generated locally. Distant swell does contribute somewhat in the northern and southern hemisphere winters. Table III presents the relationship between the local wind speed and the percentage frequency of occurrence from given directions. The data set, which spans 135 years, indicates that two-thirds of the time the wind is from the north to northwest sector and has an average speed of 15 knots. This corresponds to a fully developed wave height of about 5 feet, which may be enhanced somewhat due to bottom effects as the waves run up into the shallow water. A more detailed distribution of the wave height with wind speed, taken from a five year span of data, is given in Table IV. The wave height distribution by month of the year is shown in Table V. As anticipated, the bulk of the more severe wind and wave conditions occur in the winter. Since the YFU supply route must operate throughout the year, the wind and wave conditions must be contended with as they occur. The data is presented for planning without any alternative.

The data of Tables III and IV are taken from the "Summary of Synoptic Meteorological Observations" issued by the Navy Weather Service for the region 31^o - 34^o N. Lat., 120^o - 125^o W. Long. The data of Table V is taken from a study by Rosenthal and Helvey (1976) in which twenty months of wave height data were measured at Begg Rock. This rock, which stands 15 feet above the water and rises abruptly from a water depth of 50 fathoms, lies 8 miles northwestward from the northwesternmost point of San Nicolas Island.

3.5 Currents

The water currents at the YFU landing site area do affect the handling and maneuvering of the vessel, but do not appear to be detrimental to the operation. One predominant current is the alongshore transport towards the southeast. Evidence of this transport is the littoral drift, originating in a source at the northwestern end of the island, and depositing in a drain which is a cuspate sand spit at the southeastern end of the island. This littoral drift was estimated to be 40 to 80 centimeters per second during the period 16 - 17 April 1977, (the Project Meteor site survey). Winds at that time were light.

TABLE III

PERCENTAGE FREQUENCY OF WIND DIRECTION AND WIND SPEED

WIND SPEED (KNOTS)

WIND DIR	0-6	7-16	17-27	28-40	41+	TOTAL OBS	PCT FREQ	MEAN SPD
N	2.4	11.4	7.9	1.0		8572	22.7	15.1
NE	.7	1.1	.3			814	2.2	10.2
E	.7	.6	.1		.0	541	1.4	8.5
SE	.6	.9	.2	.1	.0	663	1.8	10.6
S	.9	2.1	.7	.1	.0	1435	3.8	11.7
SW	1.3	2.4	.5	.1		1633	4.3	10.3
W	2.9	8.8	2.7	.4		5627	14.9	12.2
NW	3.9	22.3	18.3	2.4		17761	46.9	15.9
VAR		.0	.0	.0	.0	5		2.6
CALM	2.1					785	2.1	.0
TOT	5851	18804	11642	1514	25	37836	100.0	14.1
PCT	15.5	49.7	30.8	4.0	.1	100.0		

PERIOD: (Primary) 1949-1968
(Over-all) 1854-1968

TABLE IV

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	TOTAL OBS
1	2.3	4.4	.6	.0	.0	508
1-2	1.0	12.8	10.1	.7	.0	1728
3-4	.5	9.1	17.6	2.8	.0	2110
5-6	.1	2.8	12.0	2.7		1243
7		1.1	6.7	3.4	.2	799
8-9		.3	2.5	2.1	.1	352
10-11			.9	1.1	.1	154
12	.0		.3	.7	.1	80
13-16	.0		.1	.4	.1	46
17-19	.0	.0	.0	.1		6
20-22	.0	.0			.0	2
TOTAL	278	2144	3578	984	44	7028
PCT	4.0	30.5	50.9	14.0	.6	100.0

TABLE V. SUMMARY OF WAVE DATA NEAR BEGG ROCK
(30° 22'N 119° 41.5'W) FROM 1 APRIL 1972 THROUGH 31 DECEMBER 1973
(FROM ROSENTHAL AND HELVEY (1976))

Month	Lowest Monthly 3-Minute Ave. Period (Sec.)	Average Wave Ht. (m.)	Computed Ave. Significant Height (m.)	Highest Monthly 3-Minute Average Average Height (m.)
Jan	5	1.77	2.83	3.96
Feb	6	1.52	2.44	2.74
Mar	5	2.13	3.44	3.96
Apr	4	0.95	1.55	2.44
May	5	1.04	1.65	3.05
Jun	5	1.19	1.92	3.66
Jul	4	1.13	1.80	1.83
Aug	5	1.16	1.86	2.44
Sep	6	1.40	2.23	3.66
Oct	5	1.19	1.92	2.74
Nov	5	1.80	2.93	3.05
Dec	5	1.52	2.47	3.66

The alongshore current derived from the principal wave direction is enhanced by the wind stress, which comes from the same direction. The 40 - 80 cm/sec figure for littoral transport is a reasonable estimate for the combined effects.

A locally variable current source which is influenced by local variations in the bottom bathymetry and topography is the tidal current. No measurements of this current have been made. The presence of a trench close to shore, discovered during the survey, indicates that the tidal currents are effective in maintaining that trench clear of ponded sand. The effect of tidal currents during the survey were not noticeable, and were no hindrance to the survey vessel operation. Whatever the actual levels of the currents, it appears that they will not be a source of difficulty in the YFU supply operation.

3.6 Marine Biology

The only impact that the marine biology has on the YFU landing operation derives from the extensive kelp beds which are found in the area. The survey was hindered on several occasions by the fouling of kelp in the propellers of the survey boat. This occurred mainly in the central and western portions of the site area. The kelp, however, will not be detrimental to the YFU operation.

Various seals and sea lions inhabit the waters around San Nicolas, mostly confining their habitat to the western shore. Since the YFU landing operation is located on the other side of the island, it will not interfere with the seal or sea lion habitats.

4.0 THE BATHYMETRIC SURVEY - PROCEDURE

The actual field work involved in the San Nicolas Island bathymetric survey was rather simple in both equipment and technique. Earlier work in coastal geology and in preliminary site surveys had provided a good base of information on which to plan the survey. Consequently, with good weather an added benefit, the entire survey was accomplished expeditiously, with reliable equipment and procedures, and without unexpected difficulty.

4.1 System Description

The block diagram for the survey system is shown in Fig. 6. The main items of equipment consisted of the fathometer, the navigation system, and the radio communication system. The fathometer was a Raytheon Model DE-719B battery-operated unit operating at 208 kilohertz with an eight degree transducer beamwidth (at the half power points). The transducer was located beneath the hull of the LARC-5 survey vessel with the navigation equipment antenna almost immediately above it. Consequently, no correction for the transducer offset was necessary.

The DE-719B fathometer has an internal provision for the correction for actual sound velocity, and for the correction for the transducer depth. The equipment depth measurement is ± 0.5% ± 1 inch of the indicated depth. The depth, however, was read to the nearest foot, a lesser accuracy, but better suited to the survey data. In plotting the data for the contour chart, slope corrections were not made for the rocky features. These corrections, considering the shallow water depths and the narrow transducer beam angle, are less than the accuracy of the survey system, hence, insignificant.

Navigational control was established using the Motorola Mini-Ranger Model MRS-III. The system is a ranging system using an interrogator operating on the survey vessel, which determines the range from each of two fixed transponders on the beach. The Mini-Ranger is designed for line of sight operations, hence the need to establish one of the reference stations some one-half mile from the "MARINE" benchmark. The other reference station was co-located with the "CONEY" benchmark. (These are described in the next section.)

The Mini-Ranger system is a high resolution pulse radar type equipment operating in C-band (5400 - 5600 megahertz). A spatial diversity option has been incorporated into the system to eliminate the interference between the direct signal and the reflected signal in over water paths between the transponder and the master unit. This feature and a unique pulse coding feature assure that no range data will derive from, nor be corrupted by, the extraneous signal paths. The location error of the Mini-Ranger is ± 3 meters, or nominally ± 10 feet.

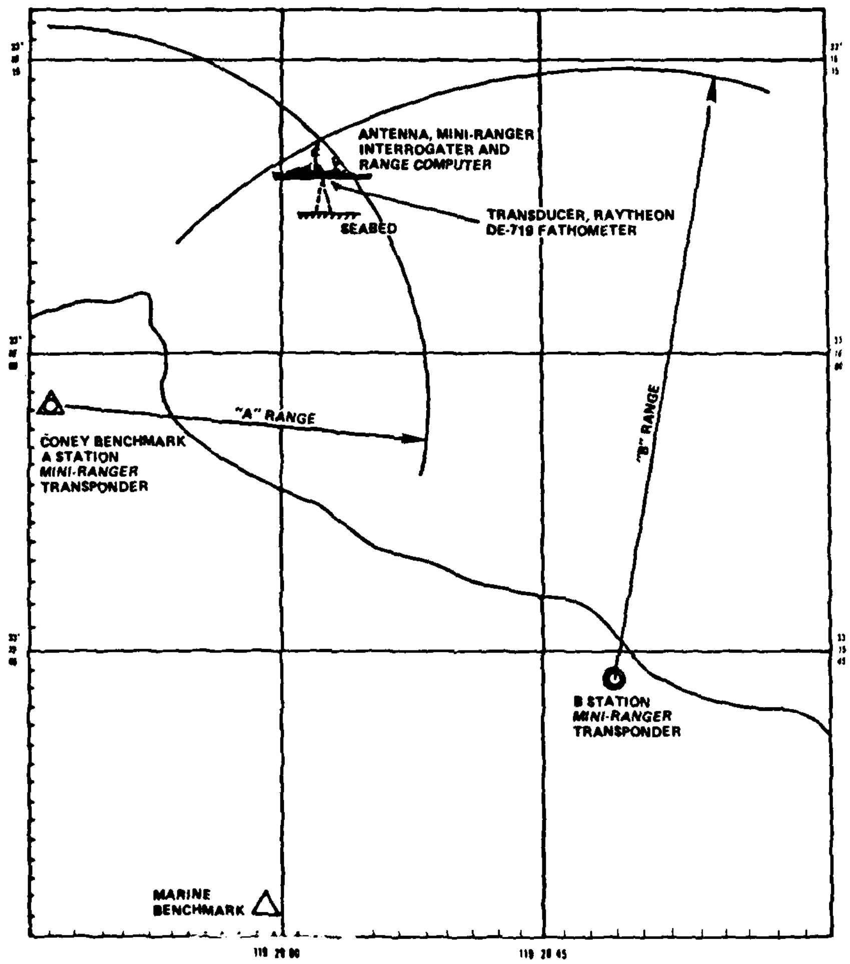


Figure 6: Block Diagram, Survey System Showing Location of Mini-Ranger Transponder Stations on Shore.

Both Mini-Ranger ranges and the fathometer-indicated depth were recorded in the logbook data once each 15 seconds of the run. The LARC speed of advance was roughly 2 knots, or about 3 to 3.5 feet per second. Hence, the annotated sounding interval was of the order of 50 feet across the bottom. This interval was highly variable as the rate of the LARC advance was modified by kelp and surf. The fathometer record was continuous in time. Hence, all bottom features were noted, and their location interpolated between the 15 second record annotations. Time marks on the fathometer record corresponded to the 15 second log entries. This procedure is consistent with the available navigation accuracy and with the requirements of the YFU landing operation.

4.2 Benchmarks; Survey Accuracy

Primary control for the offshore survey of the YFU landing site area was taken from the two USGS benchmarks identified as "CONEY" and "MARINE". These benchmarks are shown on the various charts included in this report. The latitude and longitude of each of these benchmarks has been established by the Defense Mapping Agency (DMA), and is shown on a 1:3000 scale chart made available by that Agency. Although the order of accuracy of these benchmark locations is not known at this time, it is believed to be considerably superior to the accuracy of this survey. The DMA chart was used as the basic plotting sheet for these survey data.

The "ALPHA" station Mini-Ranger transponder was co-located with the "CONEY" benchmark, the small offset being less than the resolution of the Mini-Ranger system. The "BRAVO" station transponder was located on the beach about a half mile from the "MARINE" benchmark, and the Mini-Ranger system itself was used to locate "BRAVO" relative to "MARINE". This introduced a small additional error into the survey locations, which by statistical techniques using multiple measurements of the "MARINE" location, was made insignificant compared to the basic Mini-Ranger error ± 3 meters.

4.3 Boat Tracks and Procedure

The outer limits of the site survey area were identified by the placement of fixed buoys. These buoys, identified as "A" and "B" on the charts of this report, were located roughly 1000 meters seaward of the Mini-Ranger stations "ALPHA" and "BRAVO" respectively, and were approximately 1000 meters apart. The line between the buoys was further delineated by 11 marker buoys spaced roughly 80 meters apart, and used to locate the point of commencement of each inbound survey run. All data runs were made from the outer buoy line into the beach, a procedure which permitted better navigational control, and better vessel handling. This procedure also facilitated maintenance of a clear line of sight to the destination over the entire track since the destination for each run was a 20-foot high flagpole appropriately placed on the beach.

The data runs began at the "A" buoy and proceeded to the flagpole placed at the "ALPHA" shore station, with parallel courses intended for the successive runs. Kelp beds over the western and central portions of the site survey area presented some problems with fouling of the LARC-5 propeller. This required direction reversals and maneuvers of the vessel, which had no effect on the validity of the data, but did introduce some random excursions from the basically intended tracks. In fact, from observation of the sounding sheet, which is presented as the first fold-out of the Appendix, it can be seen that the irregular courses actually enhanced the survey accuracy by providing a more thorough and refined coverage of the survey area. The last half dozen runs, terminating with the run from "B" buoy to "BRAVO" station, were relatively unhindered. The LARC tracks and various features of the beach and the survey area are shown in Figure 7.

During the progress of the survey, a boat sheet was plotted on shore showing the LARC-5 tracks, the water depths, and the time, for proper monitoring of the survey. Any difficulties that became apparent such as holidays in the data more than 10 meters across, were reason to retrace the area in the next day's runs. Consequently, an unusually finely resolved data set was acquired for the survey area, which provided a substantial means for selfchecking the data set after tidal corrections were made.

The fathometer recorded a continuous bathymetric profile of the bottom, which was monitored on board the LARC for submerged ridges and other outcroppings. Some examples of the fathometer records are shown in the following figures:

Figure 8: A run across the ridges in the western portion of the site survey area. Note that the ridges are steeper on the landward side than on the seaward side. (The left of the picture is seaward.)

Figure 9: A run across Position 5 indicating the sharp rise of this feature from the bottom on both sides.

Figure 10: A run into the beach from the sea using the present range markers as the navigation control for the LARC-5. The tidal level during the run was 5 feet above MLLW. Note that no obstructions would interfere with the YFU transit (7 foot draft) over this exact alignment at high tide.

Each discontinuity from the flat bottom profile was retraced for minimum depth verification, and marked with a buoy for later diver inspection. Ultimately, seven features were identified for diver inspection, as indicated by Positions 1 through 7 in Figure 4. The ridge nearest shore, which was inundated at the time of the survey, (it is exposed at lower low water), had already been diver inspected during an earlier survey by the Civil Engineeering Laboratory personnel. Their commentary is included in this report.

4.4 Diver Inspection of Features

The divers of Underwater Construction Team Two diving on the seven buoy-identified positions used a rod and line to measure the dimensions

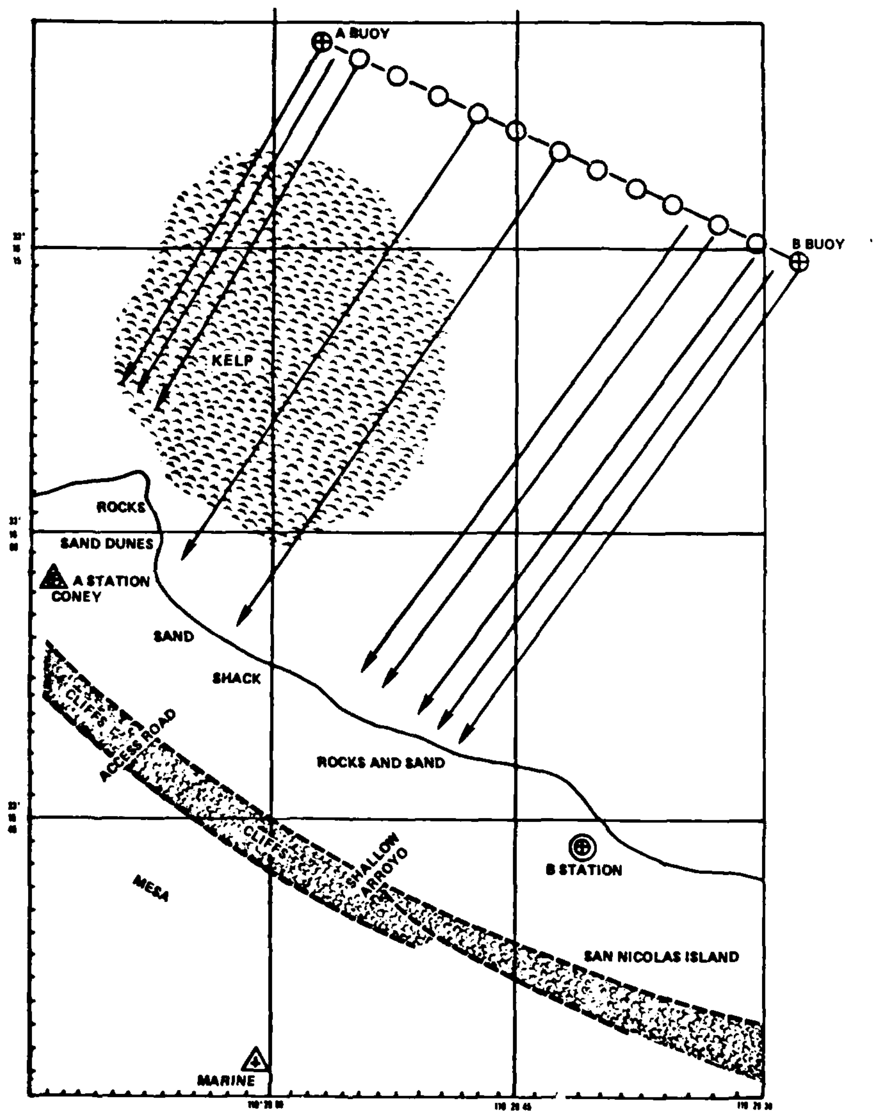


Figure 7: Boat Track Chart Showing Benchmark and Buoy Locations, Kelp Beds, and Beach Features.

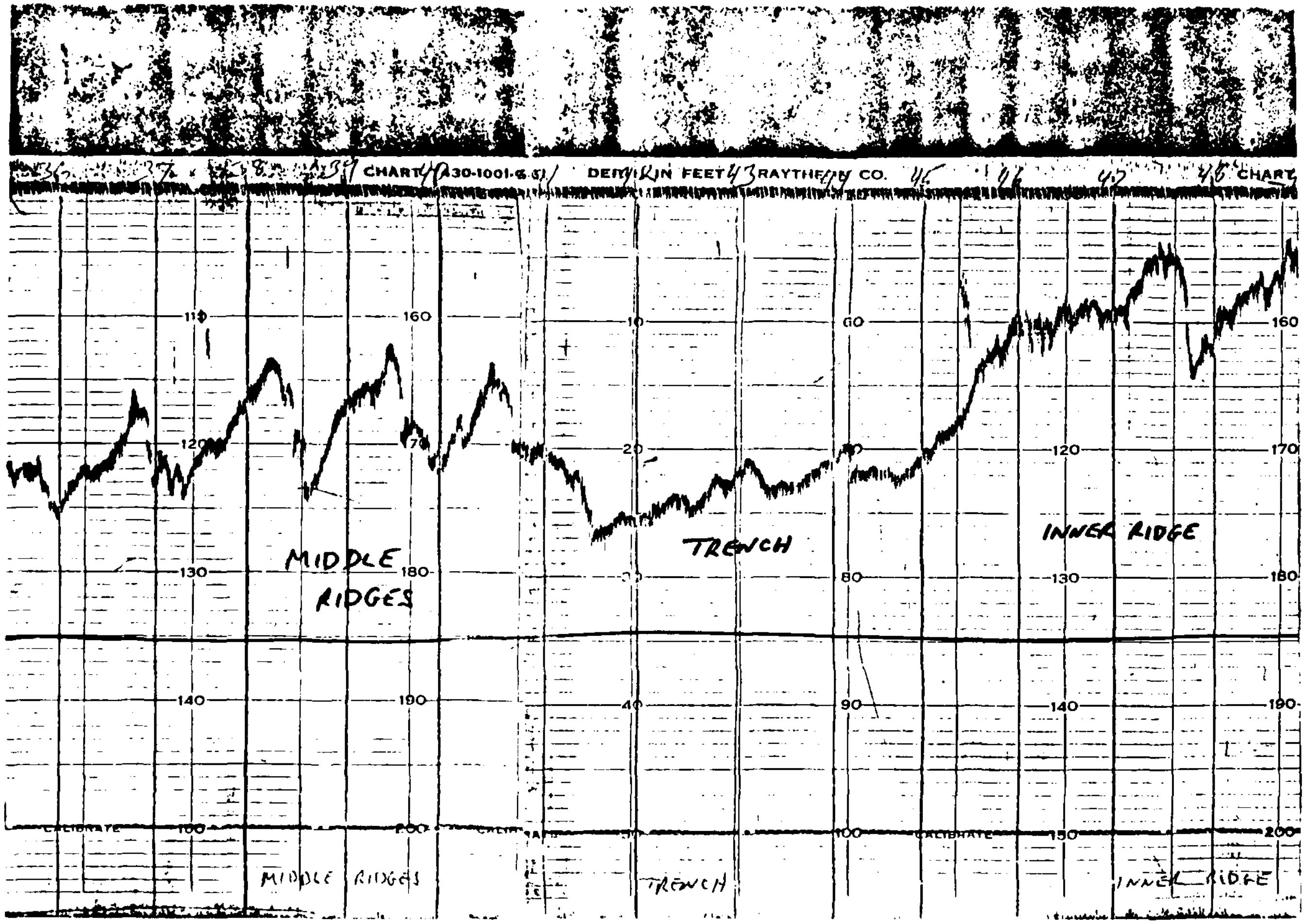


Figure 8. Fathometer Record Sample - Ridge Transect (Showing the Middle Ridges, the Trench, and the Inner Ridge).

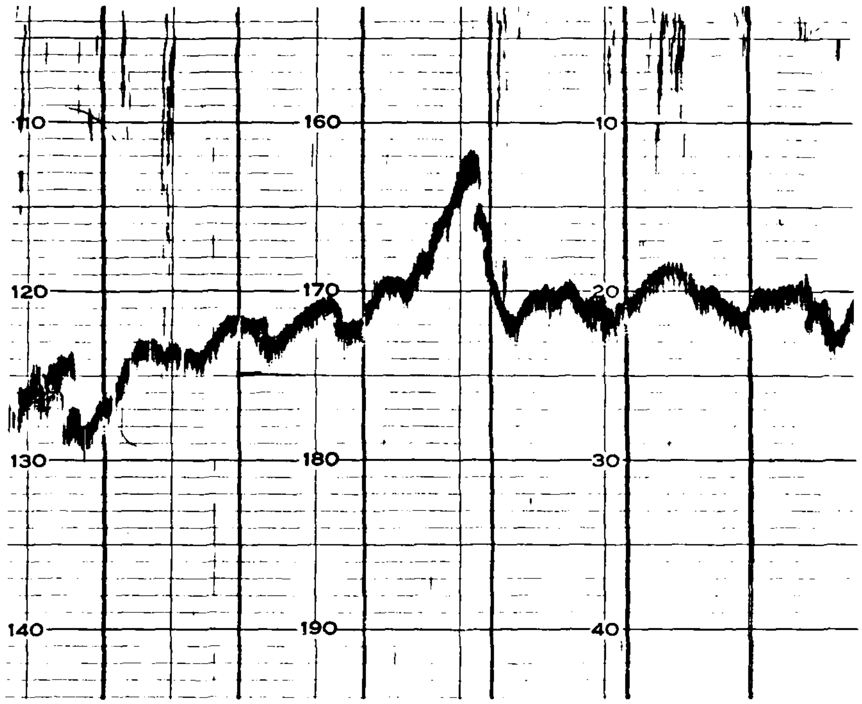
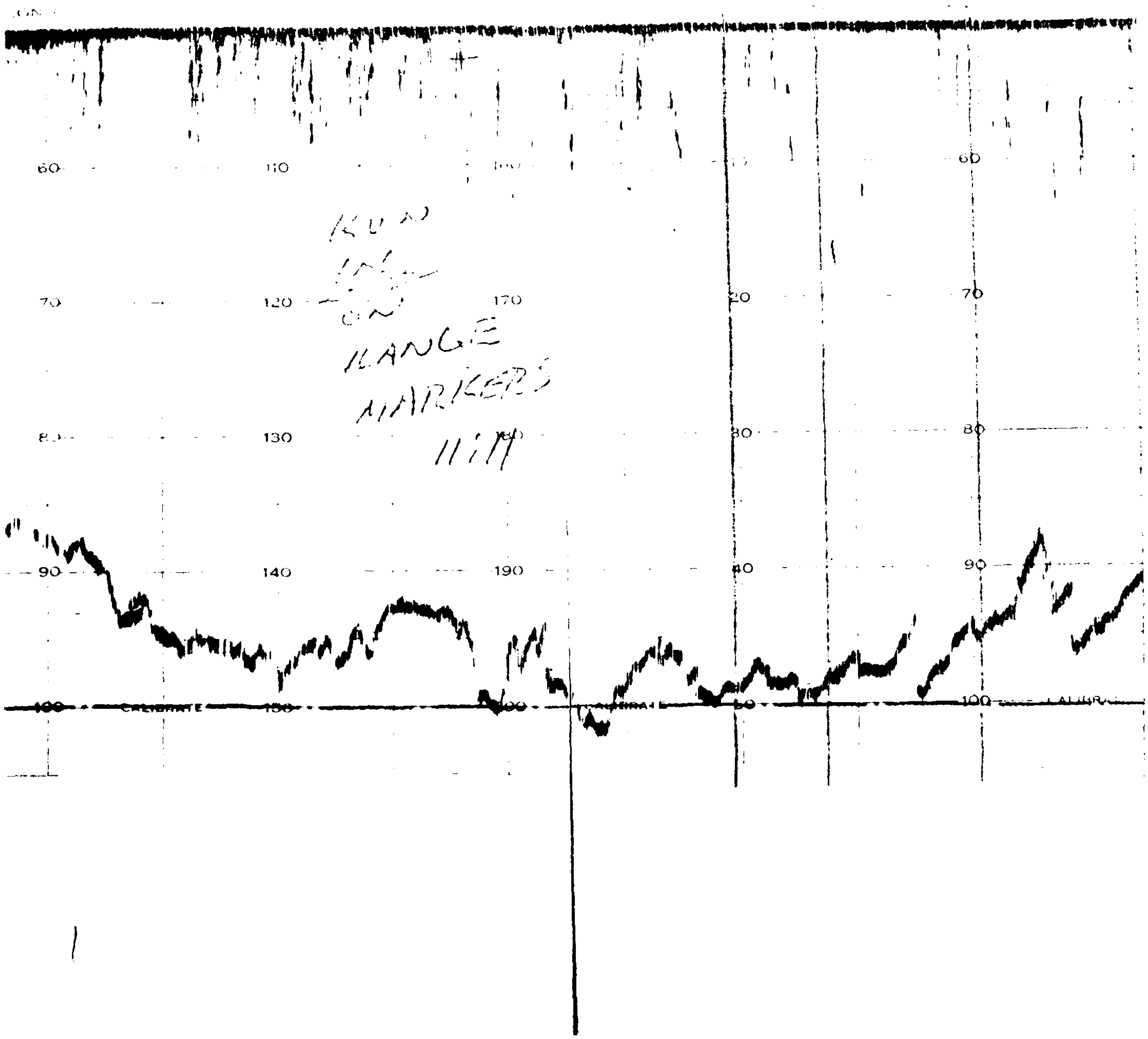
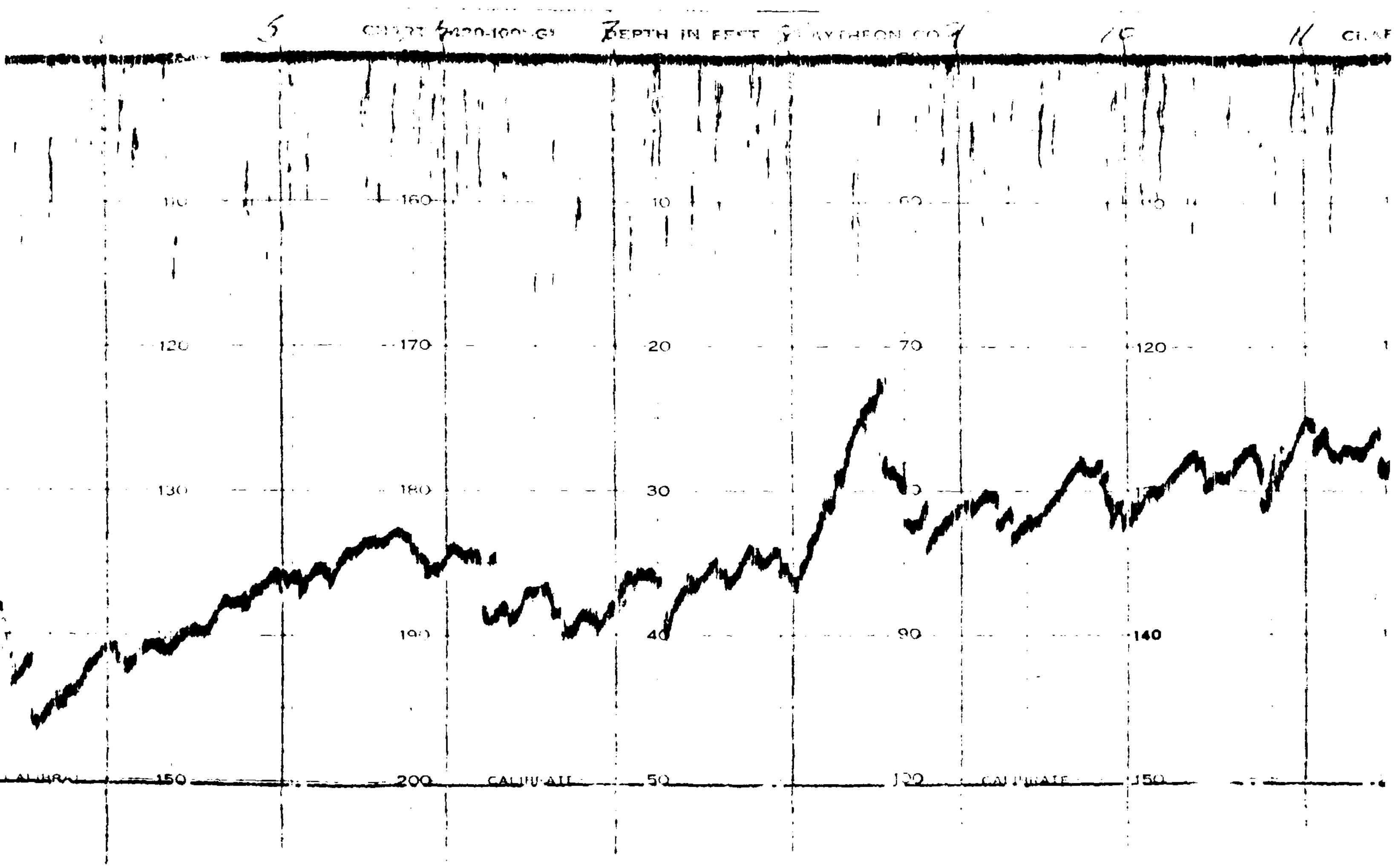


Figure 9. Fathometer Record Sample - Isolated Feature Transect
(Showing the Prominence at Position 5)



60
110
60
70
120
170
20
70
RUN IN ON RANGE MARKERS
80
130
30
80
90
140
190
40
90
100
CALIBRATE
150
100


DEPTH IN FEET
160
170
180
190
200
10
20
30
40
50
70
90
120
130
140
150
CALIBRATE

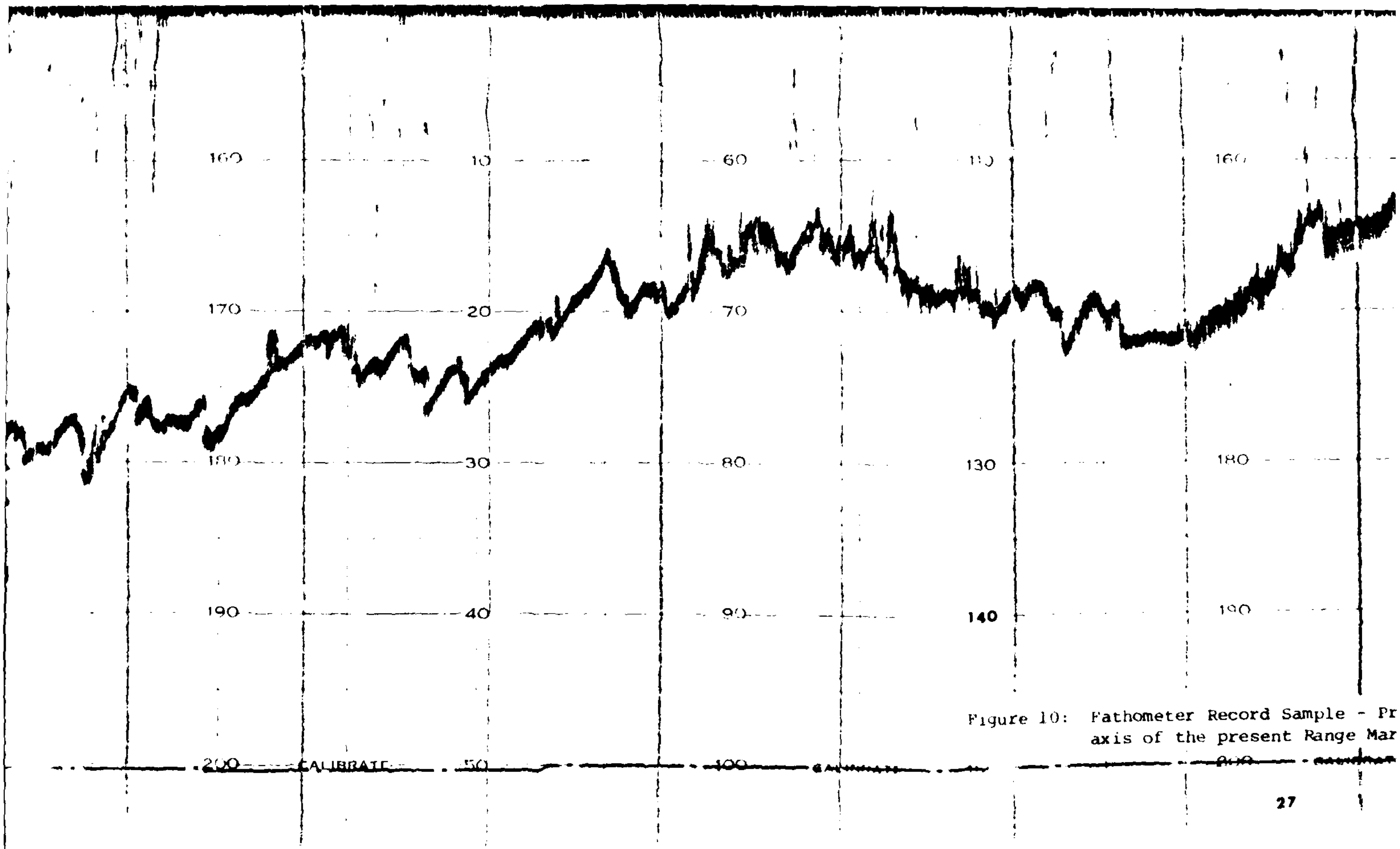


Figure 10: Fathometer Record Sample - Pr
axis of the present Range Mar

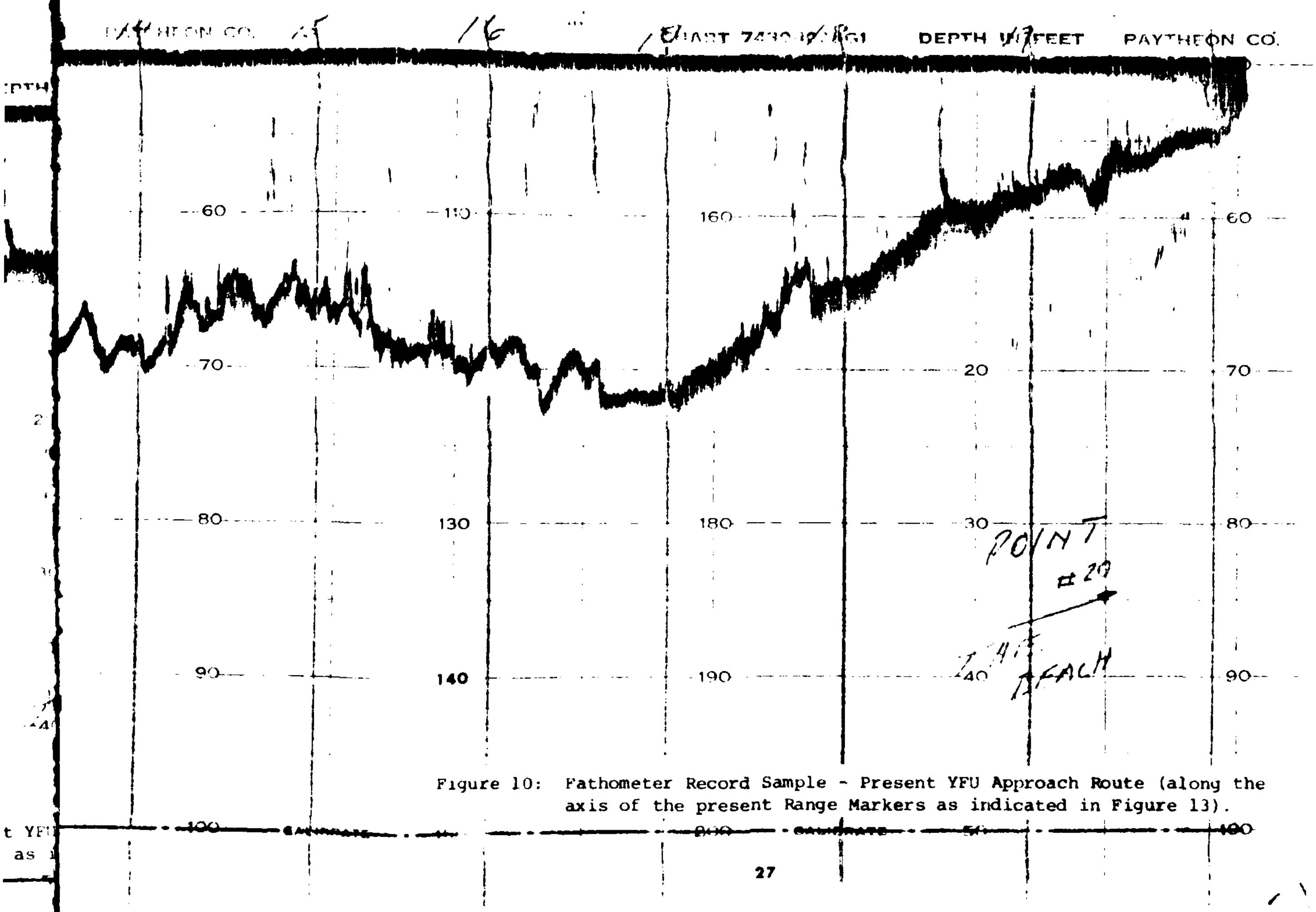


Figure 10: Fathometer Record Sample - Present YFU Approach Route (along the axis of the present Range Markers as indicated in Figure 13).

of each submerged feature and to measure the minimum depth. Observations made on each feature included a description of the visible geology, the strike and dip of the sandstone and siltstone bedding planes, and the lay of the sand around the feature. Sketches were made of the features. Periodically, a probing tool was used to verify the depth of sand over any harder material beneath the seabed. Limited visibility and rather dense coverage of kelp, even in the crevices of the rocky bottom features, prevented the taking of any useful photographs of most of the bottom features.

4.5 Chronology of Events

The following is the chronology of major events as they occurred during the survey operation. No delays were encountered. Equipment functioned well, and the weather was clear and calm during the entire survey.

Tues., 15 Aug 1978	Arrived at San Nicolas Island; checked out survey area, located USGS benchmarks.
Wed., 16 Aug 1978	Set up the Mini-Ranger system; placed the "A" and "B" marker buoys 1000 meters offshore, and the eleven intermediate marker buoys. Completed one data run.
Thurs., 17 Aug 1978	Completed 14 data runs commencing at "A" buoy and proceeding about one-third of the way across the site survey area.
Fri., 18 Aug 1978	Completed 17 data runs in the central portion of the survey area.
Sat., 19 Aug 1978	Completed 16 data runs in the eastern portion of the survey area.
Sun., 20 Aug 1978	Completed the last 6 data runs terminating with the run in from "B" buoy. Completed diver inspection of 7 previously identified submarine features.
Mon., 21 Aug 1978	Packed equipment, clean-up.
Tues., 22 Aug 1978	Depart San Nicolas Island.

5.0 THE BATHYMETRIC SURVEY - RESULTS

The progress of a bathymetric survey and its subsequent data reduction includes the preparation of numerous charts, one for control of the survey, one for prime data, several for intermediate contouring, and a final depth contour sheet. These are described individually.

5.1 The Boat Sheet

The boat sheet is a rough copy of the plotted survey vessel locations, the numerically uncorrected depths as read from the fathometer, and the actual tracks of the survey vessel during the progress of the survey. Data points are spaced at regular 15 second time intervals. It is prepared on site and used expressly for technical control of the progress of the survey. It identifies holidays in the survey data and unusual bottom features, both of which require retracking for finer resolution. It is customary to include the boat sheet in a survey report since it is the basic data. In this survey, the fine resolution entailed many large scale boat sheets, several for each day's runs. Consequently, a more useful plot, the sounding sheet, is presented in the fold-out at the end of this report.

5.2 The Sounding Sheet

The sounding sheet, which is presented in the Appendix fold-outs, is the primary plot of the fathometer data corrected for tidal variation, and the locations. Owing to the large number of closely spaced data points, the sounding sheet presented here contains only one-third of the total number of data points, selected for their significance. Individually indicated soundings are accurate in location to ± 10 feet, and have a depth accuracy superior to 1 foot. The sounding sheet is not prepared from the boat sheet. The original fathometer data is reread against the 15 second time annotations, which correspond to specific location fixes, corrected for tide and plotted on the chart provided by the Defense Mapping Agency (which has the location of the primary survey control benchmarks). The onset and termination of distinctive bottom features was taken precisely from the continuous fathometer record, and the location interpolated between the 15 second interval Mini-Ranger fixes.

Several intermediate depth contour sheets are made as overlays on the sounding sheet. These incorporate the interpretation and the artistry of the individual doing the plotting and lead to the final version of the depth contours.

5.3 The Contour Sheet

The final bathymetric chart of the YFU landing site survey area is presented as the second fold-out at the end of this report, and in less detailed small illustrations in Figure 3 (bathymetry) and Figure 4 (locations of the rocky bottom features). The local irregularity of the bottom in the site survey area hides the fact that the entire offshore area of San Nicolas Island in this vicinity is part of a submerged marine terrace which is exceptionally flat. The general seaward slope of this terrace, to the extent that it has been determined in the course of the survey, is 0.6 degrees. The marine terrace is a late Pleistocene feature combining erosion and deposition, and currently continues its formation. It is not the flatness of the terrace, however, that is of interest to the YFU landing operation; it is the local irregularity of the bottom, particularly the rocky outcroppings.

The contour chart bears out the description of the continuation of the landform into the submarine area. The remnant of the ancient arroyo is visible in the contours, and identified in Figure 3. Curiously, a trench near shore leads into the remnant arroyo. This trench originates outside the survey area, as indicated in Figure 4, and may be related to the arroyo numbered 5 in Figure 2. From the geological standpoint, it is likely the remaining evidence of a dipping soft siltstone layer which has been differentially eroded during a Pleistocene sea level regression, and remains scoured of ponded sand by the tidal currents.

The exposed Tertiary strata on shore are roughly parallel to the shoreline, and their continuation is evident in the contour chart, and in Figures 3 and 4. Five distinct ridges stand above the submarine terrace in the survey area. In the eastern portion of the site survey area, the ridges maintain a distinctive ridge characteristic. In the central portion, the ancient erosionary feature that is the arroyo has removed any evidence of the ridges. In the western portion of the site survey area, the dip of the ridge features beneath the deposits of the submarine terrace has left only the prominences standing above the terrace level. These appear as isolated features. However, their relationship to the ridges is evident in Figure 4.

A glance at the depth contour sheet indicates that without the removal of any submarine obstacles, a channel 200 - 250 feet wide can be used through which the YFU may safely approach the beach without regard for the tidal level. Since the YFU is 139 feet long, there is no room for turnaround, and the YFU must back out of the beach landing. The distance for backing out is about 500 feet, at which point the useable channel width is 400 feet. A dog leg in the channel is encountered 800 feet out from shore. Unconstrained maneuvering room is not available until the vessel is some 1500 feet from the beach. This approach to the beach, however, can be marked with staves driven into the bottom features, or with range markers ashore, and therefore can be considered a safe approach. A rigorous adherence to an approved approach procedure will be necessary, probably requiring use of the stern anchor, or a fixed mooring for stern restraint. The actual approach channel is discussed in more detail in Section 6.1 of the bottom profiles.

5.4 Description of Bottom Features

The seven rocky bottom features identified by flags during the bathymetric survey of the YFU landing site, were visually inspected by Navy divers. The following description is repeated exactly as presented by the original survey personnel and recorded on site.

"Seven locations were visually inspected. Each location is identified by a position number, shown on Figure 4. Generally at each location, the features were similar. The rock ridges consist of layers of grooved and fluted sandstone-type rock with a thin bedding of a soft siltstone substance. The layers of rock forming the ridge in all cases tilted toward the seafloor and always in a seaward direction. A scouring action by the sea appears to have removed the softer layers of rock exposing an irregular rugged ridge as shown in the diver sketch of Figure 11. Nevertheless, the seaward side of the ridges was relatively smooth compared to the landward sides." (A photograph of the landward side of one of the ridges, taken during the earlier Civil Engineering Laboratory survey, is shown in Figure 12. The irregularity, with numerous holes due to erosion and to molluscs is evident.)

"The general direction of the ridges run parallel to the shoreline, with widths varying between 20 and 40 feet. A rod and line was used for measuring the depths and dimensions of the rock ridges. The seabed was also prodded periodically to verify the type of bottom. The exposed ends of the ridges display many layers of the rock formation. Seaweed was abundant throughout the survey area and close investigation at the ridges revealed weeds rooted to the rock and crevices between the harder rock layers. All ridges investigated were partially covered with seaweed. The ridges are usually surrounded by a smooth layer of soft sand." A brief account of conditions found at each location is outlined below:

5.4.1 Position 1

"At this location, a rocky sandstone ridge extends for 70 feet in a direction parallel to the shoreline, the width of the ridge estimated to be 20 feet. Approaching the rock formation from seaward, the depth decreases progressively from a sandy seabed at 15 feet to an irregular rocky ridge. The depth of the higher points of the ridge vary between seven and nine feet. Proceeding across the ridge, towards the shore, patches of seaweed are rooted to crevices and to the upper rock layers. On the inshore side of the ridge, the depth increases abruptly to 15 feet. In some areas, the upper portions of the ridge appear to overhang lower layers of rock. The formation of the ridge appears to be influenced by sea action differently on the inshore side of the ridge than on the seaward side."

5.4.2 Position 2

"The rock ridge at this location extends 130 feet in an east-west direction and is about 45 feet across the widest area. Approaching the

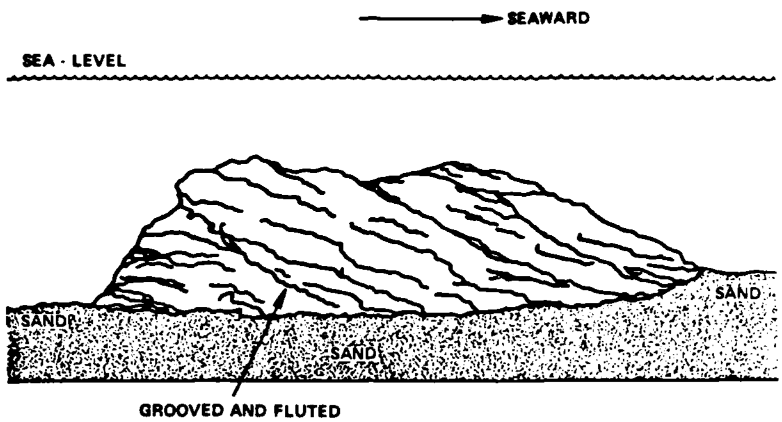


Figure 11. Diver Sketch Of A Rocky Feature (Seaward Side)

Figure 12. Photograph Of A Rocky Feature (Landward Side)

ridge from seaward, the rock formation rises rapidly from a depth of 19 feet to a rugged ridge varying from 7 to 9 feet deep. The water depth increases to 16 feet on the inshore side of the ridge. A length of steel anchor chain was observed on top of the ridge. This may be part of the missing channel buoy mooring."

5.4.3 Position 3

"The position of this rock ridge is so close to the centerline of the present navigation channel that it must be considered a serious obstruction to vessels approaching the beach. The ridge consists of a 60-foot long, 25-foot wide mass of rugged bedrock running parallel to the shoreline. It extends to within 70 feet of the centerline of the navigation channel. Approaching the ridge from seaward, the rock formation emerges from a sandy bottom at a 13-foot depth to a rugged ridge topped by two mounds of hard rock where the depth is only 2 to 3 feet. The depth on the inshore side of the rock formation increases to 14 feet."

5.4.4 Position 4

"A rock ridge located at this position extends 175 feet in a direction parallel to the shoreline. It is approximately 25 feet wide. Approaching the ridge from seaward, the water depth decreases progressively from a sandy bottom at 17 feet to a depth of 6 feet at the top of the ridge. Thick weeds, rooted to surface rock and crevices, cover a very large area of the ridge. The inshore side of the ridge drops to a depth of 16 feet and a loose sandy bottom. Some pockets and indents on the inshore side of the ridge appear to have been scoured out by sea action which has created an overhang of some top portions of the ridge over the lower rock formation."

5.4.5 Positions 5 and 6

"During the underwater inspection of position 5, it was confirmed that positions 5 and 6 were actually the same rock ridge. It extends approximately 400 feet. The length of the rock formation appears to parallel the shoreline with very little variation, the distance across the top of the ridge varies between 30 and 45 feet. Approaching the ridge from seaward, the bottom changes from a soft sandy substance, at a depth of 16 to 18 feet, to a ridge of rock where the water depth varies from 4 to 6 feet throughout the length of the ridge. The rock formation is partially overgrown with seaweed. The inshore side of the ridge slopes quickly downward toward the beach to depths between 12 and 16 feet."

5.4.6 Position 7

"At this location, a rock ridge extends for approximately 150 feet in a direction parallel to the shoreline. The rock formation is between 10 and 30 feet wide across the top, forming the ridge. The rock is partially overgrown with seaweed. Approaching the ridge from seaward, the rock formation rises from an 11 to 13 foot deep sandy bottom and slopes upward to a ridge 3 to 4 feet below the water surface. The 3 to 4 foot water depth extends for the greater portion of the ridge. The inshore side of the rock formation descends to a sandy bottom at a depth of 8 feet."

5.4.7 The Inner Ridge

Diver observation of the inner ridge on the western portion of the site survey area was not undertaken on this occasion since this work had already been accomplished in September 1977 by Civil Engineering Laboratory and PMTC staff divers. The following report of their findings is presented verbatim from Wadsworth (1977). The diver route was from a point 100 yards offshore in towards the beach.

"The divers swam into and over a reef about 50 yards off the beach with a 2-ft cover of water; it would be uncovered at LLW. Shoaling effect of waves make it evident. Bearing of the reef was on course 210° to the shack on beach. As the divers swam ashore, the bottom was weed-covered sand with a 1' - 2' abrupt rise to the beach sand at the surf line. Rock formations on either side of channel are low and not evident above the beach terrace, which runs back to steep cliffs about another 1/4 mile inland. Rock exposed is silt or sandstone. As the direction of waves and wind make the port side of channel the real hazard, the divers swim out with 5' and 6' water covering. Rock had scratch marks in it, possibly from supply craft. Another reef was found 10 yards further on at some depth. Rest of channel center looked good, thick weed on rock and sand bottom with occasional boulders but 10' - 20' of water. Tide at the time of the dive was about ± 3 feet. As the YFU draft astern is 6 - 7 feet when loaded, the reefs found would be a hazard, as the boats could only clear it at high tide."

6.0 SELECTED BOTTOM PROFILES

The locations of six selected bottom profiles over the site survey area are shown in Figure 13. The bottom profiles are keyed to position lines which are identified by convenient latitude and longitude points, as indicated in both the chart of Figure 13 and in the individual profiles. The horizontal scale of the profiles matches the scale of the fold-out charts at the end of the report and can be overlaid directly. Vertical exaggeration is 20:1.

6.1 Profile A - A' - A": The Recommended Approach Channel

The most important profile, A - A' - A", shown in Figure 14, is that taken down the center of the recommended approach channel. This is not a straight line profile. It has a change of direction about 800 feet from shore. The recommended channel follows this same offset in direction in order to avoid submerged obstacles. The profile shows the channel to be clear of submerged obstacles which might interfere with a YFU hull having a loaded draft of 7 feet. Overlaying the fold-out depth contour chart and the A - A' - A" profile permits observation of the available channel width clear of obstruction. Near shore, the channel is only 200 feet wide. At a distance of 400 feet from shore, the channel widens becoming a useable 400 foot width at 500 feet from shore. At 1000 feet from shore, the channel width is also 1000 feet. Beyond 1500 feet from shore, no obstructions reach high enough into the water column to restrict the YFU operations.

6.2 Profile A - A': YFU at the Beach

A bottom profile over the A - A' section without vertical exaggeration and with a loaded YFU at the beach is shown in Figure 15. The profile is taken at MLLW (mean lower low water), and will vary somewhat at higher waters. Notable, however, is the fact that the bottom slope is too shallow to permit dry landing of cargo when the bow ramp of the YFU is down. The YFU bow ramp must lie on a 1:10 slope (about 6.5 degrees) to permit dry landing without the redistribution of sand around the ramp. The profile shows 10 feet of the YFU hull aground. The rest of the hull clears the bottom only slightly, reaching a 2 foot clearance at the stern. This is not detrimental to the YFU operation, but may be limiting when the surf is rough. At a distance of approximately 320 feet from shore, the rise to 8 feet minimum depth is evident. The resolution of the bathymetry at this scale is insufficient to indicate the profile with precision. However, the presence of the rise on or near the axis of the channel is restrictive at water levels corresponding to the extremes of low water.

6.3 Profile B - B': A Ridge Section

A bottom profile in the eastern area of the survey site, taken along line B - B', is shown in Figure 16. This line transects several of the submerged ridges, the very shallow one near shore being prominent. Ridges

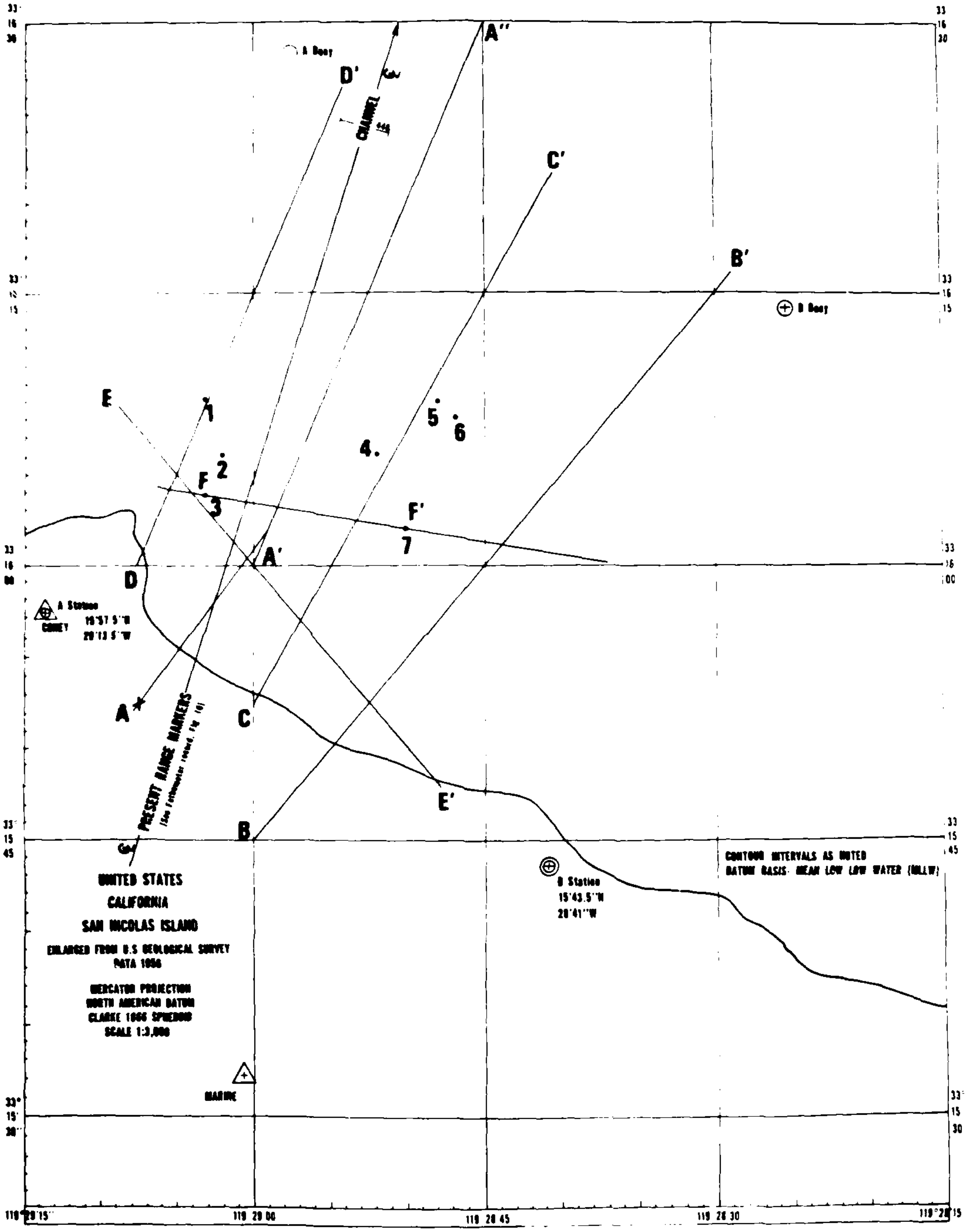
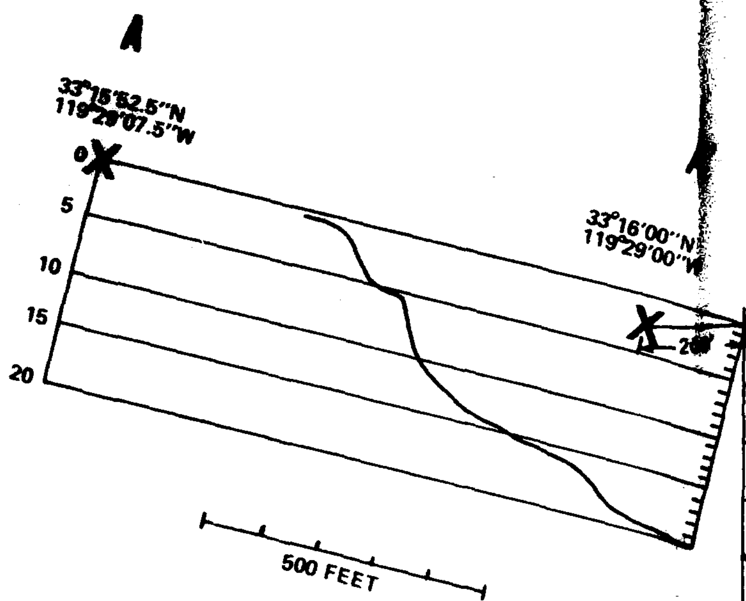
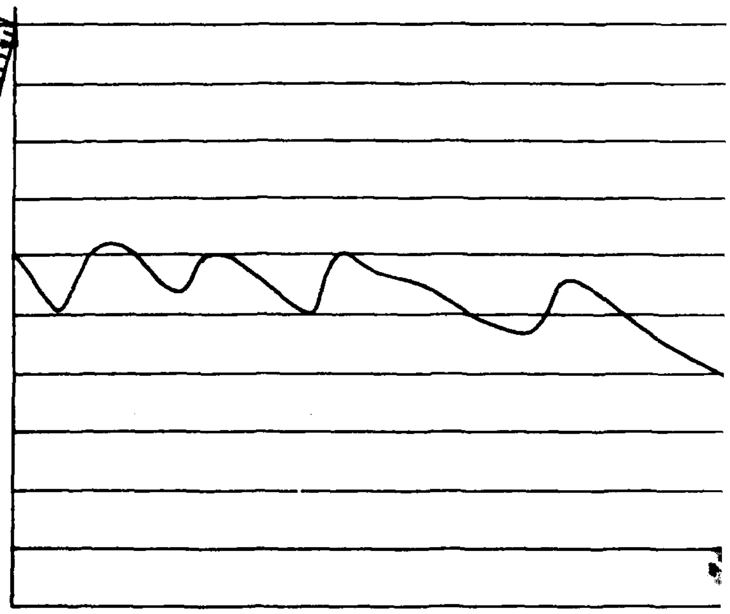


Figure 13. Chart Showing Locations Of The Bottom Profiles

CHANNEL PR





VERTICAL EXAGGERATION (20:1)

L

EL PROFILE

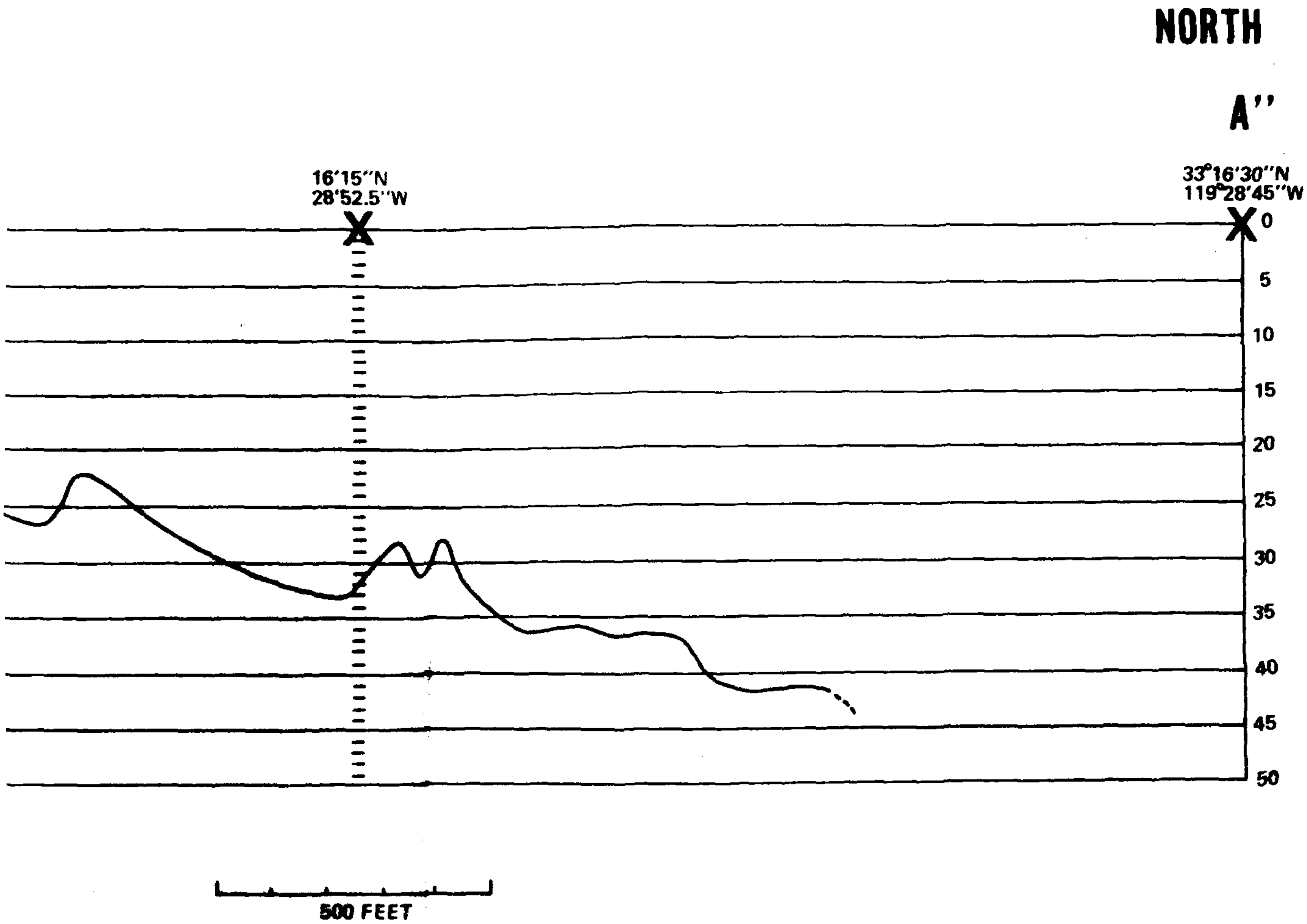
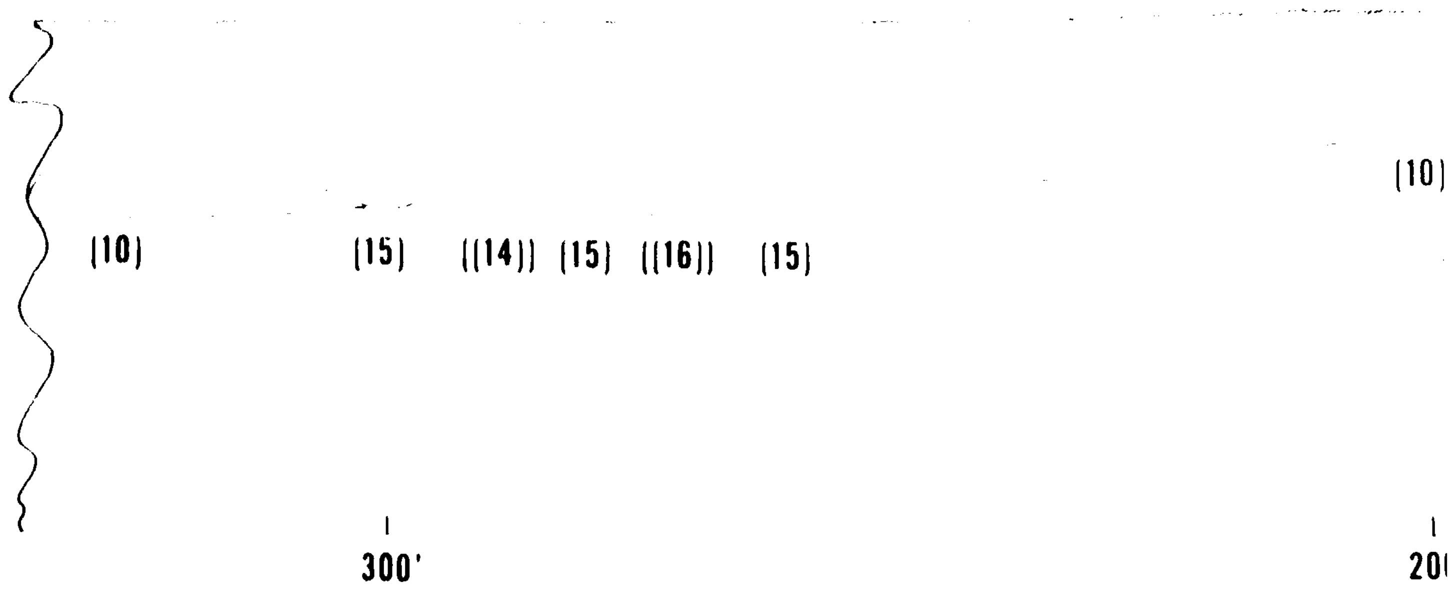
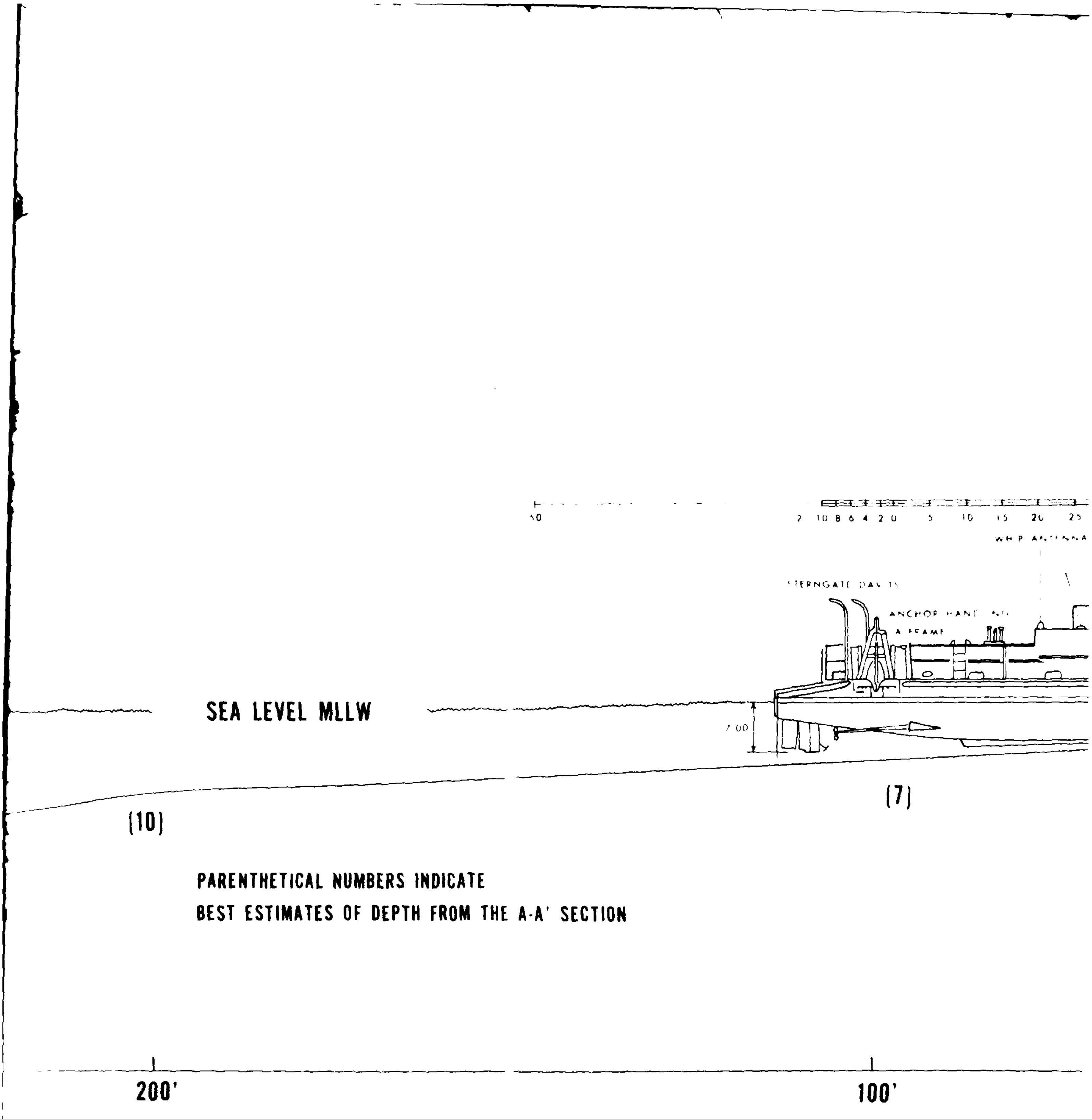


Figure 14. Bottom Profile, A - A'

(Center of Channel)


(10)
(10)
(15)
((14))
(15)
((16))
(15)
300'
20


SEA LEVEL MLLW
7.00
(7)
(10)
PARENTHETICAL NUMBERS INDICATE
BEST ESTIMATES OF DEPTH FROM THE A-A' SECTION
200'
100'

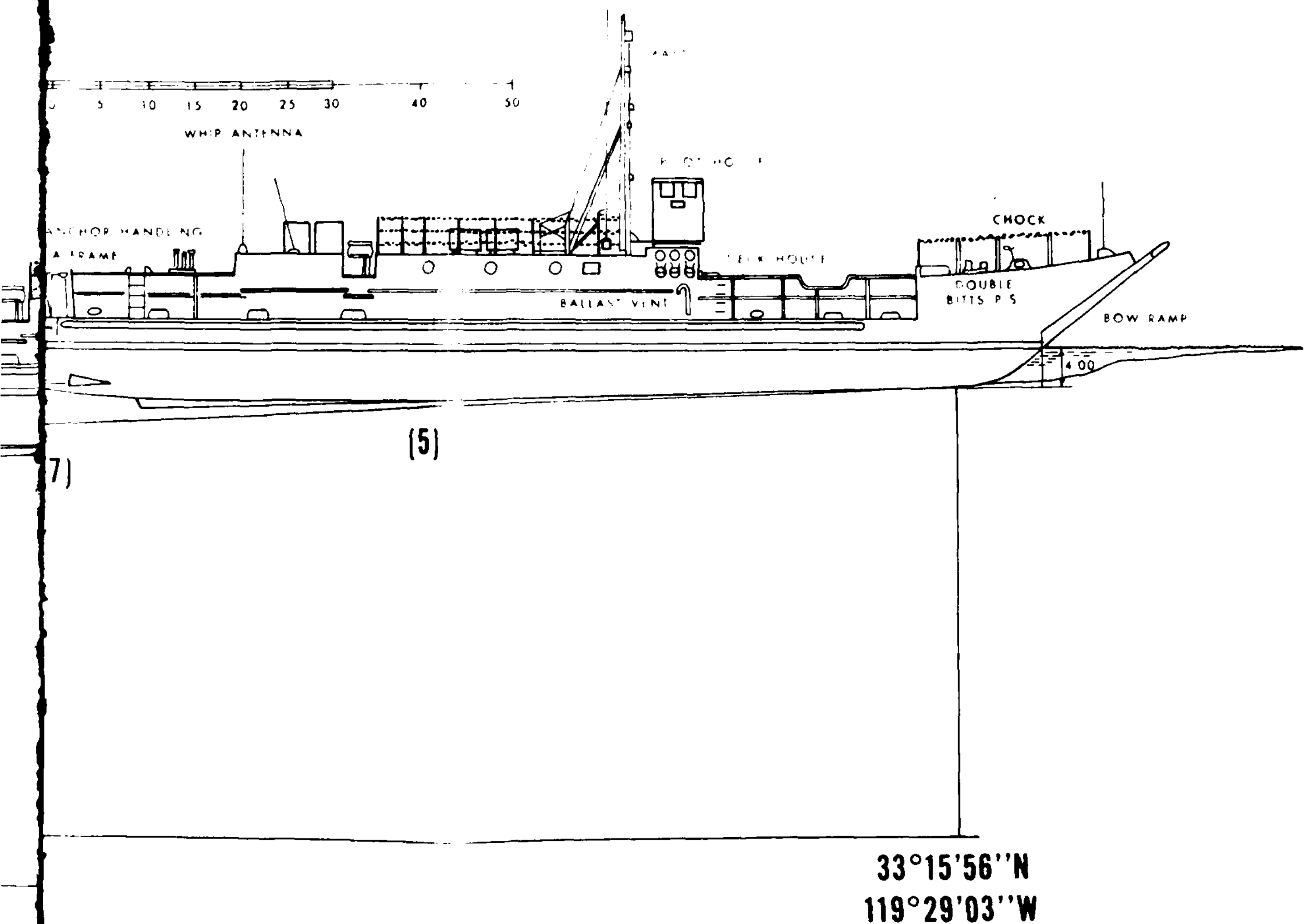
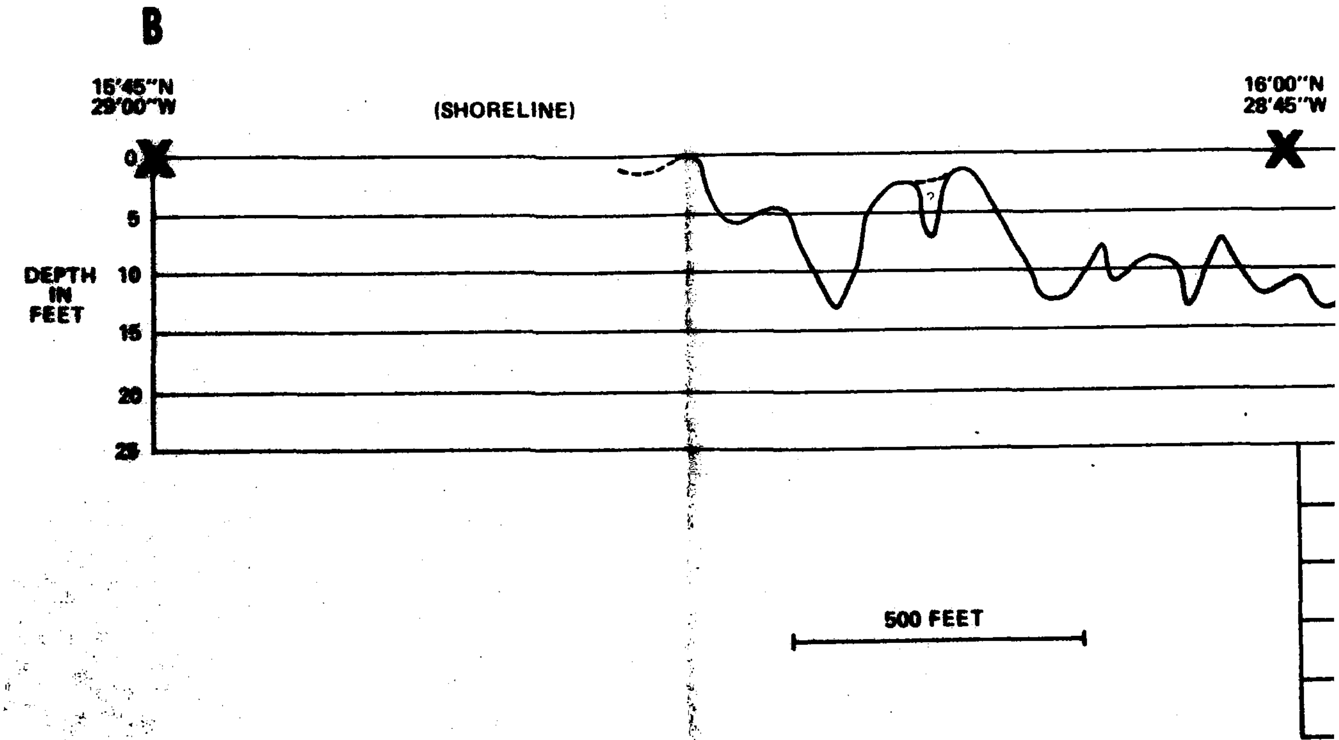


Figure 15. YFU (LCU-1610) Profile, Loaded Configuration, on A-A' Section

EASTERN AREA - A



- ACROSS RIDGES

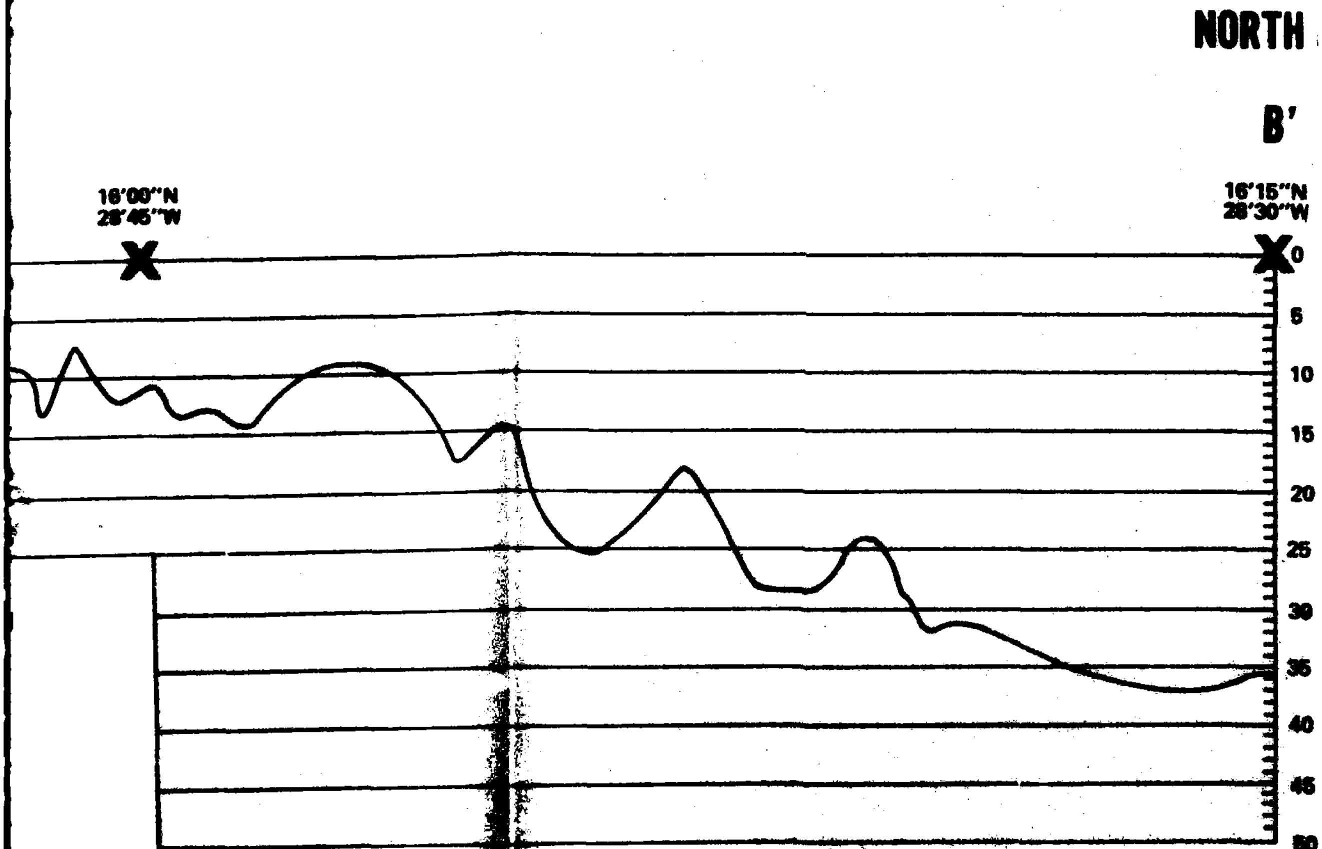


Figure 16. Bottom Profile, B - B'
(Eastern Site Area)

about 1000 feet from shore also interfere with the YFU at low water. In general, this entire eastern sector of the survey area prohibits the YFU operation due to the presence of the ridges.

6.4 Profile C - C': A Ridge Section

The profile (Figure 17) transects the ridges in the eastern sector of the survey area, along a line closer to the recommended channel. With the exception of the one near shore prominence, which limits the width of the channel near shore, the profile indicates that the bottom is relatively clear of obstruction. This profile crosses the deeper portions of the ridges of Position 4 and Position 5, which have minimum depths less than 6 feet at MLLW. Hence the profile indication is that one can expect sufficient water depth for the YFU on the side towards the channel but should be suspect on the other side (towards profile B - B').

6.5 Profile D - D': A Ridge Section

On the western side of the recommended channel, the submerged obstructions in the vicinities of Positions 2 and 3 lie close to the channel axis and restrict the channel width. A typical section from the survey area still further west is shown in the bottom profile of Figure 18 along line D - D'. This profile intersects Position 1, about 1000 feet from shore. This western area is also a prohibited operational area due to the shallow depth of the bottom features.

6.6 Profile E - E': A Cross Section

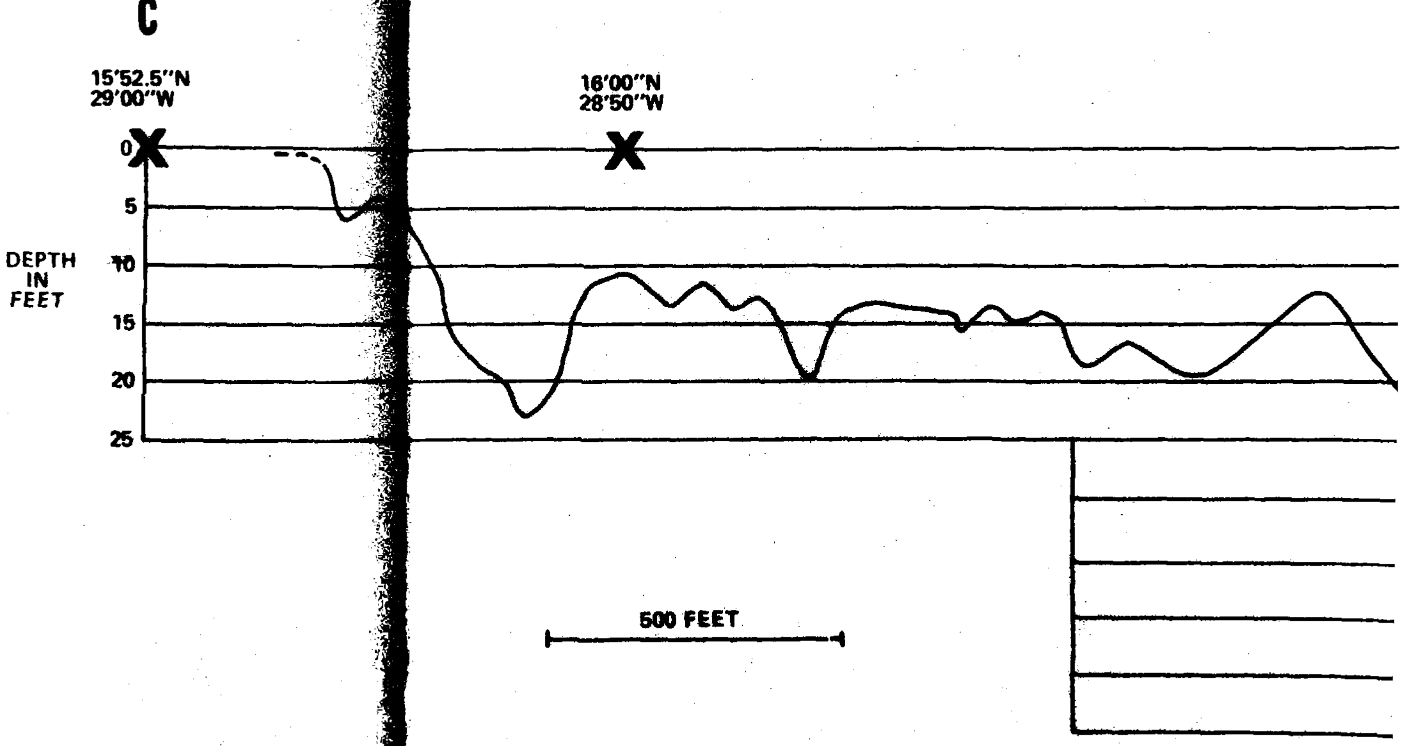
Looking across the site survey area in the vicinity of the shore, the bottom profile along line E - E' cuts the channel at nearly right angles some 700 feet from the YFU landing point, and originates and terminates in shoaling water. The channel width at this point is roughly 700 feet, with the western area obstructions closest to the surface. At the higher tidal levels, the eastern area rises are sufficiently covered with water to permit an effective channel width of 1000 feet (The profile indicates a 1400 foot width, but this is restricted further seaward). Profile E - E' is shown in Figure 19.

6.7 Profile F - F': A Cross Section

The obstructions identified by the divers in Positions 3 and 7 lie on opposite sides of the recommended channel. A profile of the bottom through these obstructions is shown in Figure 20, line F - F'. This profile is almost perpendicular to the channel axis about 900 feet from shore and indicates a channel width of 800 feet.

In general, the bottom profiles in conjunction with the depth contour chart indicate that the prospective YFU operating channel is very restricted in the area within 1500 feet of shore, and particularly so at the lower tidal levels.

ENTRAL AREA - ACROS



EA - ACROS RIDGES

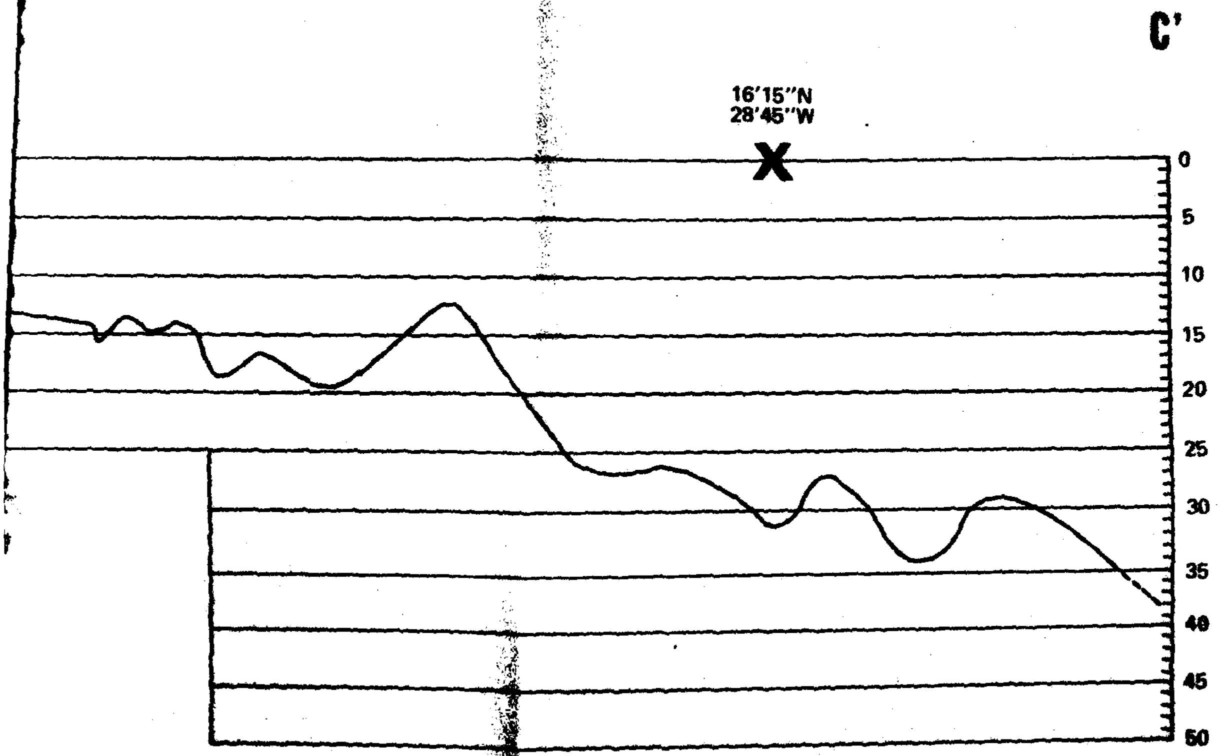
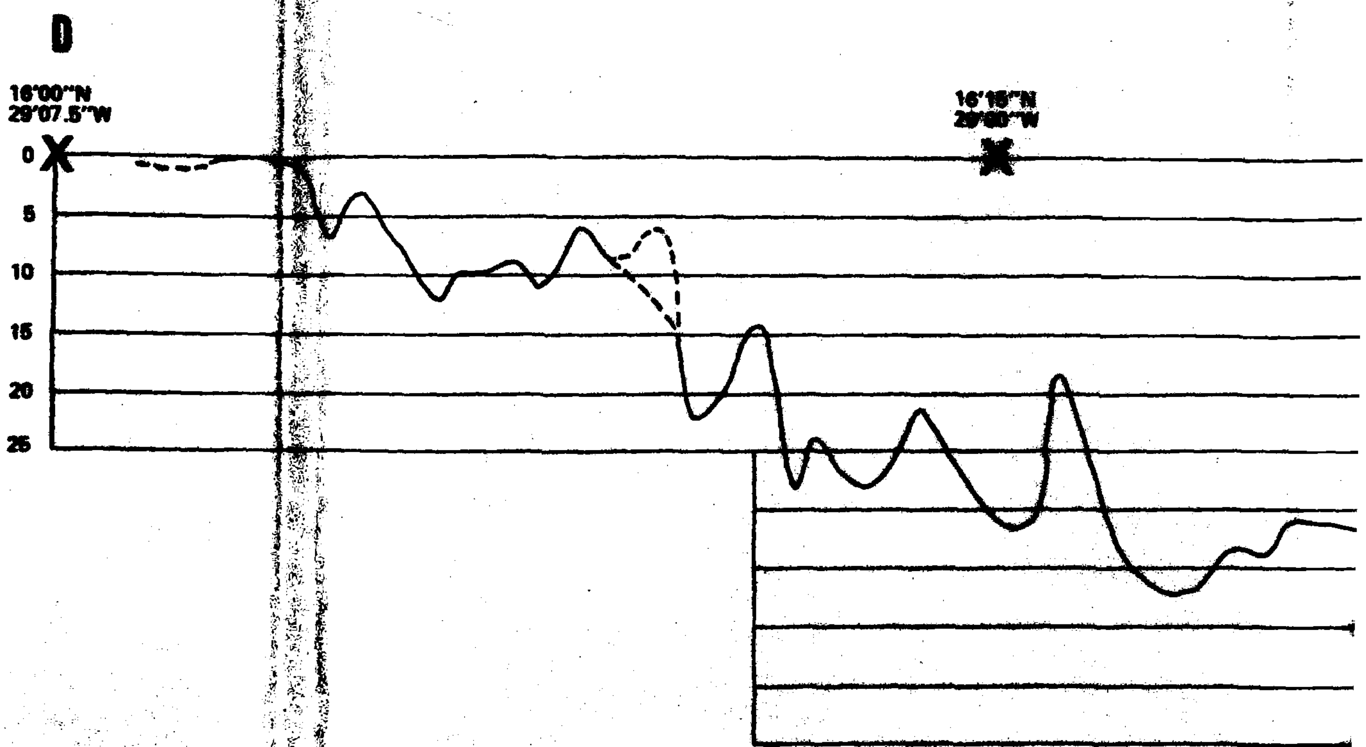


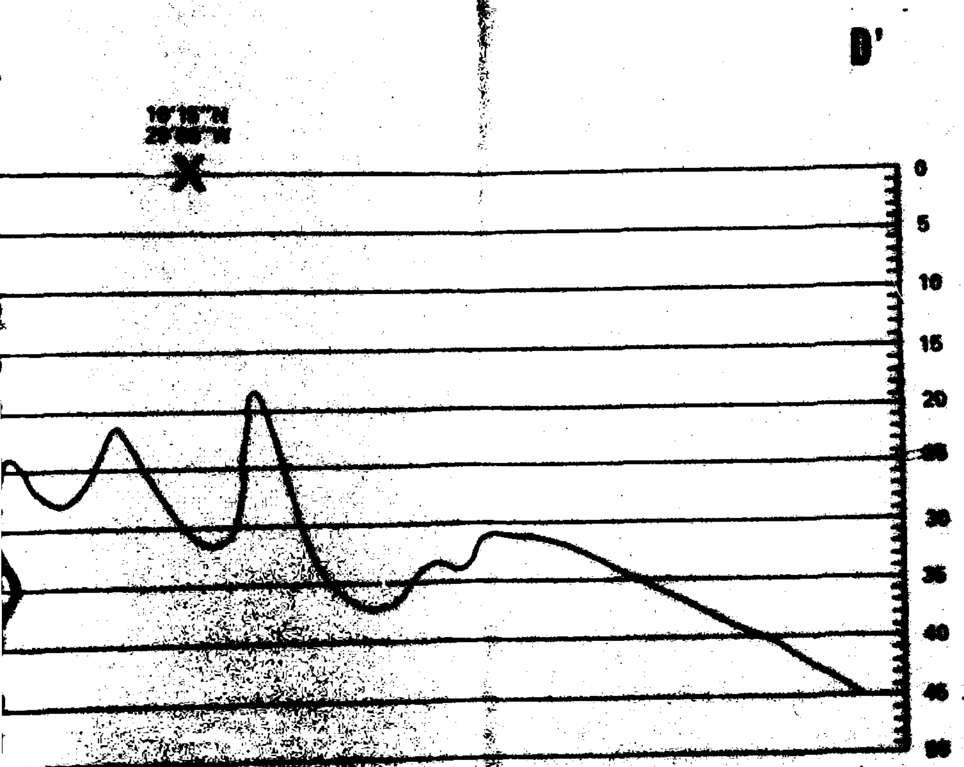
Figure 17. Bottom Profile, C - C'

(Transect of Ridges)

ESTERN AREA - OFF POI

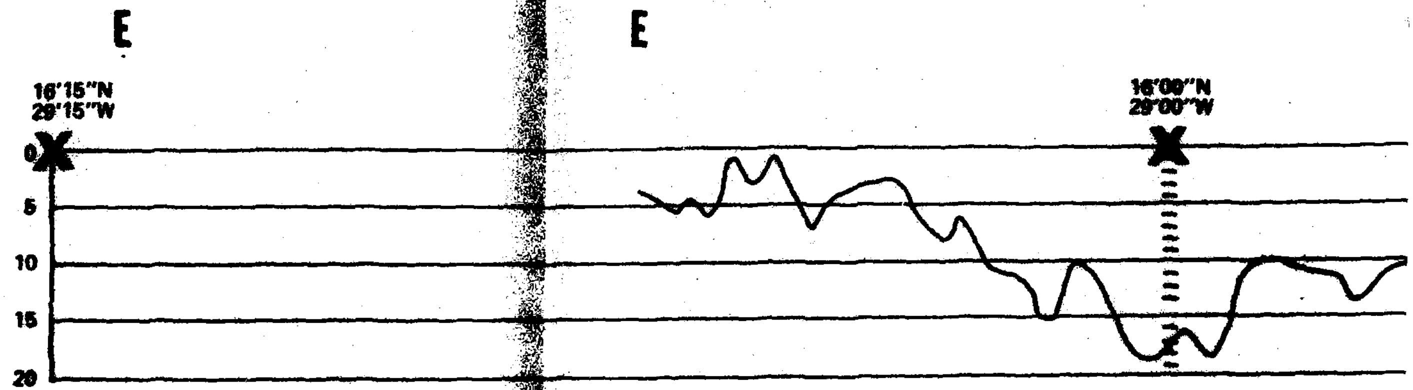


EA - OFF POINT



[illegible] D - D' ([illegible])

NEARSHORE PR(



VERTICAL EXAGGERATION (20:

500 FEET

HORE PROFILE

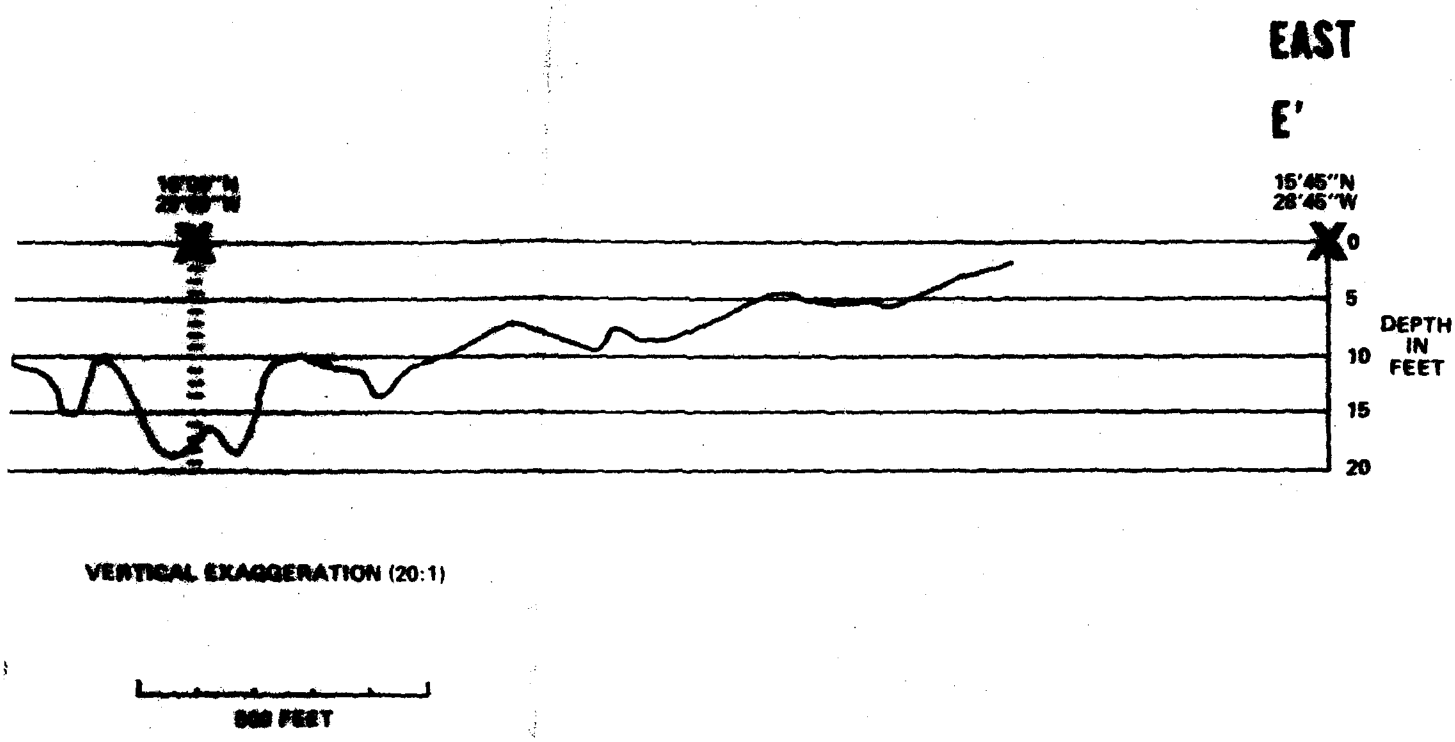
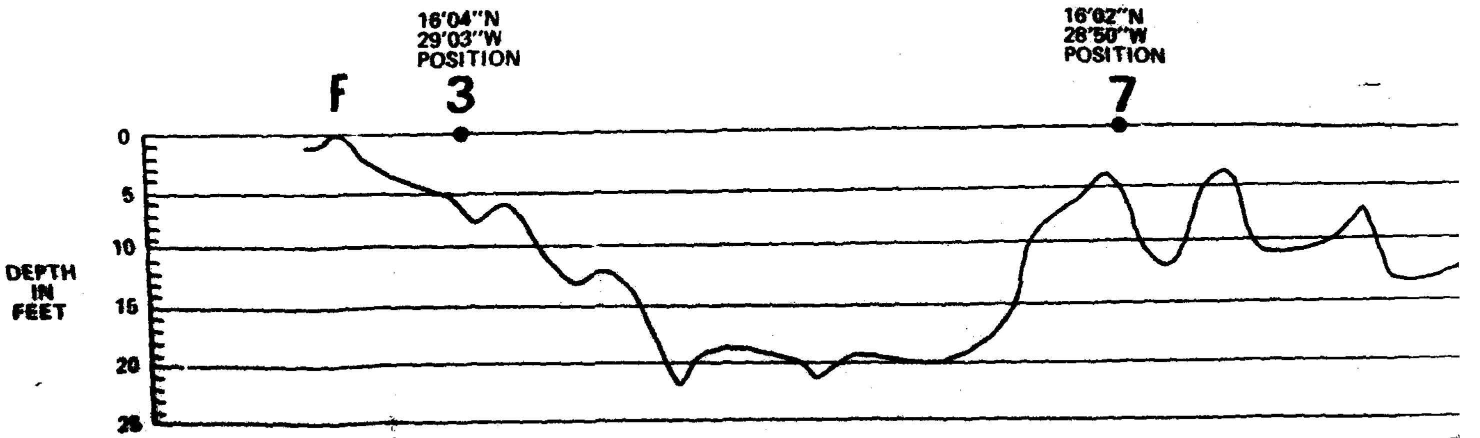


Figure 19. Bottom Profile, E - E'

(Approximate 5' Contours Parallel to Shore)

TRANSECT OVER "3" & "7" ACROS



& "7" ACROSS CHANNEL

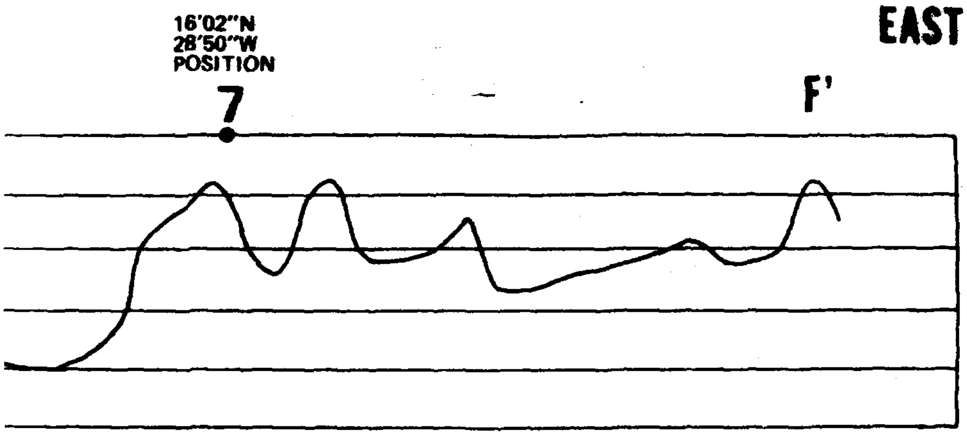


Figure 20. Bottom Profile, F - F'
(Transect, Position 3 - Position 7)

7.0 PHOTOGRAPHS OF THE LANDING SITE AREA

The geology and the layout of the YFU landing site area can be seen in the following photographs. Since these items have been fully described in the earlier sections of this report, the photographs only add an ease of visualization. (Subsequent copies of this report without color renditions of the photographs may lose the detail, but do not detract from the technical content.)

7.1 San Nicolas Island Landform

The San Nicolas Island landform as seen from the sea at the YFU landing beach approach is shown in the photograph of Figure 21. The major portion of the bathymetric survey area is covered by the foreground of the picture, with notable surface evidence of the extensive kelp beds. The marine terrace, which is the beach platform, is distinctly visible, as is the marine terrace which is now the upper mesa. Many arroyos indent the landform along the coast. The principal arroyo of interest in this survey is located almost exactly in the center of the picture. The beach shack, which stands to the left of the YFU landing, is visible just left of center in the picture (It has a flat roof, in contrast to the peaked roof of another structure also visible in the center of the picture). The arid nature of the climate is evident in the sparse vegetation and the absence of trees on the landform. The large sand dune in the right of the picture stands in front of the CONEY bench mark, and identifies the location of rock outcroppings (visible mostly by the breakers on them) in the water in front of the dune.

7.2 Rock Outcroppings

The rock outcroppings at the waterline are shown in more detail in the photograph of Figure 22, which also shows the beach shack at the left of the picture. The present YFU landings are made between the rock outcropping and the shack. The major characteristic of the outcropping is its dip to the right (northwest) and towards the sea, and its apparent differential erosion of the interbedded layers. This type of formation is similar to the underwater ridges found in the survey area and described earlier. (The small distortions are due to water spots on the camera lens.)

7.3 Survey Area Overview

A view of the site survey area from on top of the mesa is shown in the photograph of Figure 23. This picture was taken several months before the survey, and shows a considerable discoloration of the offshore water due to sand transport. This is one of the periodic onshore/offshore transports, the storm waves carrying the sand out, and in this instance, the calmer wave system returning the sand to the beach. The entire landform in the picture is that of the first marine terrace above the present water line, which is the beach platform. The flat-roofed beach shack once again identifies the YFU landing site, to the left of the shack in

Figure 21. Photograph Of Survey Site Landform From The Sea

Figure 22. Photograph Of Survey Site Rock Outcrop At The Water Line

Figure 23. Photograph Of Survey Site Beach *Platform* From The Mesa

this view. One of the range markers used to bring the YFU into the landing site is visible in the center of the picture. A large rock outcropping at the left of the picture is a continuation of the same strata as shown in the previous picture. It is the site of the CONEY benchmark and the ALPHA Mini-Ranger station for the site survey. A shallow arroyo cuts through the beach platform at the right of the picture, beyond which was located the BRAVO Mini-Ranger station.

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Brackett, R. L., Parisi, A. M. (1975), "Handheld Hydraulic Rock Drill for Divers", Civil Engineering Laboratory Tech. Report No. 824, August 1975.

Revelle, R., Shepard, F. P. (1939), "Sediments Off the California Coast", in Trask, P. D., "Recent Marine Sediments", Dover Publications, New York, 1963.

Rosenthal, J., Helvey, R. (1976), "Some Geophysical Considerations for Site "C" on Northern San Nicolas Island", Atmospheric Sciences Technical Note No. 47, Pacific Missile Test Center, CA.

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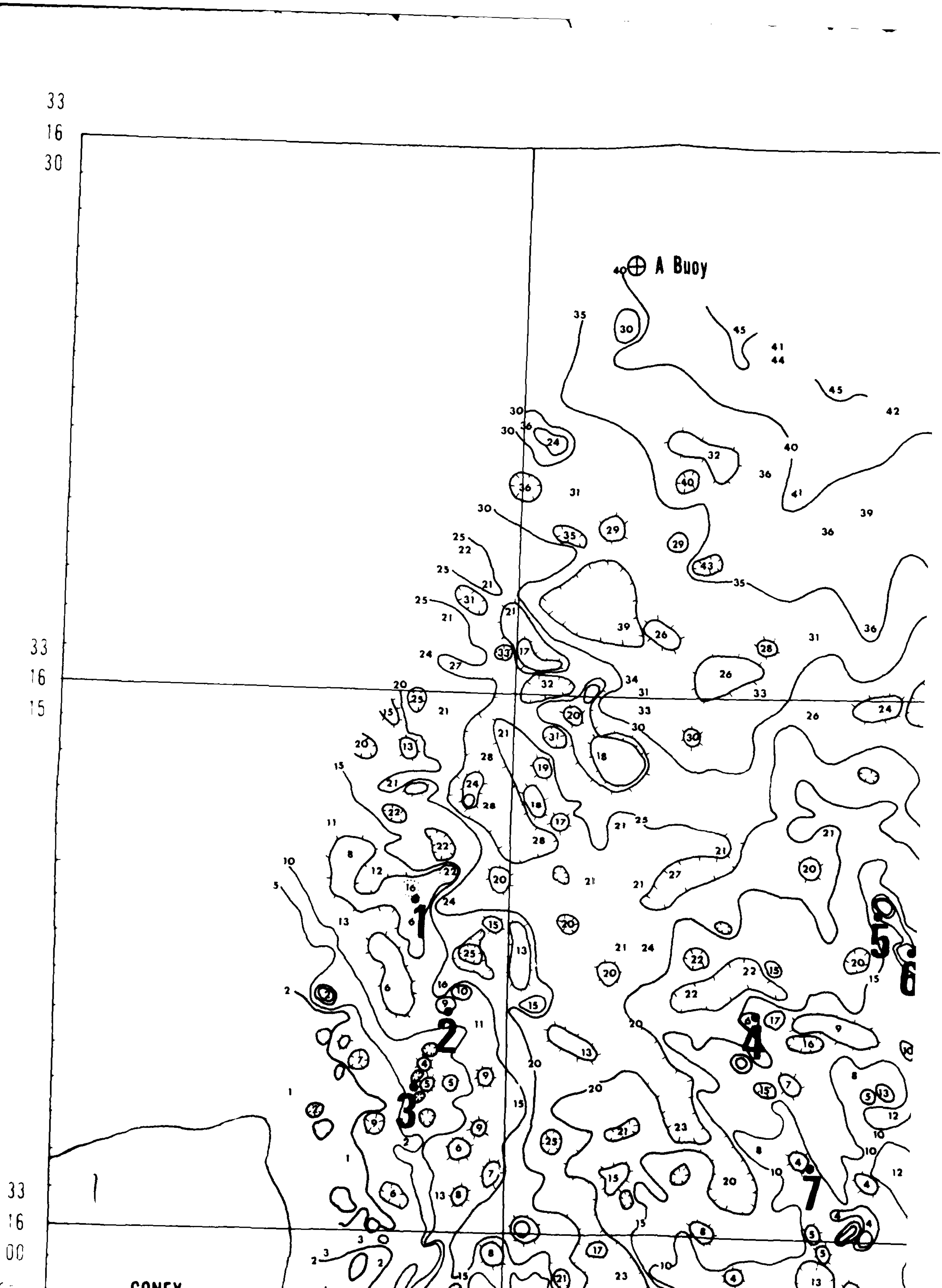
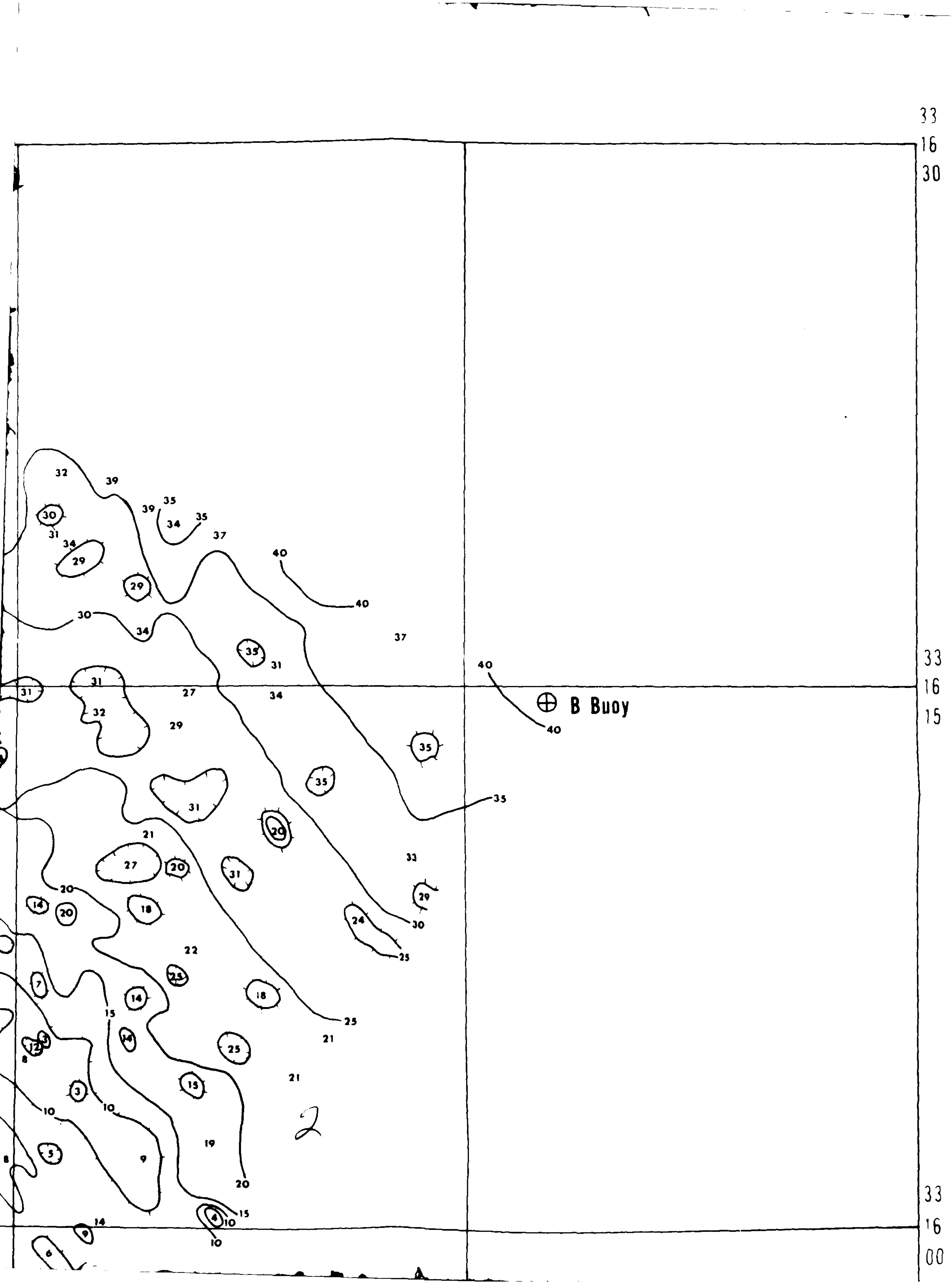
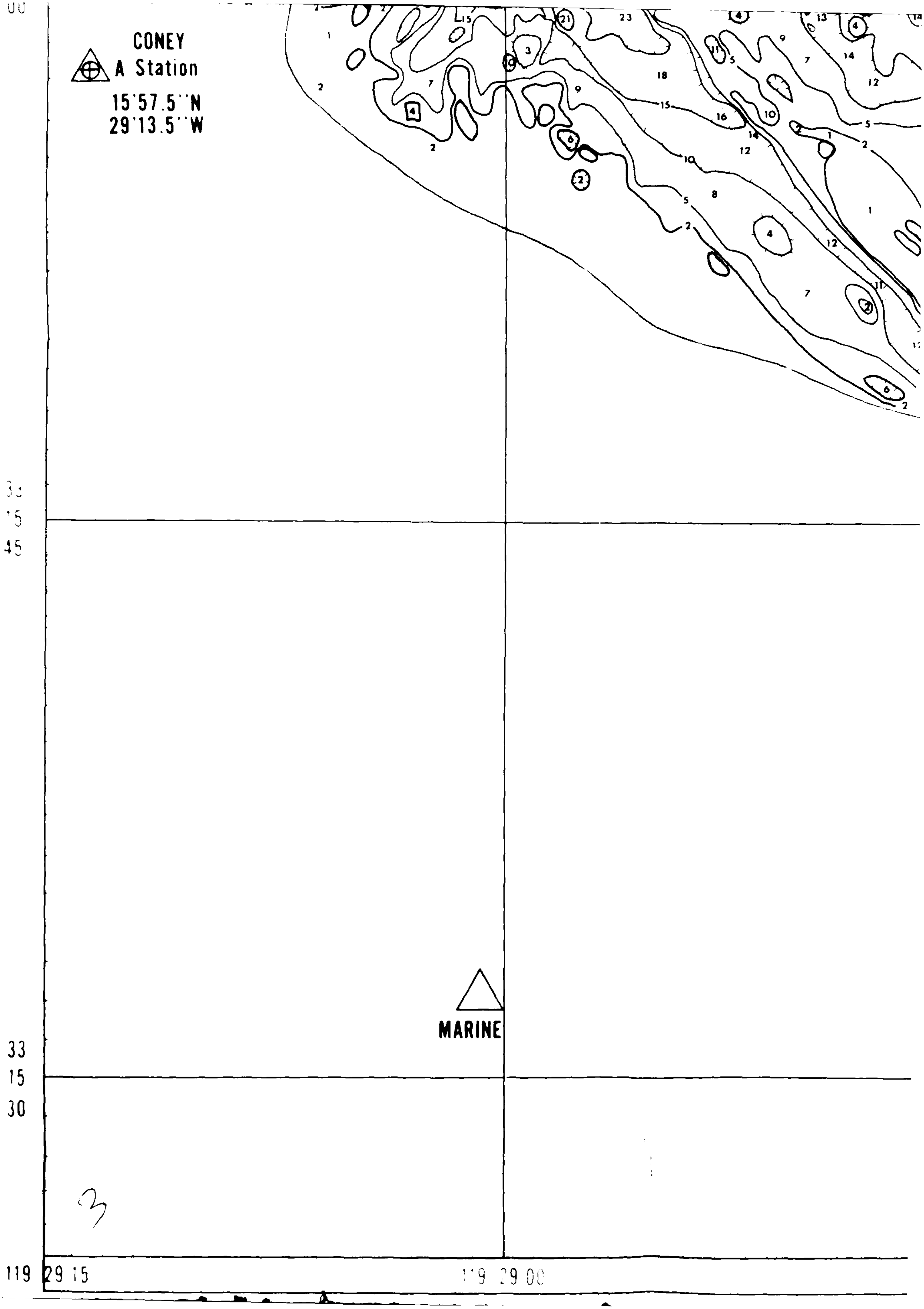
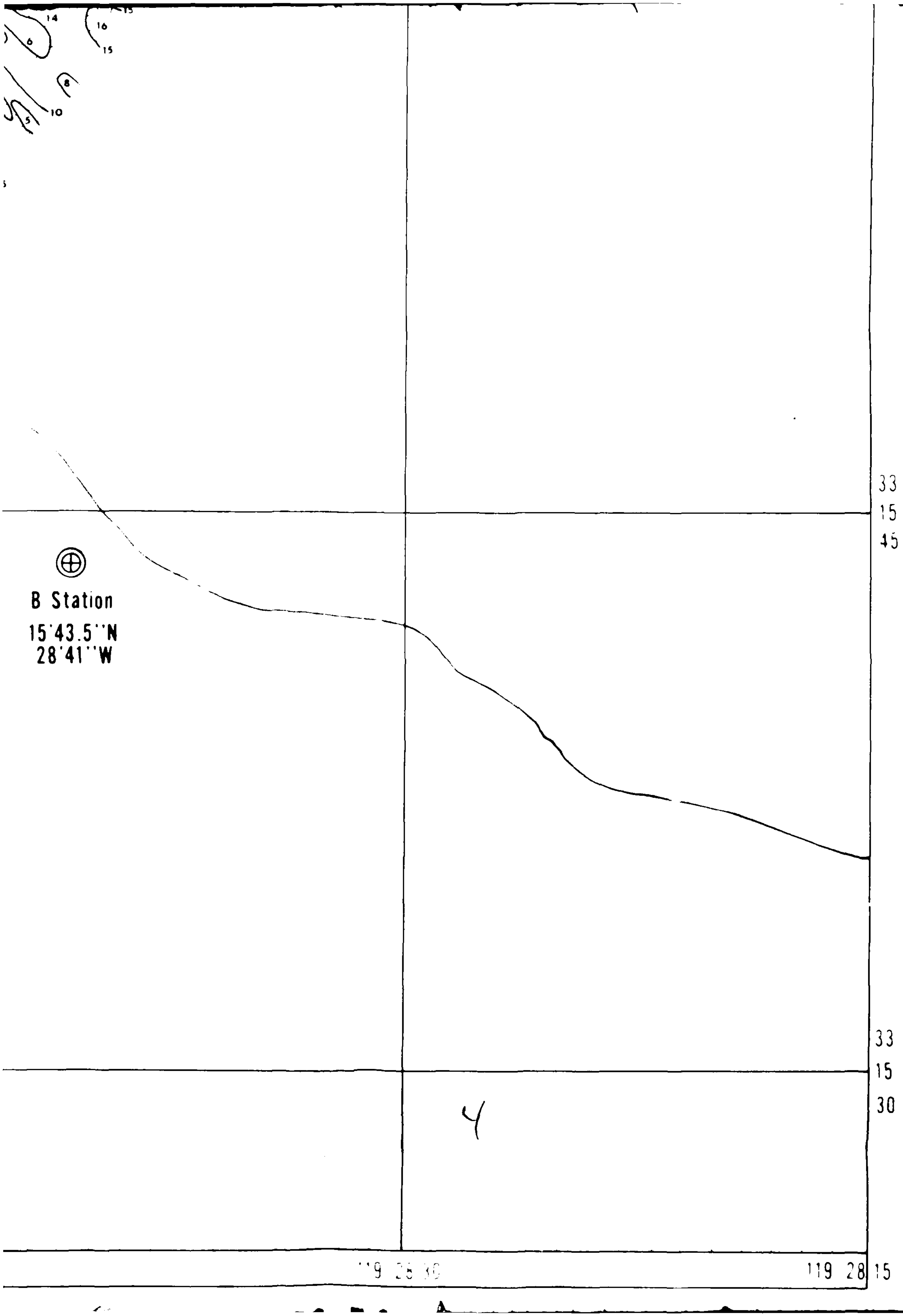
Wadsworth, J. (1977), "Preliminary Bottom Survey of Channel at Barge Landing Site, San Nicolas Island, CA", Civil Engineering Laboratory unpublished manuscript, 28 September 1977.

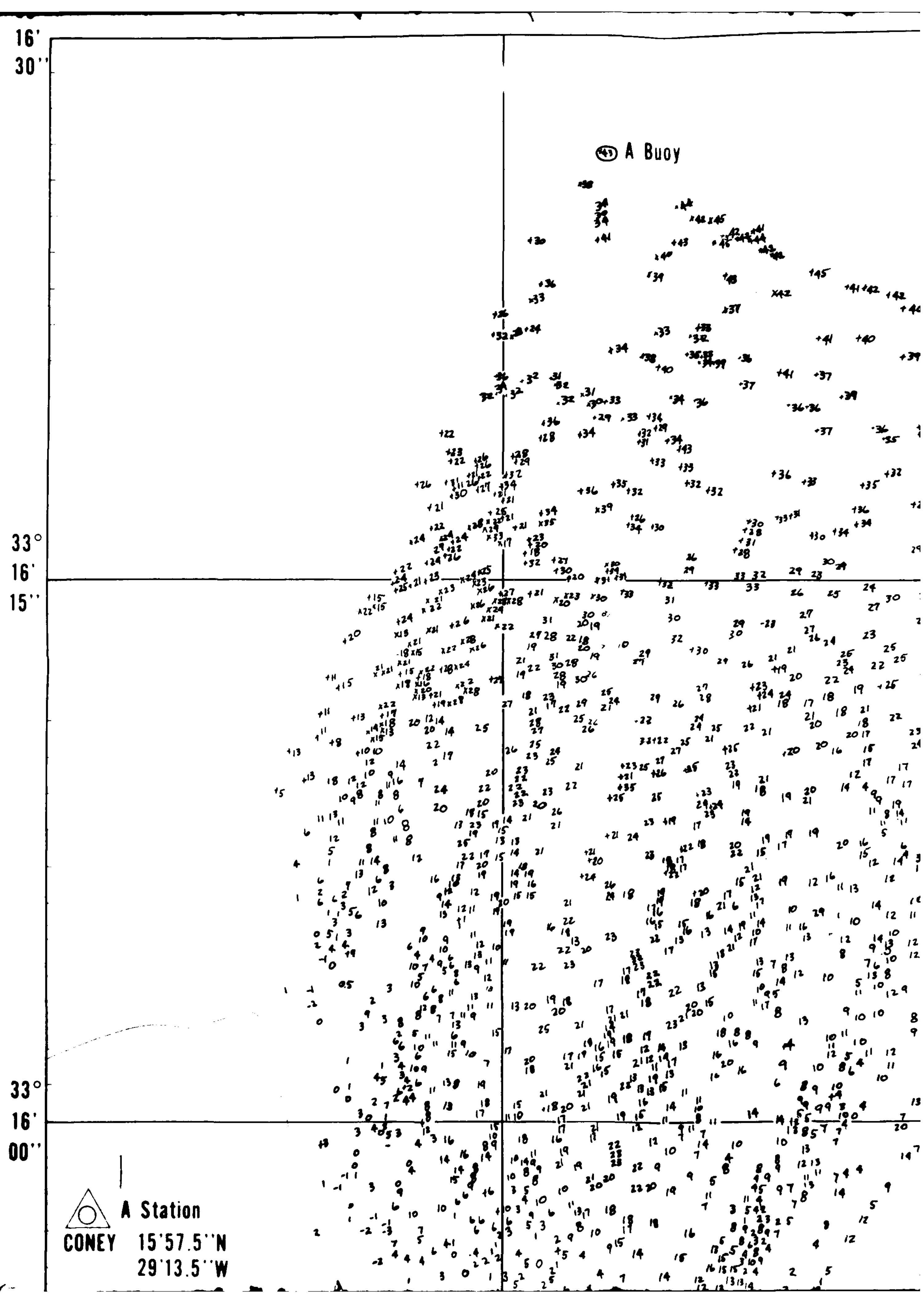


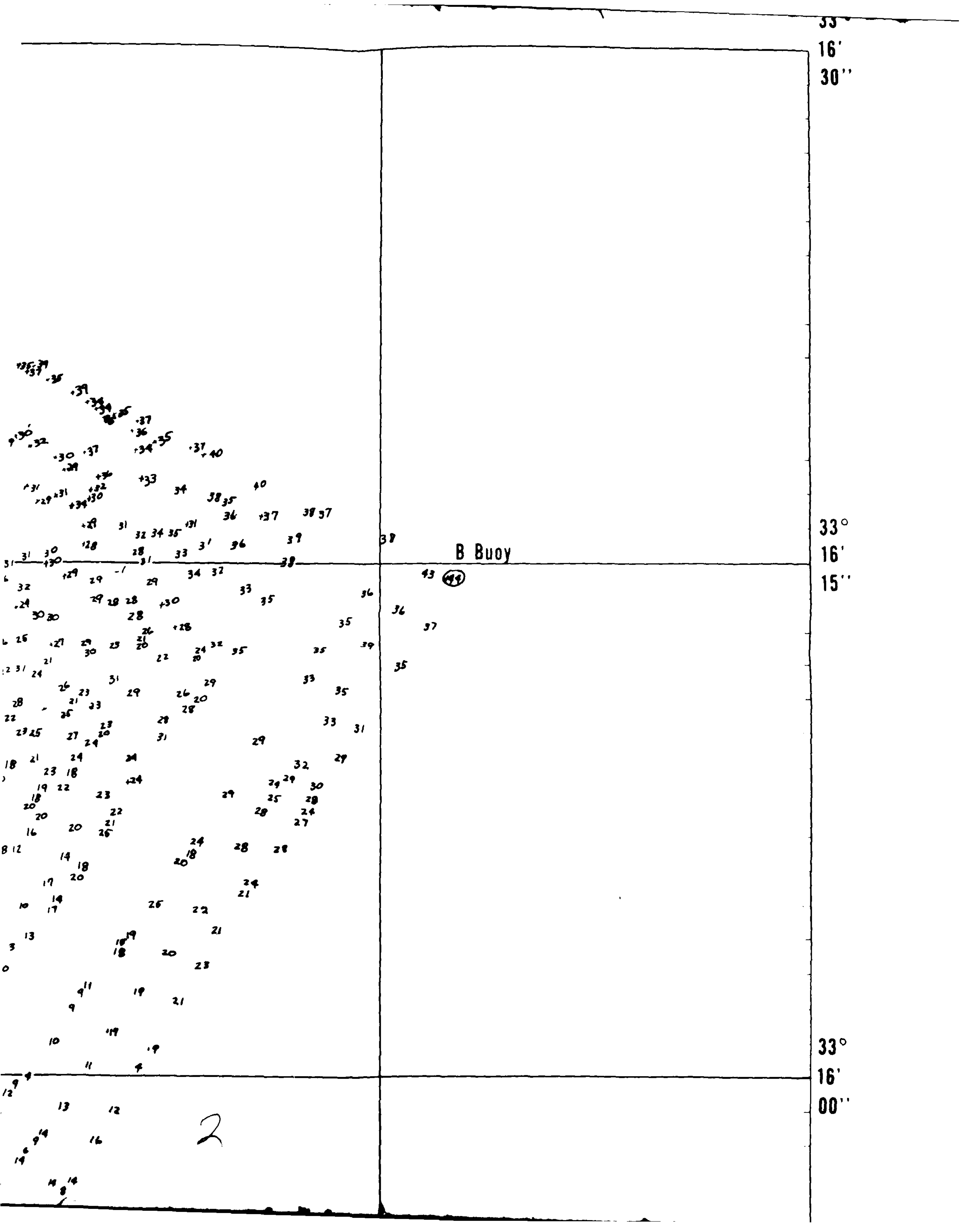
33 16 30
33 16 15
33 16 00
A Buoy
CONEY

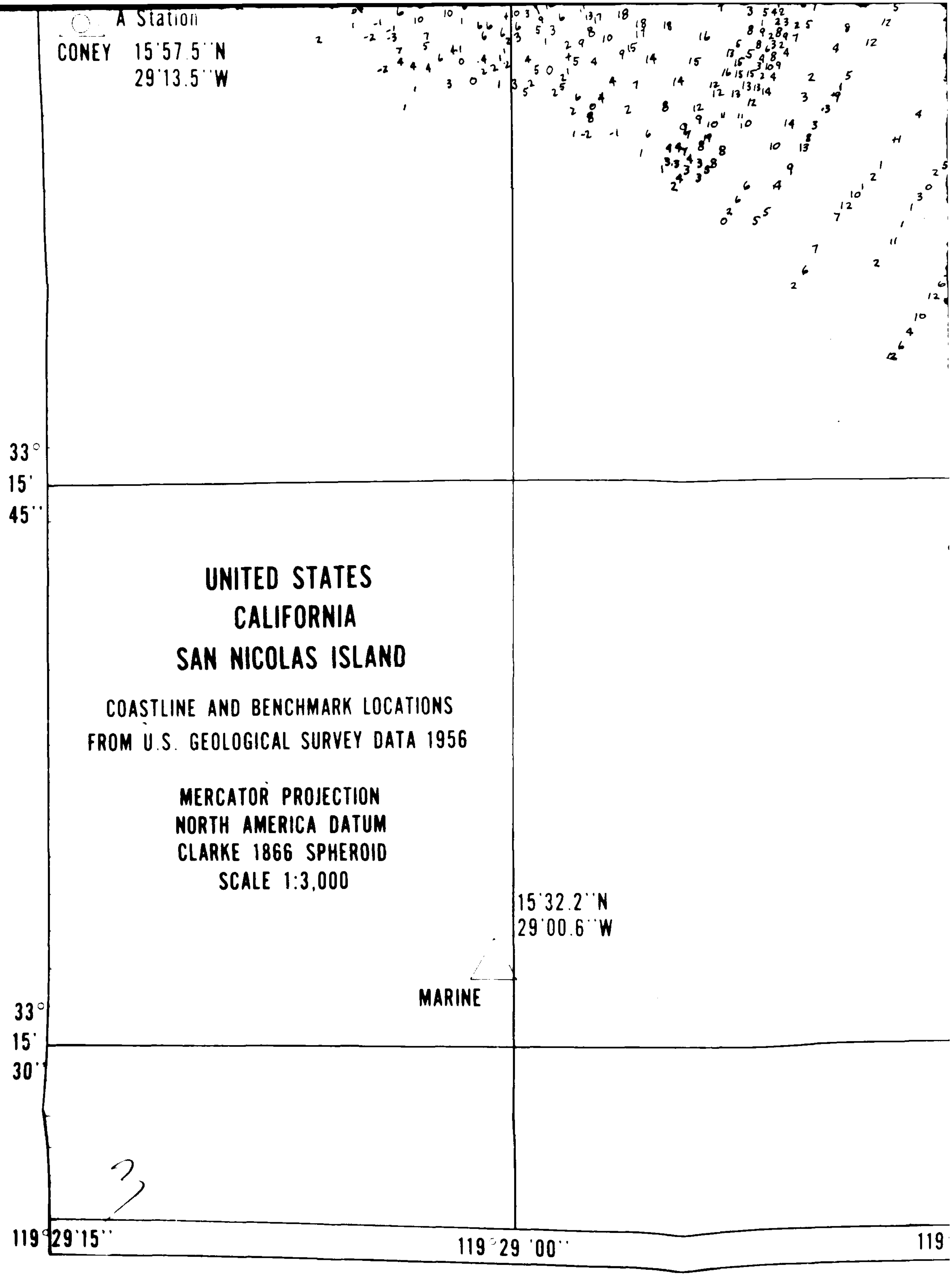

33 16 30
33 16 15
33 16 00
B Buoy


CONEY
A Station
15'57.5''N
29'13.5''W
MARINE
33
15
30
119 29 15

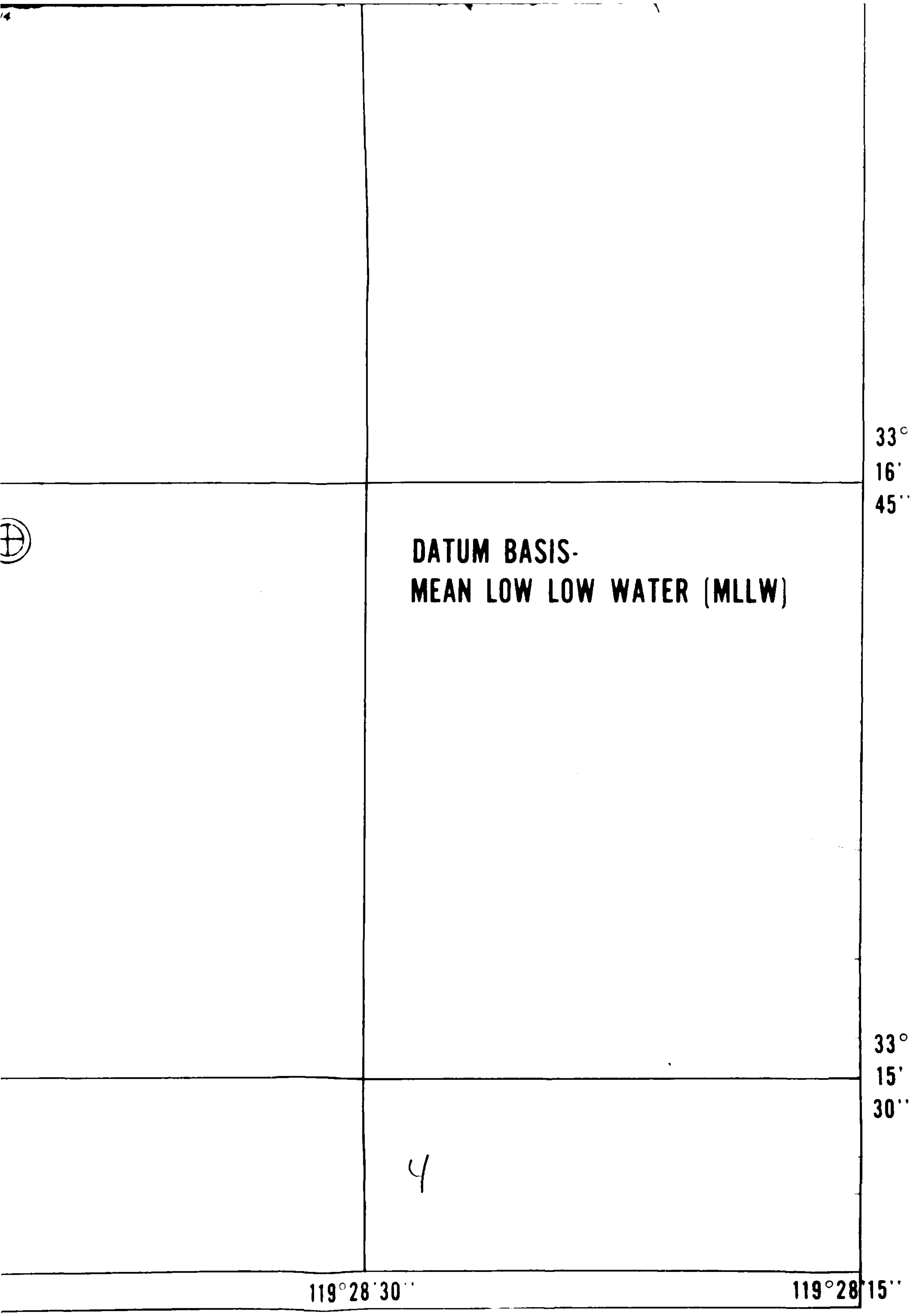

14
16
15
6
8
10
5
B Station
15'43.5''N
28'41''W
33
15
45
33
15
30
4
119 28 15


16' 30''
A Buoy
33° 16' 15''
33° 16' 00''
A Station
CONEY 15'57.5''N
29'13.5''W


33° 16' 30''
B Buoy
33° 16' 15''
33° 16' 00''
2



A Station
CONEY 15'57.5''N
29'13.5''W
33°
15'
45''
UNITED STATES
CALIFORNIA
SAN NICOLAS ISLAND
COASTLINE AND BENCHMARK LOCATIONS
FROM U.S. GEOLOGICAL SURVEY DATA 1956
MERCATOR PROJECTION
NORTH AMERICA DATUM
CLARKE 1866 SPHEROID
SCALE 1:3,000
15'32.2''N
29'00.6''W
MARINE
33°
15'
30''
119°29'15''
119°29'00''
119


33°
16'
45''
DATUM BASIS-
MEAN LOW LOW WATER (MLLW)
33°
15'
30''
4
119°28'30''
119°28'15''

END

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