SEASONAL BEACH RESPONSE
AT EAST HAMPTON, N.Y.

H. J. Bokuniewicz, M. Zimmerman,
M. Keyes, and B. McCabe

marine sciences research center
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J.R. Schubel

J. R. Schubel, Director

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INTRODUCTION

The East Hampton Beach is in what is known as the headland section of the shore, and there are severe erosional problems in many areas of the headland section, as there are in other coastal areas of Long Island. Over long time periods, the East Hampton beach appears to be accreting or, at least, stable in marked contrast to the long-term recession of both the barrier beaches to the west and the high cliffs to the east. This does not mean that East Hampton's shore front does not suffer from erosion. All beaches undergo seasonal changes. Sand is removed from the beach by large winter waves and stored temporarily in offshore bars. In the summer when the waves are less severe, the process is reversed and sand is returned to the beach. This onshore-offshore motion is superimposed upon the longshore drift of sand east or west down the beach. Although the net result of many seasonal cycles may be accretion of the beach, irregular but severe, erosion during the winter may cause serious loss of property or may break through the dunes that protect the inland areas from flooding.

Despite the fact that Long Island is heavily populated, and has been for a long time, we know very little about the magnitudes of the seasonal changes that occur regularly. One reason for this lack of information is that the processes that shape the shoreline are very complicated. The form of the beach at any partiular location involves the winds, waves, locations of bars and jetties, and even the size of the individual sand grains that make up the beach. As a result each stretch of beach has its own individual characteristics. Specific problems in shore erosion can not be adequately answered in general terms and require special studies at the site. The beach is also part of a system with many components and a study of the beach should include as many elements as possible.

This study provides specific information for the East Hampton beach by describing the magnitude of seasonal changes along the beach--the amount of sand gained or lost every month--and the characteristics of the waves that cause these changes.

BACKGROUND

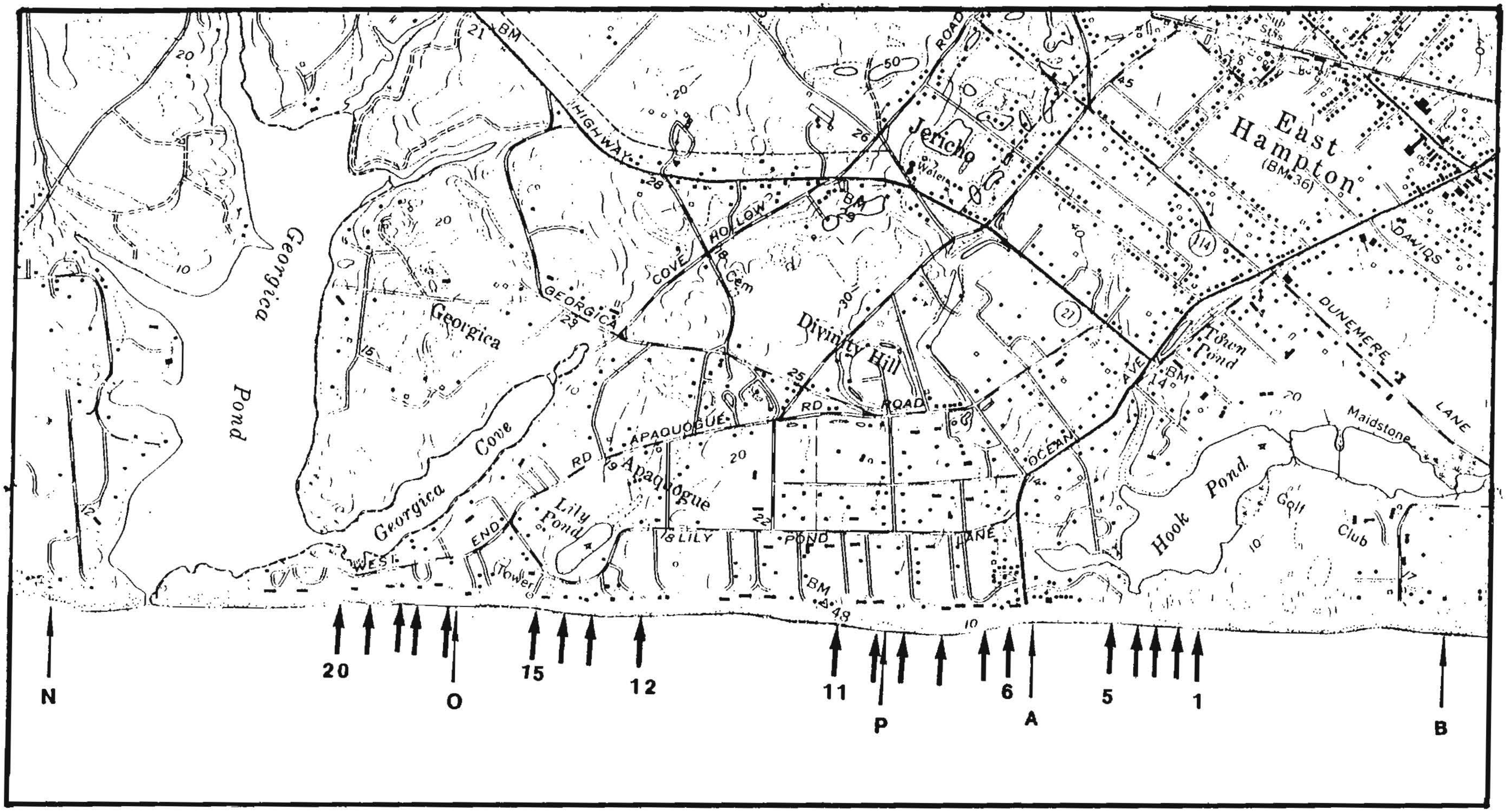
Changes of the East Hampton beach have been included in two earlier studies. In 1961, Taney measured changes in the position of the high-water shoreline for the entire south shore of Long Island. The position of the shoreline was measured about every mile along the coast from charts covering a period from 1838 to 1956. Four of the places where measurements were made were in or near our study area, and the approximate locations are shown in Figure 1. Over the entire 118-year period, there has been net accretion in the eastern part of our study area (Table I) and this trend continues for seven miles further east (Taney, 1961). During the most recent period studied by Taney, changes which have occurred within our study area have been accretionary. A later study (Rich, 1975) also indicates a recent, net accretion of the beach at East Hampton. An investigation of aerial photographs that were taken between 1938 and 1972 suggested that the beach here had accreted at a rate of about one foot/year during the period (Rich, 1975). The general shore processes and the structures on the beaches of East Hampton have been the subject of two unpublished reports by O'Brien (1979), and O'Brien and Dean (1978). They have reviewed the historical records of the beach's changing forms and conclude that there has been little net change over the past century. The magnitude of the seasonal changes of the beach here had not been documented before our study although these changes are generally known to be large.

Table I

Changes in the position of the high-water shoreline in our study area from Taney (1961). Changes are in feet; positive numbers indicate an advancing shoreline; negative numbers, a retreat.

	Station				
Period	N	O	P	A	B
1830-1891	- 20	+100	- 10	-160	0
1891-1933	-200	-120	-100	0	+100
1933-1940	0	0	0	0	0
1940-1956	+ 60	0	+100	+200	0
Net change	-160	- 20	- 10	+ 40	+100

Figure 1. Approximate location of survey stations (heavy arrows) along the East Hampton Beach (see Appendix I for exact locations). Wave observations were made at Station 6. The light arrows (N, O, P, A, B) are the approximate locations where long-term shoreline changes were measured (Taney, 1961).


East Hampton
(BM 36)
Jericho
Georgica Pond
Georgica
Georgica Cove
Divinity Hill
Apaquogue
Lily Pond
Town Pond
Hook Pond
Maidstone Golf Club
HIGHWAY
COVE HOLLOW
GEORGICA
APAQUOGUE RD
ROAD
DAVIDS
DUNEMERE LANE
OCEAN AVE
LILY POND LANE
WEST END RD
Tower
Cem
Water
20
O
15
12
11
P
6
A
5
1
B
N

Our study was done along a three-mile section that includes the Town Beach and Georgica Beach. The eastern part of the section includes only one groin at the eastern end. Three rock groins have been built across the western section. All these groins were built in the 1960s. Topographic profiles were made across sections of the beach including sections that are backed by revetments or bulkheads, sections near groins, and sections backed by natural dunes. Our study extended over nine months from October 1979 to June 1980 and plans have been made to continue the observations throughout the summer of 1980.* The bulk of the measurements that were made for our study was made by students of the East Hampton High School so the techniques were designed to be as straightforward as possible. A detailed account of the methods is given in Appendix I and a brief summary will be given here.

METHODS

Before the first survey we had established 20 permanent stations on the beach by driving stakes near the dune line. The general locations of the stations are shown in Figure 1 and more specific locations and descriptions are given in Appendix I. The stations were set in four groups. Within each group the stations were typically 100 m apart and the distance between groups was about 400 m. Five stations were grouped near the groin east of Main Beach, six from Main Beach west, four from Georgica Beach east, and five near the first groin west of Georgica Beach. These stations were leveled in relation to a National Ocean Survey benchmark at Georgica Beach. The surveys are done approximately every

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* An additional partial survey was made on 14 July 1980; see Appendix III.

29 days. The dates and times were chosen to coincide as nearly as possible with the time of low spring tides, so that we could make measurements across the greatest possible width of beach.

The surveys were done as follows. At each station, a line was laid out on the beach along a compass course from the stake. This line was approximately perpendicular to the shoreline. Measurements were made along this line by using two staffs five feet long. The staffs are graduated into feet and tenths of a foot and connected by a five-foot string. One end of the string was attached to the three-foot mark on one staff, and the other end was looped around the second staff and was free to slide along it. A line-level was attached to the string. A measurement was made by holding the staffs along the line with the string taut and then the free end of the string was slid up or down until it was level. The height difference between the two staffs was then read off and recorded. The measurement was repeated every five feet across the width of the beach. At the station marker the elevation of the top of the stake relative to the staff was measured. The measurements were then added and a section constructed.

Observations were also made of the daily wave activity. These were visual observations of wave height, period, and angle of attack. The observations made for this study were similar to those made in other areas of the country by the Coastal Engineering Research Center under a program known as the Littoral Environmental Observation (LEO) Program (DeWall, 1977; Bruno and Hiipakka, 1973; Schneider, 1978). Initially one set of observations was made each day but during the last four months, data were collected twice a day so that we could include some diurnal variations. The details of this procedure are also included in Appendix I.

RESULTS

Eleven surveys were done (Table II). Profiles were made at all 20 stations for each survey, and duplicate measurements were made at some stations during each survey. The number of stations where duplicate profiles were made varied, depending on the width of the beach, the weather, and the number of students available. The number of duplicated stations ranged from four to thirteen; typically seven were done. Figure 2 shows two profiles made on the same day at the same station by two different groups. By looking at all such pairs of profiles we can estimate the accuracy of the surveys. The maximum difference between duplicate profiles was usually less than two feet (Fig. 3). The cumulative difference between duplicates is equivalent to the closure error; it was usually less than two feet (Fig. 3). Occasionally large differences were found. Differences greater than five feet occurred between 4% of the duplicate profiles. In these cases we were usually able to decide which profile was in error by studying other profiles done by the same groups or by comparing the profiles with those that were done at the same station previously. It appears that large differences were due to some irregularity in the staffs. The connecting string might have been too short or the line level was not suspended freely on the string. Because of the possibility of large errors, conclusions should not be based on a single profile

Table II

Survey schedule

Date	Duplicated stations
4 Oct 1979	1, 7, 8, 9
16 Oct 1979	1, 2, 5, 13, 14, 16, 17, 18
1 Nov 1979	4, 7, 10, 13, 14, 19
20 Nov 1979	3, 8, 13, 19
18 Dec 1979	5, 10, 13, 19
18 Jan 1980	1, 3, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 19
1 Feb 1980	5, 6, 10, 13, 15, 16, 19
29 Feb 1980	5, 6, 7, 9, 10, 13, 18
1 Apr 1980	1, 5, 6, 7, 8, 9, 10, 11, 13, 16, 19
2 May 1980	1, 5, 6, 7, 8, 9, 10, 13, 16, 19
29 May 1980	1, 5, 6, 8, 9, 13, 19

Figure 2. Duplicate profiles at Station 4 made on the same day by two different groups.

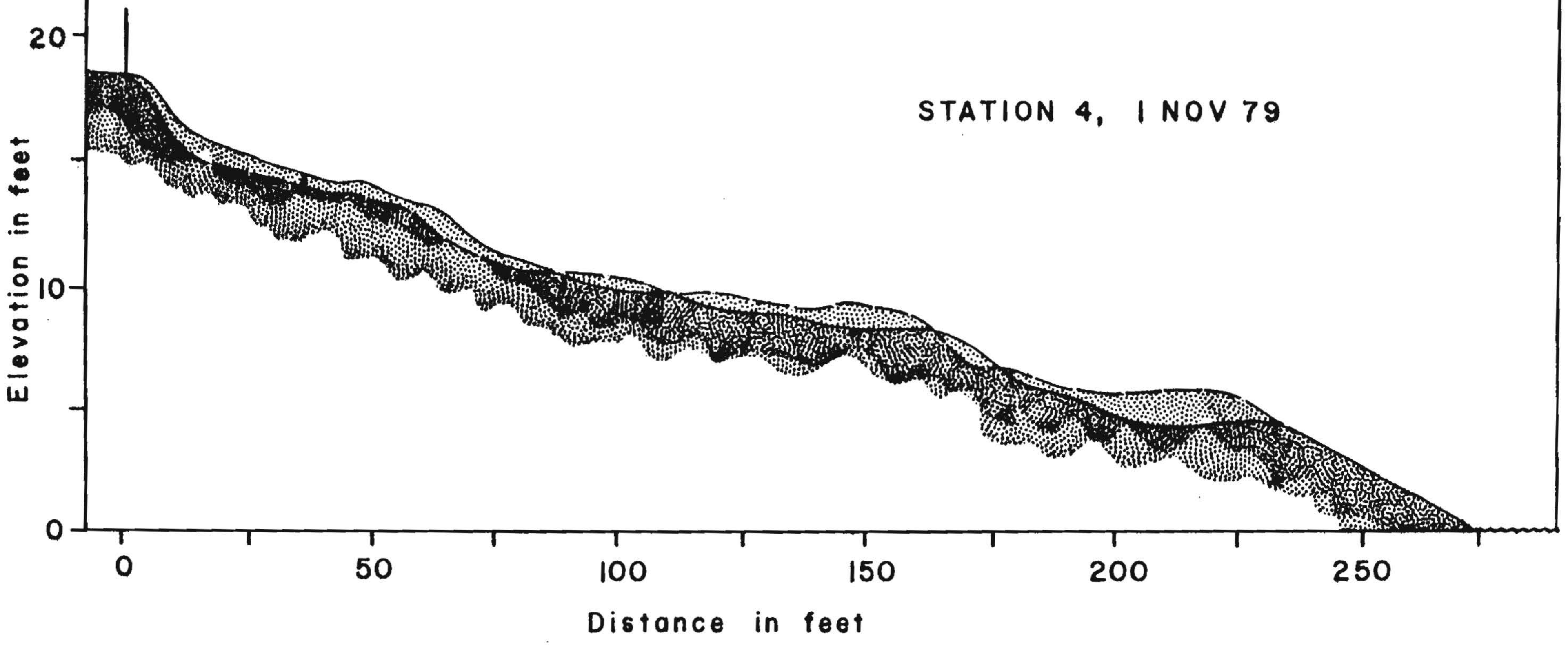

STATION 4, 1 NOV 79
Elevation in feet
Distance in feet
20
10
0
0
50
100
150
200
250

Figure 3. Distribution of elevation differences between duplicate profiles. The maximum difference the greatest measured difference anywhere along any pair of profiles. The cumulative difference is the difference at the end of the profile.

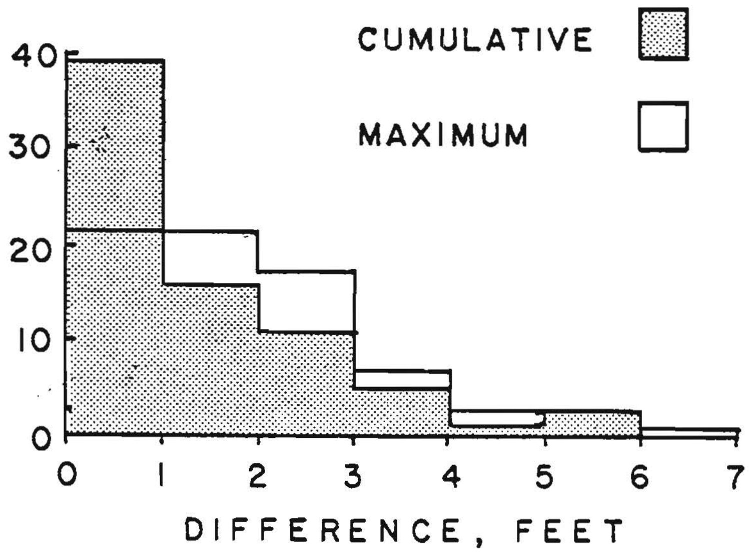
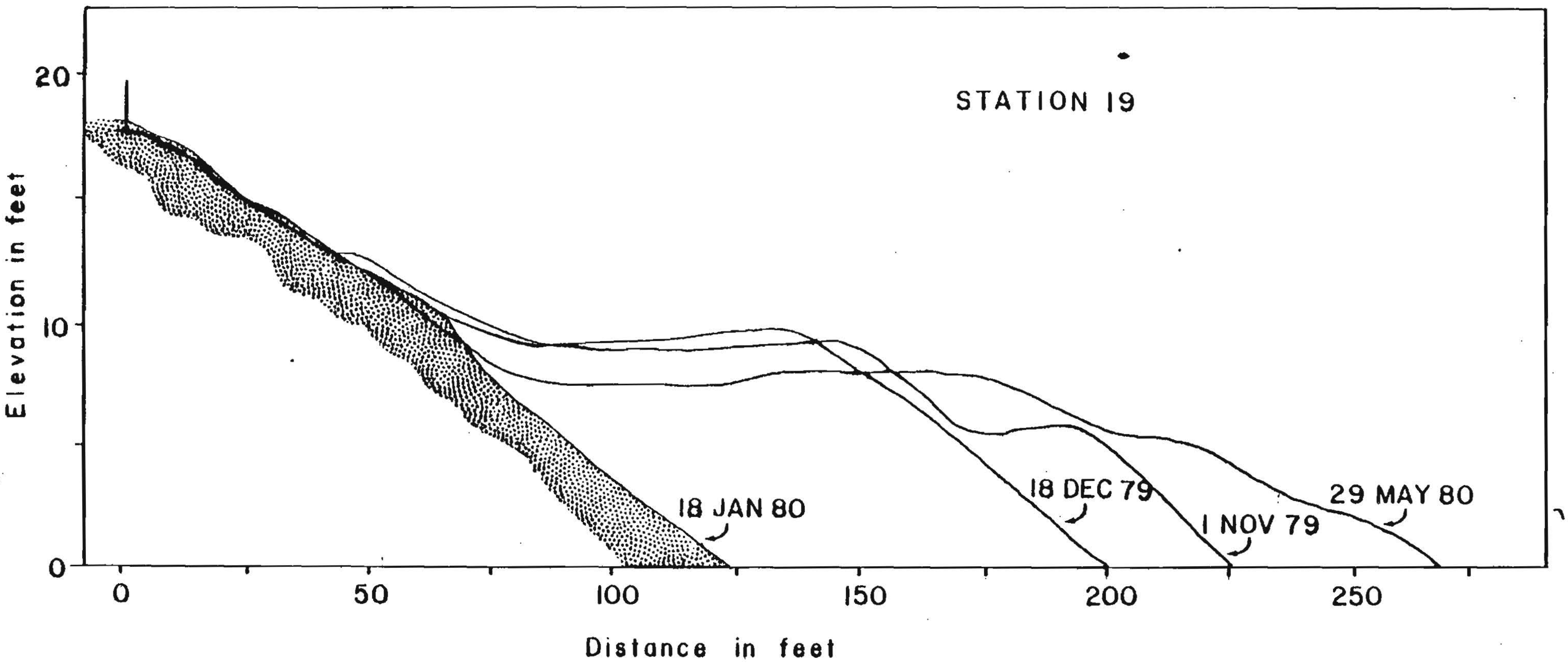

CUMULATIVE
MAXIMUM
40
30
20
10
0
0
1
2
3
4
5
6
7
DIFFERENCE, FEET

Figure 4. Selected profiles at Station 19 showing the magnitude of the seasonal response.


STATION 19
Elevation in feet
20
10
0
Distance in feet
0
50
100
150
200
250
18 JAN 80
18 DEC 79
1 NOV 79
29 MAY 80

except where it has been verified by a duplicate profile. The accuracy is adequate, however, to monitor the large seasonal changes in the beach as shown in Figure 4, and trends defined by many profiles should be valid.

Volume changes. At every station the volume change in the beach between successive surveys was measured to mean sea level. The measurements were made near the time of spring low tide so that they often extended below mean sea level. Sometimes, however, they did not. This was most frequently the case during the winter months when the top of the swash zone was several feet above the water level. Measurements made to the top of the swash zone even at times of low tide could be still above mean sea level. To measure the volume changes in these cases, the slope of the beach face was extrapolated to mean sea level. The extrapolation is reasonable because, as we shall show later, the slope of the beach face was relatively constant. Several profiles had to be discarded because measurements had not been made to the post marking the station and, as a result, we could not determine the absolute elevation and position of the profile. For example, several surveys at Station 12 were discarded because a revetment was being constructed immediately to the east of this location and the students could not safely reach the station marker because of construction activity in front of the dune.

Changes in the volume of the beach from the station marker to mean sea level are given in Table III. Volume changes at any station between surveys are typically about 11 yds^3/ft. These are comparable to the changes observed at Westhampton Beach by DeWall (1979). The largest changes at East Hampton exceeded 40 yds^3/ft

Table III. Volumetric changes in cubic yards per foot

(E = Erosion. A = Accretion)

	Station									
Period	1	2	3	4	5	6	7	8	9	10
4 Oct ↓ 16 Oct	24.0E	8.4E	11.3E	31.6E	12.8E	-	7.8E	13.4E	0.1A	-
16 Oct ↓ 1 Nov	10.2E	11.5E	6.7A	18.1A	14.6A	7.8A	3.9A	11.4A	6.9A	-
1 Nov ↓ 20 Nov	7.4A	1.9E	8.8E	25.9E	11.8E	0.7A	2.0A	2.9E	5.7E	34.7E
20 Nov ↓ 18 Dec	0.4A	1.2E	14.9A	39.4A	1.9E	8.7E	11.8E	0.2A	11.8E	5.8E
18 Dec ↓ 18 Jan	1.9A	11.6A	28.8E	42.8E	11.2E	17.2E	7.3E	11.1E	9.8E	
18 Jan ↓ 1 Feb	1.6E	0.4A	6.3A	25.7A	10.0E	15.4E	1.0E	7.4A	2.4A	8.3A
1 Feb ↓ 29 Feb	1.0A	9.5A	12.4A	21.0A	6.2A	3.3A	1.7E	5.2A	5.0A	15.6A
29 Feb ↓ 1 Apr	8.0A	8.5E	7.3A	28.2E	10.5E	13.6E	1.1E	11.8E	10.5E	11.2E
1 Apr ↓ 2 May	14.4E	9.0E	2.8A	2.0A	3.4A	4.3A	0.9E	3.8A	1.1E	0.2E
2 May ↓ 29 May	6.9E		26.7A	24.8A	9.4A	10.1A	-	11.9A	13.2A	8.9A
Gross Accretion	18.7A	21.5A	77.1A	131.0A	33.6A	26.2A	5.9A	39.9A	27.6A	38.8A
Gross Erosion	57.1E	40.5E	48.9E	128.5E	58.2E	54.9E	31.6E	39.2E	38.9E	51.9E
Net Change	38.4E	19.0E	28.2A	2.5A	24.6E	28.7E	25.7E	0.7A	11.3E	19.1E

Table III (concluded)

Period	Station 11	12	13	14	15	16	17	18	19	20
4 Oct ↓ 16 Oct	-	-	3.7E	13.6E	3.5E	6.7E	0.7E	7.5A	2.0A	13.3E
16 Oct ↓ 1 Nov	-	3.0E	2.4A	0.8A	7.6A	6.7E	11.4E	6.7E	4.4A	4.6A
1 Nov ↓ 20 Nov	-		5.5E	0.8E	5.2E	0.2E	3.1A	0.6A	10.2A	0.8A
20 Nov ↓ 18 Dec	3.5E		1.1E	6.5E	10.1E	10.3A	0.4E	2.5A	4.4A	3.0A
18 Dec ↓ 18 Jan	8.6E	20.4E	12.8E	10.0E	9.5E	15.3E	0.4A	9.2E	27.5E	17.0E
18 Jan ↓ 1 Feb	29.5A	11.5A	6.2A	7.1A	22.3A	12.6A	8.3A	1.2E	14.2A	4.3A
1 Feb ↓ 29 Feb		8.0A	28.3A	11.0A	9.9A	10.5A	12.9A	13.9A	16.4A	18.9A
29 Feb ↓ 1 Apr	9.1E	0.9A	29.3E	4.3E	8.2E	17.7A	11.1E	9.1E	11.6E	33.7E
1 Apr ↓ 2 May	9.8E		17.3A	41.2A	5.9A	19.6A	35.3A	11.2A	5.0E	25.7A
2 May ↓ 29 May	42.1A	32.8A	3.6A		21.9A	29.8E	22.0E	26.1A	18.2A	15.8A
Gross Accretion	71.6A	53.2A	57.8A	60.1A	67.6A	70.7A	60.0A	61.8A	69.8A	73.1A
Gross Erosion	31.0E	23.4E	52.4E	35.2E	36.5E	58.7E	45.6E	26.2E	44.1E	64.0E
Net Change	40.6A	29.8A	5.4A	24.9A	31.1A	12.0A	14.4A	35.6A	25.7A	9.1A

between surveys.

The volume changes are irregular. There were some periods when erosion was widespread, like that period ending on 1 April 1980, and there are some periods in which most of the beach accreted as in the period ending on 29 February 1980. Nevertheless, in any particular period both erosion and accretion were observed at different places along the beach. Large advances in the shoreline sometimes were due to ridge-and-runnel systems attaching themselves to the beach. Such systems typically extended over several hundred yards along the shoreline. At other times scarps about four feet high were found at the top of the foreshore indicating sudden erosion. These features never extended along the entire shoreline in the study area but were usually pronounced in a stretch of beach a few hundred yards long.

The magnitude of the volume changes were slightly greater for the sections near groins and for undisturbed sections (Stations 1-6 and 16-20) than they were for sections that were backed by bulkheads or revetments (Stations 7-15) (Table IV). That is to say sections of the beach that were backed by bulkheads or

Table IV

Average, gross erosion and accretion for groups of stations

Stations	Average erosion Yd^3/ft	Average accretion Yd^3/ft
1 to 5	65	51
7 to 15	38	47
16 to 20	48	67

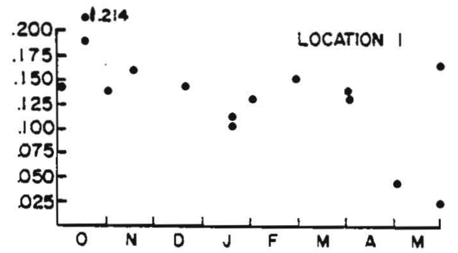
revetments lost slightly less sand during periods of erosion and gained slightly less sand during periods of accretion than did other sections. Such a difference is not unreasonable, because during erosion the amount of beach that can be removed is limited by the structures and during accretion there is a tendency for the shoreline to remain fairly straight so that the beach in front of the structures builds out only as far as the adjacent beach along other sections.

The recovery of the beach, or the net volume change over the entire study period, seems to be unrelated to the structures. The western half of the study area (Stations 11-20) showed net accretion. This section included undisturbed stretches, groins, and revetted sections. The eastern half of the study area generally showed net erosion. This section contained bulkheaded sections as well as undisturbed stretches and groins. The only appreciable net accretion in the eastern half was at Station 3 which is immediately west of a groin.

Foreshore slope. The slope of the foreshore was measured on every profile and plotted in Figure 5. This slope depends primarily upon the sand grain size (Bascom, 1959). A sample taken from the foreshore at about mean sea level on Georgica Beach had a mean grain size of 0.46 mm. Based on data presented in the *Shore Protection Manual* (U.S. Army Corps of Engineers, 1977) beaches with this grain size show slopes of between 0.08 and 0.18. The measured slopes at East Hampton fall in this range. The slope remained relatively constant throughout the study period even though the shoreline was alternately receding and advancing. This was true whether or not a berm was able to be maintained; in cases where the foreshore slope ended at a bulkhead the slope did not depart significantly from the usual values. There seems to be a slight trend toward less steep slopes during the study period. This may reflect a change in the grain size or a modification in the wave conditions. Data are not on hand to decide on the cause of the changes in beach slope.

Beach width and berm height. The width of the beach at each station was measured from the station marker post to mean sea level (Table V). The foreshore slope was extended in those cases where the measurement ended above mean sea level. During the summer preceding our study, several of the residents commented that the beach was as wide that summer as they could ever recall it having been in the past. At most of the locations the beach reached a minimum width on 18 January 1980 although at four locations the minimum width was attained a month earlier, and at one two weeks later. These differences do not appear to be caused by the presence or absence of particular structures. The beach was found to have its minimum width on 18 December at two stations (1 and 2) to the east of a groin and at two stations (13 and 14) that were far from the groins and in front of a revetment. Other stations near groins or in front of revetments reached their minimum widths on 18 January. The one station (7) where the minimum beach width occurred in February was at the east end of a revetment and west of the Town Beach but comparable stations (e.g. 12) had reached their minimum widths in January. Six stations in the eastern part of the study area (4, 5, 6, 7, 8, and 9) showed a secondary recession on 1 April or 2 May. This second erosional period is probably the reason why

Figure 5. Slope (tangent of the angle measured upward from a horizontal at the water level beneath the beach) of the foreshore at each station during the study period.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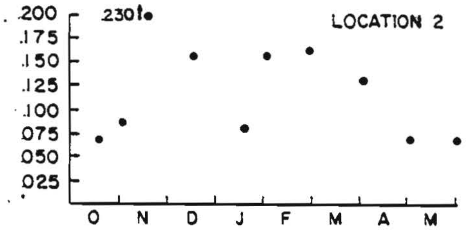
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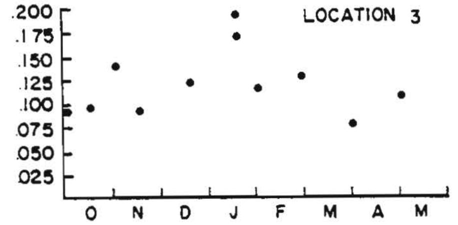
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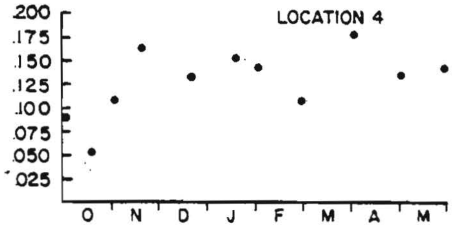
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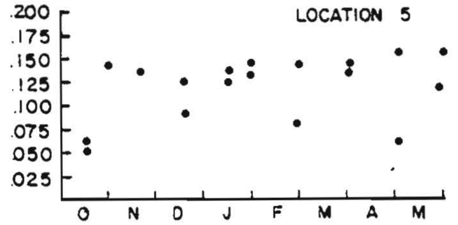
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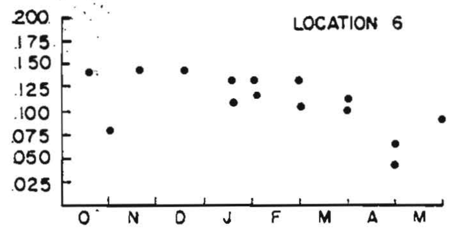
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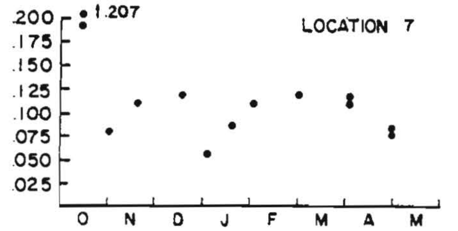
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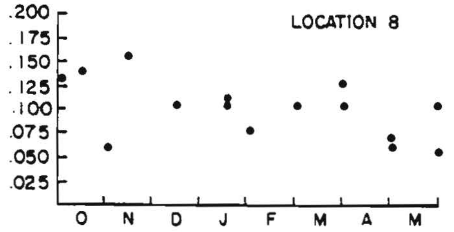
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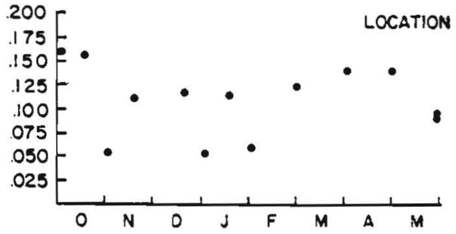
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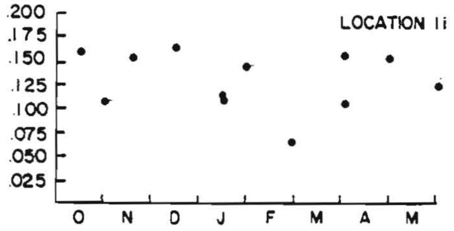
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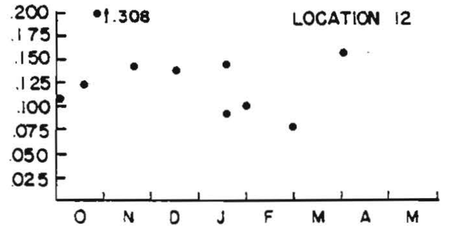
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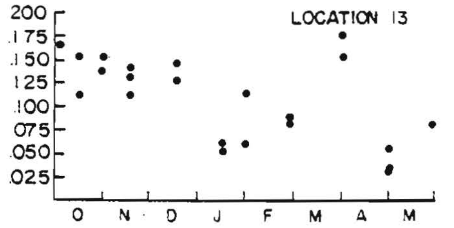
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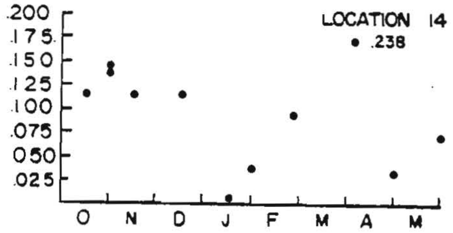
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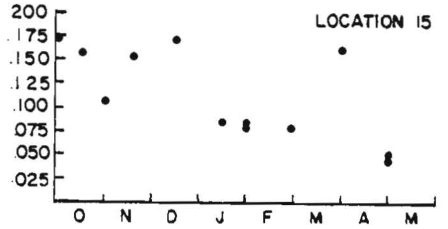
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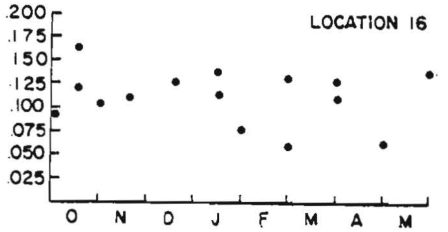
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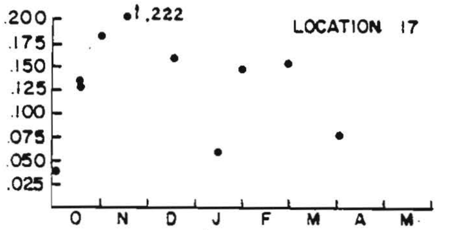
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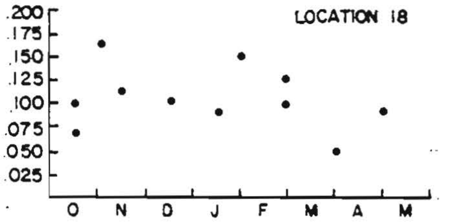
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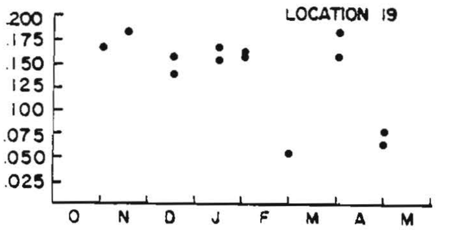
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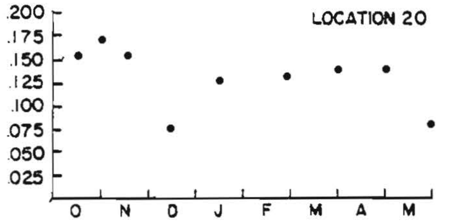
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O N D J F M A M

Table V

Beach width and berm elevation
(Both values are in feet; the berm elevation is the number in parentheses.)

	Station									
	1	2	3	4	5	6	7	8	9	10
4 Oct	236.0	227.5	225.0	312.5	267.5	-	123.5	132.0	86.0	-
	(9.1)	(9.5)	(8.0)	(10.5)	(7.8)	-	(8.5)	(11.7)	(6.2)	-
16 Oct	182.0	203.0	190.0	281.5	217.5	171.5	111.5	95.0	83.0	-
	(6.8)	(9.1)	(7.7)	(7.8)	(8.0)	(8.6)	(7.5)	(10.6)	(13.1)	-
1 Nov	171.5	195.0	214.5	278.5	260.0	228.0	141.5	165.0	130.0	165.0
	(5.9)	(9.4)	(5.4)	(7.8)	(5.9)	(9.1)	(6.9)	(8.4)	(6.5)	(9.8)
20 Nov	202.5	173.5	205.0	229.0	239.5	203.0	117.5	126.0	111.5	97.5
	(6.9)	(6.9)	(5.2)	(7.5)	(5.5)	(8.3)	(8.5)	(9.0)	(8.1)	(8.5)
18 Dec	167.0	165.5	230.0	278.0	228.0	174.0	93.0	136.5	80.0	89.0
	(8.8)	(9.4)	(9.8)	(11.8)	(7.5)	(8.6)	(6.0)	(8.6)	(-)	(9.5)
18 Jan	202.0	218.0	145.0	186.0	174.0	118.5	59.0	63.0	50.0	60.0
	(6.6)	(5.6)	(11.2)	(11.5)	(9.7)	(-)	(-)	(-)	(-)	(7.0)
1 Feb	199.5	212.5	177.0	203.0	181.0	145.0	51.5	125.0	118.0	160.0
	(7.0)	(7.8)	(12.0)	(12.0)	(11.3)	(-)	(-)	(4.1)	(3.5)	(3.3)
29 Feb	213.0	200.5	202.0	246.5	206.0	166.0	62.0	125.0	85.0	152.5
	(5.8)	(10.5)	(7.5)	(11.0)	(8.8)	(5.8)	(2.1)	(6.5)	(6.2)	(7.3)
1 Apr	246.0	234.0	205.0	184.0	181.0	112.5	37.5	66.0	35.0	107.5
	(10.6)	(8.7)	(8.3)	(9.7)	(8.7)	(5.5)	(-)	(-)	(-)	(-)
2 May	210.0	-	-	203.5	178.0	142.0	27.5	97.0	30.0	126.5
	(7.8)	(-)	(-)	(10.0)	(9.4)	(5.6)	(-)	(-)	(-)	(-)
29 May	243.0	248.0	-	279.5	238.0	188.0	-	142.0	102.5	135.0
	(4.1)	(8.2)	(-)	(9.2)	(7.5)	(4.5)	(-)	(7.1)	(4.7)	(6.0)

Table V (concluded)

	Station									
	11	12	13	14	15	16	17	18	19	20
4 Oct	- (-)	- (-)	138.0 (11.6)	187.0 (12.6)	163.0 (11.5)	230.0 (8.5)	240.0 (6.9)	205.0 (10.0)	207.5 (9.1)	210.0 (8.3)
16 Oct	- (-)	218.0 (16.2)	128.5 (12.6)	171.5 (6.1)	150.0 (11.8)	195.0 (9.2)	235.0 (7.5)	259.0 (8.2)	198.0 (9.3)	150.5 (7.4)
1 Nov	- (-)	- (-)	136.5 (7.3)	176.0 (7.2)	177.5 (12.5)	205.0 (7.4)	221.0 (4.8)	169.5 (6.7)	226.0 (6.3)	176.0 (5.0)
20 Nov	115.0 (10.8)	- (-)	113.0 (10.8)	175.0 (10.2)	154.0 (12.8)	205.0 (8.6)	205.0 (7.0)	128.5 (8.5)	208.0 (10.5)	175.0 (7.8)
18 Dec	105.0 (10.3)	155.0 (9.9)	108.0 (10.3)	140.0 (10.2)	142.0 (11.7)	203.0 (11.0)	215.0 (8.0)	210.0 (9.3)	200.0 (10.3)	178.5 (7.6)
18 Jan	90.0 (-)	102.0 (-)	166.5 (-)	181.0 (5.8)	123.0 (7.7)	174.5 (8.6)	196.5 (6.8)	166.5 (11.4)	125.5 (11.2)	136.0 (12.0)
1 Feb	- (-)	180.0 (4.5)	175.0 (5.1)	220.0 (3.5)	234.0 (6.0)	270.0 (7.1)	275.0 (6.5)	260.0 (5.0)	205.0 (6.5)	163.5 (5.9)
29 Feb	211.0 (8.2)	161.0 (5.9)	178.0 (8.8)	226.0 (7.8)	244.0 (6.8)	281.0 (7.3)	298.5 (8.6)	263.5 (5.1)	235.0 (6.0)	191.0 (7.5)
1 Apr	160.0 (9.8)	- (-)	92.5 (9.1)	170.0 (8.5)	207.0 (8.0)	347.0 (7.8)	310.0 (5.7)	260.5 (7.5)	206.0 (9.0)	157.5 (5.3)
2 May	117.5 (10.9)	187.5 (7.1)	180.0 (6.9)	169.5 (8.6)	250.0 (8.5)	361.5 (9.6)	361.5 (8.0)	221.5 (10.6)	235.0 (4.2)	200.0 (7.0)
29 May	253.0 (9.2)	217.0 (11.9)	177.0 (7.0)	250.5 (10.5)	286.5 (9.6)	313.0 (7.2)	240.0 (9.1)	251.5 (13.0)	272.5 (6.1)	248.0 (7.8)

stations in the eastern half of the study area showed a net volume loss for the entire period while stations in the western section which were unaffected by the spring erosional event showed a net gain of sand.

Berms are typically between eight and nine feet in elevation. No systematic differences in the berm height are apparent although there is a very slight tendency for the berms to be higher in the eastern part of the section than in the western part and to be lower in the early winter. In front of revetments and bulkheads, however, it was sometimes the case that the beach was not sufficiently wide for a berm to develop. At these times the foreshore slope extended from the water level to the structure.

Wave characteristics and longshore transport. The wave information is tabulated in Appendix II and we will confine our attention here to using that data to calculate the longshore wave energy flux and the longshore transport rate. The quality of the data is virtually impossible to assess and we will accept it at its face value in the hopes that observational errors will be random and tend to average out. The wave period was easiest to measure. This was done twice during each observation and the two measurements are usually within one second of each other. The wave height was probably the next most accurate measurement; fairly coarse divisions were made for classifying the wave heights because we were most concerned with large changes. The angle of wave attack was the most difficult measurement to make. Two methods proved practical and both were used during each observation. One of these involved plotting the angle of attack on a protractor that was printed on each data sheet. This is the method used by the LEO program mentioned earlier. In the other method, the observer would choose a figure that best represented the wave condition that day from a series of seven figures on the data sheet. The angles measured by the first method were consistently larger than the angles measured by the second method sometimes by as much as 10°. After one observer was watched completing the data sheet, it seemed to us that the second method (choosing one of the seven figures) would give the best results. Measurements made on 2 May 1980, however, proved otherwise. On that day, a set of aerial photographs were made while the beach survey was being conducted. The wave crests are easily seen on these photographs and appear to be approaching the shore at an angle of about 15°. The values measured by the observer on that day were 15° and 28.5° by the first method and 5° by the second. In this case, the use of the protractor gave the better results. Since we were unable to decide that one method was superior to the other, the analyses were done separately with both measured angles and the differences treated as an uncertainty in the results.

The wave energy flux was calculated in two ways. One uses the wave breaker height and the angle of attack; this is equation 4-35 in the *Shore Protection Manual* (U.S. Army Corps of Engineers, 1977). The other uses the wave breaker height, the period, and the angle of attack; this is equation 4-28 in the *Shore Protection Manual* using linear wave theory to estimate the group velocity (Figure 4-34, U.S. Army Corps of Engineers, 1977). On the wave-data sheets the wave height is designated by one of four categories. Category A is less than one foot; B is one to three feet; C is three to five feet; D is over five feet. For the energy flux calculations, if the wave height fell in Category A, a height of one foot was used. If the waves were in Category B or C the root mean square height for the category was used; 2.24 feet for B and 4.12 feet for C. For Category D, 5 feet was used as the wave height unless some other specific value was recorded by the observer. The average wave period was used because the two measurements of the period made for each observation had similar values. As we discussed earlier, the wave angle of attack was measured by two methods and the results were significantly different. As a result the calculation for the wave energy flux was done using each formula twice, once with the angle determined by one method and once using the angle measured with the other method. The results are tabulated in Appendix II and summarized in Figure 6. For each period between surveys the average energy flux to the east and to the west was calculated as the average of all the energy flux values in one direction regardless of the angle of attack or the formula used. The results are given in Table VI. The average energy flux to the east was comparable to, but smaller than, the flux to the west. There were only two periods in which the average energy flux to the east was larger than that to the west. These were between 1 November and 20 November 1979 and between 1 April and 2 May 1980. Although the eastward energy fluxes were usually lower than those to the west, eastward fluxes occurred more often. Conditions for an eastward flux were observed 45% of the time while a westward flux was recorded 38% of the time.

To calculate the longshore transport rate the average wave energy flux to the east (or west) in each

Figure 6. Average wave energy flux between surveys. The vertical bars at the top of each histogram element show the range of energy fluxes calculated by different methods as described in the text.

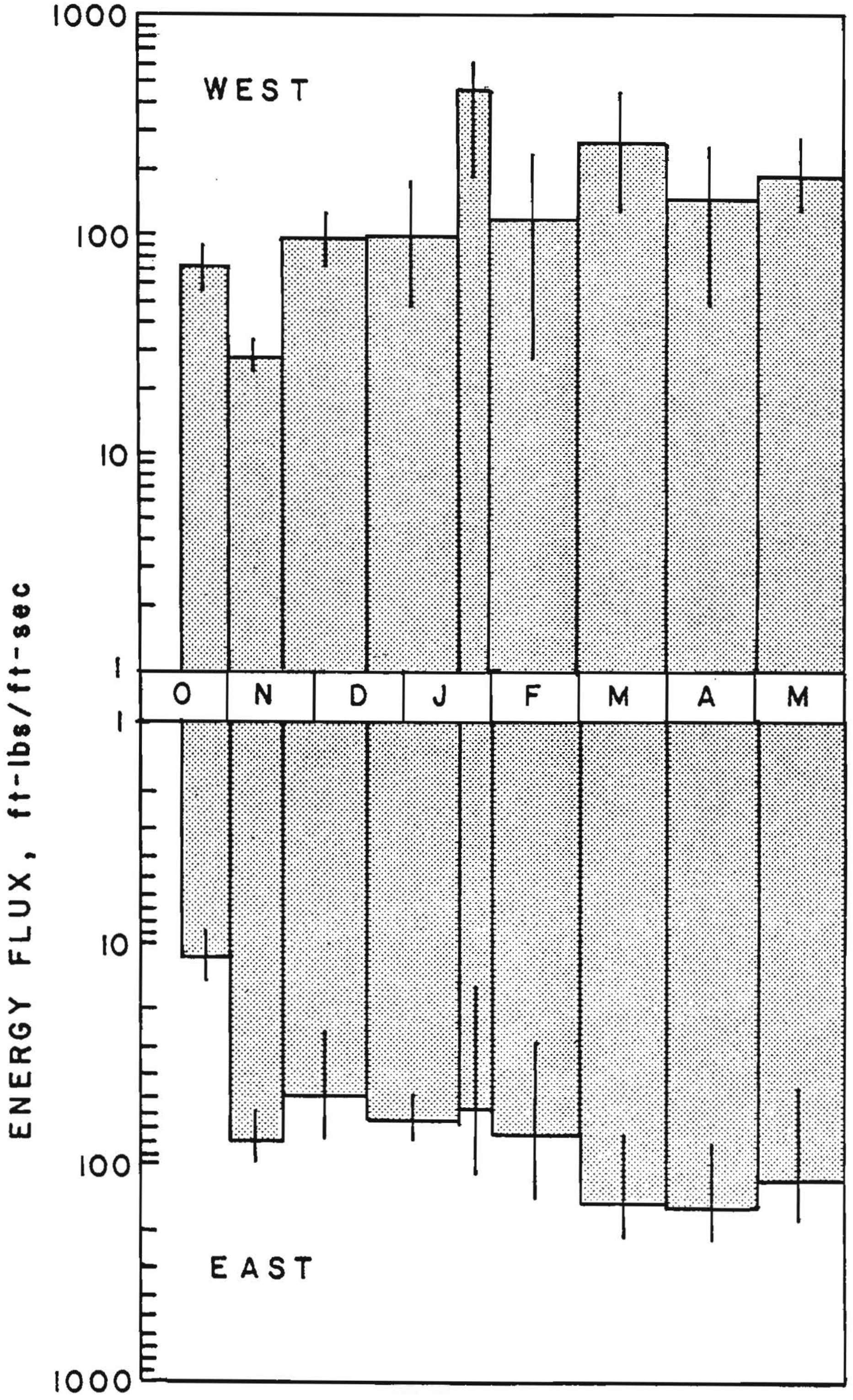ENERGY FLUX, ft-lbs/ft-sec
1000
100
10
1
1
10
100
1000
WEST
EAST
O
N
D
J
F
M
A
M

Table VI

Wave energy

Period	Average energy flux (ft-lbs/ft-sec)		% of observation	
	East	West	East	West
4 Oct - 16 Oct	No data	No data		
16 Oct - 1 Nov	11.73	71.04	25.0	12.5
1 Nov - 20 Nov	79.97	27.78	64.0	8.0
20 Nov - 18 Dec	49.62	92.67	58.3	16.7
18 Dec - 18 Jan	63.64	97.51	35.7	57.1
18 Jan - 1 Feb	59.19	341.88	20.0	60.0
1 Feb - 29 Feb	76.40	111.54	51.4	30.6
29 Feb - 1 Apr	141.76	257.90	48.0	34.7
1 Apr - 2 May	141.64	133.78	40.3	48.4
2 May - 29 May	109.30	185.54	39.6	41.5

period was multiplied by the duration of the period and by the fraction of the observations indicating an eastward (or westward) flux made in that period. These values were then added and divided by the lifetime of the study. This procedure gives the average total energy flux east (or west) in ft-lbs/ft-sec. This value is then multiplied by 7,500 (equation 4-40, U.S. Army Corps of Engineers, 1977) to give the total sand flux east (or west) in yds^3/yr. To estimate the accuracy of this calculation the entire procedure was repeated twice, once using the mean low energy flux calculated in each period and again using the mean high energy flux. The results are shown in Table VII.

Table VII

Longshore transport rate (Yd^3/yr)

	Low	Average	High
To the west	210,826	436,009	699,292
To the east	161,575	295,973	451,817
Gross	372,401	731,982	1,151,109
Net westward	49,251	140,036	247,475

The longshore transport rate calculated from our wave data agrees with the rates that have been estimated by independent methods. Johnson (1957) cites a value of 200,000 yds^3/yr to the west for the south shore of Suffolk County as determined from the accretion rates near inlets. By a similar technique L. McCormick (personal communication) estimates a value of 150,000 yds^3/yr to the west. It is generally agreed that the rate of transport increases to the west and estimates of 300,000 yds^3/yr to the west are calculated from the migration rate of Moriches Inlet (U.S. Army Corps of Engineers, 1957; Taney, 1961). Panuzio (1968) gives a value of 300,000 yds^3/yr to the west.

As shown by our data, both the eastward and westward sand transport rates are significantly larger than the net transport rate to the west. Furthermore, although wave conditions generating an eastward sand transport are seen more frequently than those causing a westward transport, the annual westward transport is larger than the eastward transport by a factor of 1.47. As a result during periods of westward transport the instantaneous transport rate must be 1.74 times larger than the typical, instantaneous transport rate to the east.

SUMMARY AND CONCLUSIONS

1. Changes in the volume of the beach at all stations were irregular with a magnitude of about 10 yds^3/ft-month.

2. The seasonal response was comparable in all sections of the study area. Over the entire period of our study, however, both the total erosional losses and the total accretion were less for sections of the beach backed by bulkheads and groins than they were for undisturbed sections near groins that, incidentally, were not backed with bulkheads or revetments. The volume of the erosional losses in front of revetments and bulkheads was about 70% of the volume lost in other areas; the volume of depositional gains in front of revetments and bulkheads was about 80% of the volume gains in other areas. (The 10% net difference between comparable losses and gains is probably not significant).

3. Over the observation period there was a net accretion of the beach in the western section of our study area. This included undisturbed stretches, stretches backed by revetments, and sections near the west groins.

4. Over the observation period there was generally net erosion of the beach in the eastern section of our study area. This section included stretches of the beach backed by revetments and bulkheads, as well as undisturbed stretches and sections near groins. This does not mean that this section will not recover this summer; the summer beach was still developing when the last survey was made (29 May). In the eastern

section the only stations that showed net accretion were immediately west of the groin.

5. Wave conditions causing an eastward longshore transport of sand were observed to occur 1.18 times more frequently than those causing a westward transport of sand. Nevertheless, the calculated annual westward sand transport was 1.47 times larger than the eastward transport. The net transport rate was 140,036 yds^3/yr to the west. This means that the instantaneous westward transport rate must be 1.74 times greater than the instantaneous transport rate to the east.

6. The use of high school students in making observations on the beach is a practical and potentially valuable strategy. The methods must be kept simple and straightforward. As this report shows, however, useful data can be collected efficiently and the quality of the work can be improved by following the suggestions outlined in Appendix I.

ACKNOWLEDGEMENTS

This work could not have been completed without the constant attention and cooperation of A. J. Minardi in organizing and supervising the student volunteers. He was assisted in this task by D. Buckhout. We are grateful to have had this cooperation and are pleased to commend the students of East Hampton High School for the fine job they did for this project. The work was greatly facilitated by the Village of East Hampton which contributed the use of Village trucks and supplied drivers to help transport students on the beach. We wish also to thank Edward Matthews of the Cooperative Extension Office for his support and assistance. The project also benefited from the advice of M. O'Brien, B. Kinsman, J. Schubel, R. Dean, and P. Sanko. We greatly appreciate their suggestions. This project was supported by the East Hampton Beach Preservation Society and, in part, by the New York Sea Grant Institute.

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APPENDIX I

METHODS

Before the first survey, we had established 20 permanent stations on the beach by driving 5-foot wooden stakes near the dune line. At some locations where we though there was danger that the stake would be lost, a second stake was placed farther back on the dune. They were driven three to four feet into the sand and, with few exceptions, they survived the study period well. The stakes were set in four groups. Within each group the stations were typically 100 m apart and the distance between groups was about 400 m. The locations of the stations were plotted on aerial photographs (scale 1" = 200 feet) of the area using the many landmarks that can be found along the shore and using ranges and bearings taken between stations. The locations were then transferred to topographic maps compiled by Suffolk County. The scale of these maps were 1" = 200 feet and the locations of the stations were measured in terms of the New York Grid System, Long Island Zone, from these maps (Table AI-I). Five stations were grouped near the groin east of Main Beach, six from Main Beach westwardly, four from Georgica Beach eastwardly, and five near the first groin west of Georgica Beach. The stations immediately west of the Main Beach and the group east of Georgica Beach are on sections of the beach backed by bulkheads or revetments. The stations around the groins at either end of the study area are on relatively undisturbed stretches of beach, that is, the beach at these stations is not backed by bulkheads or revetments but by a natural dune.

The stations were leveled in relation to a National Ocean Survey benchmark at Georgica Beach. At the time of the study there were no vertical controls near the study area. The benchmark that was used was a horizontal control, but nonetheless provides us with a permanent reference point for the surveys. The benchmark is numbered 1011. It is at 40°56'13".33809N, 72°12'54".07371W, or 2,493,159.92E, 264,249.01N in terms of the New York Grid System, Long Island Zone. It is 108 feet northwest of the northwest corner of the National Guard building, 54 feet south of the approximate center of Lily Pond Lane, 41.3 feet east of a 6 x 6 foot brick building, numbered 20647, and 31 feet west of the west edge of a driveway encircling the National Guard building. It is a standard brass disk, stamped "Georgica, 1962," set in the top of a square concrete monument that is flush with the ground. It was found in good condition. There are reference marks and an azimuth mark associated with the station mark.

The approximate elevation of the benchmark was taken from Suffolk County topographic maps. The elevation is approximately 10.2 ft above mean sea level. Within each of the four groups of stations, the relative elevations of the tops of adjacent station markers were measured to within one foot with a transit.

To improve the absolute leveling between groups of stations, the simultaneous elevation of pairs of stations was also measured with respect to the water level as follows. Small, transparent stilling wells were attached to the bottoms of two stadia rods. At one station the elevation of the station marker was measured with a transit. The stadia rod would be held just offshore with the stilling well partially submerged. The elevation of the water level in the well was measured with respect to the bottom of the rod while a sighting between the rod and the station marker was taken from shore. This measurement was repeated every 10 minutes for about an hour and a half. During this period, similar measurements were made using another set of equipment at one other station in every group. The elevation of stations between groups was then adjusted to the instantaneous water level. The elevation of the stations are given in Table AI-I.

The surveys were done with the help of students from East Hampton High School. Usually, 30 or 40 students would be on hand for each survey. Before each survey one group of students would visit each benchmark. At each location they would mark the transit measuring 10° west of north from the benchmark with a hand-bearing compass and by putting a small stake just above the swash zone. At the beginning of each survey transit, a line would be laid out from the benchmark to the stake. Measurements were made along this line by using two staffs five feet long. The measurements would begin to be made as close to the water level as possible and continue along the line to the benchmark. The staffs are graduated into feet and tenths of a foot and connected by a five-foot string. One end of the string was attached to the three-foot mark on one staff, and the other end was looped around the second staff and was free to slide along it. A line-level was attached to the string. A measurement was made by holding the staffs along the line with the string taut and then the free end of the string was slid up or down until it was level. The height difference between the two staffs was then read off and recorded. The measurement was repeated every five feet across the width of the beach. At the station marker the elevation of the top of the stake relative to the staff was measured. Measurements were recorded on a standardized data sheet (Fig. AI-1). The time and date of the surveys were chosen to be as close to spring low tide as possible and all measurements were made within an hour of the time of low water. This was done so that the widest section of the beach could be measured each time. This was only possible by having a large number of students working simultaneously. One group of three students could easily make 120 to 150 measurements in two hours. During the survey another group would travel the entire length of the beach and measure transits at preselected stations. These transits served as a check on the students' work. The number of stations that could be repeated depended primarily upon the width of the beach and ranged from four to thirteen. The initial surveys were done every two weeks so that we could resolve problems quickly. Later, surveys were done at intervals of about one month according to the tides.

The following are some of the problems we encountered and some suggestions for improving the procedure:

1. The most serious difficulty in interpreting the data was in reading the numbers. Some students did not record the measurements properly. For example, "65." has been written instead of "0.65." While some of these mistakes are easy to catch, others are ambiguous. For example, in some places we could not be sure that what was written as "1.5" was not supposed to be "0.15." If these uncertainties can not be resolved by comparing duplicate transects, the whole transect can be invalid. This situation was ameliorated by labeling the lines on the measuring staff. Perhaps the divisions could even be color-coded to reduce the chance of errors.

2. Everyone did not fill out all the blanks on the data form. The students should label each form with their full names, not just their first names. It is important to be able to recognize individual or group biases in the measurements and knowing who's who helps. The starting and finishing time is also important for planning future surveys. It also helps to know the sequence in which the stations were done in order to account for the tides.

3. Even though a schedule was made beforehand so that each group of students would make approximately the same number of measurements, it was sometimes necessary to make adjustments in the field perhaps because a post was missing or the beach at some location was unexpectedly wide or the beach had lowered so that some of the posts that were on bulkheads could not be easily reached. One disadvantage to employing high school students was that because of their inexperience, when unusual situations arose, the survey group was not able to complete the survey or would make the wrong decision about how to modify the measuring technique to meet unexpected conditions. For this reason, supervisors should check the students' progress in the field as often as possible and be alert to potential difficulties.

4. It is very important that the measurements at the post be made correctly. These measurements are the only way we have to determine the absolute elevation and position of the survey so that sequential surveys can be compared to one another and to other surveys made on the same day. If these critical measurements are not made or made incorrectly or ambiguously the entire profile is useless. The students should be carefully trained to make the proper measurements.

5. As many stations as possible should be repeated, or duplicated. These measurements are needed to assess the quality of the data. They can be repeated in two ways--one station can be done by two different groups of students or the profile on one station can be done twice by the same group perhaps working upbeach on one and working downbeach on the other. Both methods should be used if

there is time. If this cannnot be done, the first method should be used if the supervisor does not believe that all students are making the measurements accurately or correctly. If the supervisor believes that all groups are competent, and the equipment has been calibrated beforehand, then the second method should be used.

6. The largest differences between duplicate measurements were caused by faulty equipment. If the string connecting the staffs is slightly too long or short or if the line level is not suspended freely, a consistent error will be present in the measurement. We suggest that each set of staffs be checked before each survey. When the measurements were being made the most common errors were made by not keeping the string taut or not holding the staffs vertical.

Profiles were plotted from all the data within a few days after each survey. The profiles were done with a five-fold vertical exaggeration, and the position and height of the post were also plotted. Successive profiles were compared by overlaying the two graphs, carefully superimposing the posts and aligning the axes. The proper position of mean sea level was plotted relative to the top of the post. The difference between the profiles was then measured with a planimeter to within ± 10%.

The wave data were collected twice a day by two different student observers using standard data sheets (Fig. AI-2). The data are tabulated in Appendix II, and the accuracy of the data and the data analysis is discussed in the text. The biggest problem we had with this part of the project was an unexpected rapid turnover in the student observers. We believe that the quality of the data would be better if the same two observers could consistently make all the measurements. This, unfortunately, was not the case during our project; the observers changed several times during the study period.

Table AI-I

Station locations

Station	Long Island Lambert Grid Coordinates East	Long Island Lambert Grid Coordinates North	Elevation to top of post. Ft. above MSL	Comments
1	2,500,809	267,576	24.9	400 feet east of groin on an unobstructed dune. (Post 1A was placed seaward of Post 1 on 4 Oct. 1979; elevation to top of 1A was 17.9 feet.)
2	2,500,540	267,453	22.7	100 feet east of groin on an unobstructed dune. (Post 2A was placed seaward of Post 2 on 4 Oct. 1979; elevation to top of 2A was 18.9 feet.)
3	2,500,352	267,366	20.2	115 feet west of groin on an unobstructed dune.
4	2,500,139	267,290	21.4	335 feet west of groin on an unobstructed dune.
5	2,499,838	267,177	27.5	660 feet west of groin on an unobstructed dune. (Post 5A was placed seaward of Post 5 on 4 Oct. 1979; elevation to top of 5A was 17.1 feet.)
6	2,498,490	266,504	20.3	Southernmost wooden fence post on southwest corner of parking lot.
7	2,498,244	266,295	9.6	East end of rock revetment.
8	2,497,772	266,069	13.4	East inside corner of aluminum bulkhead.
9	2,497,413	265,860	14.8	West inside corner of wooden bulkhead.
10	2,496,905	265,635	16.2	West end of rock revetment. (Post 10A was placed seaward of Post 10 on 20 Nov. 1979; elevation to top of 10A was 11.6 feet. Post 10A was lost between 18 Dec. 1979 and 3 Jan. 1980.)

Table AI-I (concluded)

Sta-tion	Long Island Lambert Grid Coordinates East	North	Elevation to top of post. Ft. above MSL	Comments
11	2,496,640	265,508	19.6	East end or rock revetment. (Post 11A was placed seaward of Post 11 on 20 Nov. 1979; elevation to top of 11A was 11.0 feet.)
12	2,494,660	264,544	22.3	100 feet west of rock revetment (that was constructed during the winter of 1979-80) on unobstructed dune. (Post 12A was placed seaward of Post 12 on 3 Jan. 1980; elevation to top of 12A was 15.2 feet.)
13	2,494,120	264,178	15.4	East end of rock revetment. (Post 13A was placed seaward of Post 13 on 20 Nov. 1979; elevation to top of 13A was 14.0 feet.)
14	2,493,746	264,026	16.7	Center of rock revetment.
15	2,493,424	263,850	13.6	West end of rock revetment.
16	2,492,693	263,484	18.0	350 feet east of groin on an unobstructed dune.
17	2,492,441	263,319	18.8	50 feet east of groin on an unobstructed dune.
18	2,492,240	263,196	17.9	Between two groins, 180 feet west of one groin, 1,240 feet east of the other.
19	2,491,885	263,049	19.4	Between two groins, 570 feet west of one groin, 850 feet east of the other.
20	2,491,527	262,850	17.2	Between two groins, 980 feet west of one groin, 440 feet east of the other.

Figure AI-1. Survey data sheet.

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EAST HAMPTON HIGH SCHOOL SURVEY SHEET

1. STUDENTS____________, ____________, ____________, ____________

2. DATE________ 3. LOCATION NUMBER________ 4. STARTING TIME________

5. IS THIS TRANSECT UPBEACH OR DOWNBEACH?

6.

MEASUREMENT NUMBER	CHANGE IN HEIGHT (IN FEET)	MEASUREMENT NUMBER	CHANGE IN HEIGHT (IN FEET)	MEASUREMENT NUMBER	CHANGE IN HEIGHT (IN FEET)

THERE ARE MORE SPACES ON THE OTHER SIDE

7. MEASUREMENT NUMBER_____ GOES PAST THE POST (THE NUMBER ON THE POST IS______).

8. THE LAST STAFF GOES_____ FEET BEYOND THE POST.

9. THE TOP OF THE POST IS____ FEET ABOVE THE ELEVATION OF THE BASE OF THE STAFF CLOSEST TO IT ON THE SEAWARD SIDE.

10. FINISH TIME____________________.

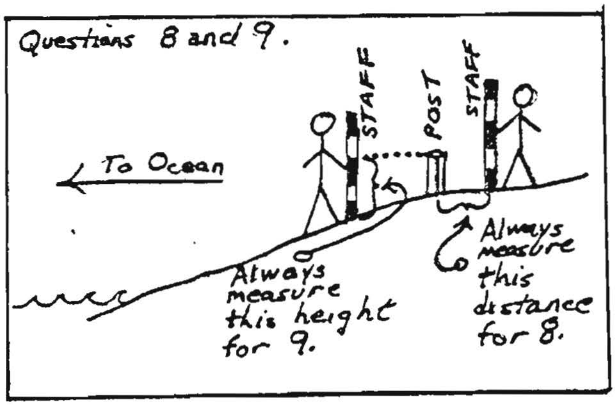

Figure AI-2. Wave data sheet.

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EAST HAMPTON HIGH SCHOOL WAVE STUDY

DAY: MON., TUES., WED., THURS., FRI., SAT., SUN.

DATE_____ START TIME_____OBSERVER_____________LOCATION___________

1. THE WAVE HEIGHT IS

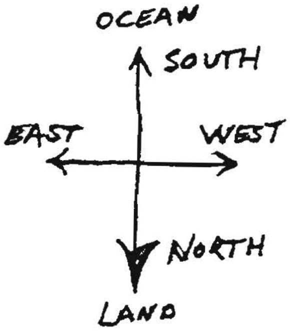
   A. LESS THAN 1 FOOT
   B. BETWEEN 1 AND 3 FEET
   C. BETWEEN 3 AND 5 FEET
   D. OVER 5 FEET (ABOUT _______FEET).

2. THE TIME NEEDED FOR 10 WAVES TO HIT THE SHORE IS

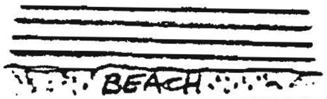
   ______________MINUTES AND ______________SECONDS

3. HERE ARE SEVERAL DIAGRAMS SHOWING VARIOUS ANGLES AT WHICH WAVES ATTACK THE BEACH. WHICH DIAGRAM BEST REPRESENTS TODAY'S CONDITIONS?

   A, B, C, D, E, F, G, H



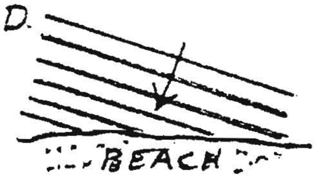
A.



B.

C.

D.



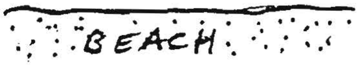
E.

F.

G.

H.

OTHER? PLEASE DRAW YOUR OWN



4. ARE WAVES BREAKING FAR OFFSHORE (THAT IS, ARE THEY BREAKING ON THE OFFSHORE BAR)? YES, NO

5. BY STANDING AT SEA LEVEL THE ANGLE OF WAVE ATTACK CAN BE MEASURED WITH THE HAND BEARING COMPASS.

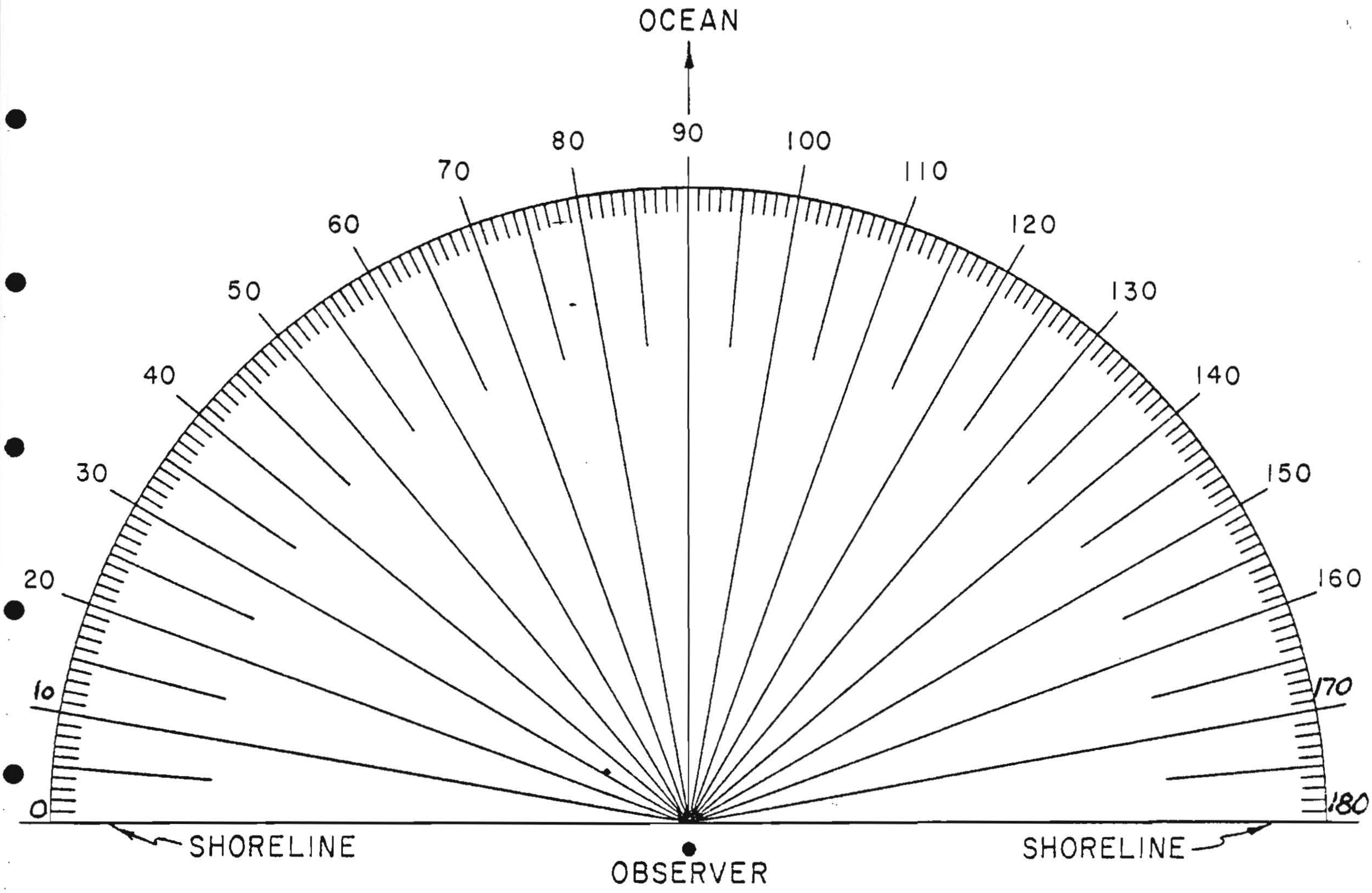
   A. THE WAVES' CRESTS ARE AT _______° MAGNETIC,

   B. THE SHORELINE IS AT______° MAGNETIC FROM THE OBSERVATION POINT.

Figure AI-2. Continued

5. PLEASE REPEAT THE TIMING OF THE WAVES. THE TIME NEEDED FOR 10 WAVES TO HIT THE SHORE IS NOW__________MINUTES AND __________ SECONDS.

6. LET'S TRY ONE MORE TYPE OF MEASUREMENT OF THE ANGLE OF THE WAVE ATTACK. HERE IS A PROTRACTOR; LINING THE BASE OF IT UP WITH THE SHORELINE INDICATE THE ORIENTATION OF THE WAVE CRESTS.



7. FINISH TIME__________.

5

APPENDIX II

TABLE OF WAVE DATA

This is the wave data collected during our study and the calculated energy flux as described in the text. The wave height classifications are as follows:

A = less than 1 foot
B = 1 to 3 feet
C = 3 to 5 feet
D = over 5 feet

In some cases, the observer specified a value for the wave height. When this was done the value was entered in the table. (If a different range was specified, the tabulated value is the root-mean-square of the extreme values.) Two values for the angle of attack were measured by different methods. The first value in Table AII-I is from question 2 on the data sheet (Fig. AI-2); the second angle recorded in the table is from question 6. The energy flux was calculated with each angle in two ways using two equations from the *Shore Protection Manual* (U.S. Army Corps of Engineers, 1971). The value labeled "I" in the table was calculated from equation 4-34 using the wave height and angle of attack. The value labeled "II" was calculated from equation 4-28 using the wave height, the angle of attack, and the wave period. The direction of the energy flux is tabulated as to the east (E) or to the west (W).

Table AII-I

Wave data

Date 1979	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec		Angle °	Energy flux ft-lbs/ft-sec		Dir
					I	II		I	II	
Oct 22	B	7.78		0	0	0				
23	B	6.67		0	0	0				
24	A	8.11		2.5	2.80	2.19				E
25	B	7.22		2.5	21.01	15.78				E
26	A	10.00		0	0	0				
27	A	10.00		0	0	0				
28	3.0	5.00		5	86.89	55.99				W
31	A	4.44		0	0	0				
Nov 1	A	7.22		0	0	0				
2	B	5.55		2.5	21.01	15.01				E
3	3.0	6.11		2.5	45.08	31.62				E
4	B	8.89		2.5	21.01	16.65				W
5	B	8.33		0	0	0				
6	A	7.22		0	0	0				
7	A	6.67		0	0	0				
8	A	5.55		2.5	2.80	2.19				E
9	B	10.56		2.5	21.01	15.38				E
10	C	11.66		15.0	552.99	410.43				E
11	C	12.78		2.5	96.39	67.48				E
12	B	7.78		5.0	41.86	31.57				W
13	A	11.78		0	0	0				
14	B	10.11	10.56	0	0	0	2.0	16.82	12.91	E
15	B	9.56	10.22	2.5	21.01	15.44	17.5	138.27	102.90	E
16	B	11.22	11.67	2.5	21.01	16.08	17.0	134.80	119.14	E
17	B	9.89	10.11	2.5	21.01	15.61	18.0	141.69	114.45	E
18	B	8.33	9.22	2.5	21.01	15.99	18.0	141.69	109.63	E
19	B	10.22	10.66	0	0	0	2.0	16.82	13.04	E
20	A	11.22	10.94	2.5	2.80	2.07	6.0	6.67	4.83	W
21	A	11.11	10.27	2.5	2.80	2.08				W
22	B	12.22		0	0	0				
23	B	12.22	14.67	0	0	0	2.0	16.82	13.15	W
24	B	11.00	11.55	0	0	0				

Table AII-I (continued)

Date 1979	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Dir
Nov 25	B	11.44	10.44	2.5	21.01	16.51	5.0	41.86	33.01	W
26	7.5	8.89	7.78	2.5	433.86	293.40	2.0	347.24	244.50	W
27	D	5.11	5.11	2.5	156.40	105.97	5.0	311.60	211.93	E
28	B	7.22	6.11	2.5	21.01	18.04	12.0	98.05	76.34	E
29	B	6.11	5.67	2.5	21.01	15.32	9.0	74.49	55.16	E
30	B	3.89	4.44	5.0	41.86	28.64	16.0	127.74	91.12	E
Dec 1	B	6.78	5.89	2.5	21.01	15.17	5.0	41.86	31.66	E
2	B	9.56	10.11	2.5	21.01	15.36	9.0	74.49	56.31	E
6	B	10.00	9.22	0	0	0	2.0	16.82	12.50	E
7	A	9.22	8.89	0	0	0	4.0	4.47	3.38	E
8	B	9.22	8.67	2.5	21.01	14.90	15.0	120.53	93.12	E
9	B	7.89	8.22	2.5	21.01	15.51	21.0	161.30	117.41	E
10	B	7.33	6.67	5.0	41.86	34.23	26.0	189.96	138.39	E
11	B	8.33	8.89	2.5	21.01	15.68	12.5	101.88	77.04	E
12	A	10.00	10.33	0	0	0	2.5	2.80	2.11	E
13	A	9.44	10.00	0	0	0	4.0	4.47	3.12	E
14	A	10.00		0	0	0	5.0	5.57	4.15	E
15	A	9.89	10.56	0	0	0	5.0	5.57	4.24	E
17	A	11.11	10.56	2.5	2.80	2.02	10.0	10.98	6.74	E
18	A	8.33	8.89	2.5	2.80	2.23	10.0	10.98	7.14	W
19	B	12.22	12.78	2.5	21.01	51.61	10.0	82.45	52.02	W
20	B	10.00	7.78	15.0	120.53	83.25	20.0	154.95	92.50	W
21	B	8.34	7.22	5.0	41.86	30.76	20.0	154.95	117.38	W
22	C	7.78	7.22	5.0	192.05	142.56	15.0	552.99	422.39	W
23	B	10.00	11.11	2.5	21.01	15.38	5.0	41.86	32.96	E
25	C	10.00	9.44	5.0	192.05	143.70	5.0	192.05	145.70	E
26	C	10.00	10.56	5.0	192.05	144.74	5.0	192.05	144.74	E
27	A	8.89	8.33	5.0	5.57	4.20	8.0	8.85	6.25	E
28	B	5.00	6.11	5.0	41.86	10.41	14.5	116.87	86.78	E
29	A	7.22		5.0	5.57	4.34	20.0	20.63	14.97	E
30	A	6.11		15.0	16.05	11.40	20.0	20.63	16.47	E
31	A	8.89		0	0	0				

Table AII-I (continued)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	II	Angle °	Energy flux ft-lbs/ft-sec I	II	Dir
Jan 1	A	8.89		5.0	5.57	4.42	15.0	16.05	10.51	W
3	1.70	5.78	5.56	5.0	96.80	73.90	25.0	41.86	31.79	W/E
4	B	6.11	6.89	5.0	41.86	31.79	21.5	164.40	121.74	W
5	B	8.89	9.44	2.5	21.01	14.31	11.5	94.19	70.61	W
6	B	7.78	6.67	5.0	41.86	31.60	21.5	164.40	127.89	W
7	B	6.11	5.56	5.0	41.86	31.60				W
8	B	5.00	5.56	15.0	120.53	87.90	38.5	234.88	192.28	W
9	B	6.11	6.11	5.0	41.86	31.79	21.0	161.30	123.97	W
27	B	8.11	7.78	2.5	21.01	15.72	14.0	113.17	86.85	E
28	B	8.33	8.00	0						
29	C	13.33	12.70	15.0	552.99	366.64	15.0	552.99	366.64	W
30	C	14.22	14.44	5.0	192.05	151.32	22.0	768.28	756.61	W
31	B	12.22	11.66	2.5	21.01	16.15	30.0	208.76	149.08	W
Feb 1	A	7.78	7.56	2.5	2.80	2.23	3.0	3.36	2.70	E
2	A	8.89	8.56	15.0	16.05	9.05	30.0	27.80	16.29	E
3	A	5.56	5.22	5.0	5.57	3.91	11.0	12.02	8.94	E
4	A	5.56	5.89	5.0	5.57	4.16	11.0	12.02	9.03	E
6	B	6.11	7.22	5.0	41.83	31.92	17.0	134.80	97.16	W
7	C	8.56	8.89	2.5	96.39	70.68	32.5	1,002.36	860.42	W
8	B	8.56	8.89	15.0	120.53	95.38	18.0	141.69	122.63	E
10	B	14.44	13.78	2.5	21.01	14.68	6.0	50.12	38.17	E
11	C	11.67	12.22	0	0	0	30.0	957.81	841.27	E
12	B	8.89	9.44	5.0	41.86	31.49	25.0	186.66	162.20	E
13	B	11.67	13.33	2.5	21.01	16.91	5.0	41.86	31.86	E
14	B	4.44	4.76	5.0	41.86	29.42	35.0	226.52	185.04	E
15	A	7.22		2.5	2.80	2.10	10.0	10.98	8.23	E
16	A									
17	B	13.00	13.89	2.5	21.01	16.09	7.0	58.32	44.78	E
18	B	7.78	8.33	15.0	120.53	92.25	20.0	154.95	117.41	E
19	B	6.67	6.11	15.0	120.53	92.79	20.0	154.95	125.93	E
20	A	13.89	13.33	0	0	0	0	0	0	
20	B	7.78	6.67	0	0	0	0	0	0	
21	C	7.78	6.67	2.5	96.39	66.17	19.5	696.02	534.43	W
21	2.45	11.67	11.22	2.5	26.29	19.95	5.0	52.37	41.33	W

Table AII-I (continued)

Date 1980		Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec		Angle °	Energy flux ft-lbs/ft-sec		Dir
						I	II		I	II	
Feb	22	B	6.67	6.67	5.0	41.86	31.23	10.0	82.45	62.46	W
	22	B	7.22	7.22	2.5	21.01	15.02	10.0	82.45	60.10	E
	23	B	11.89	9.78	2.5	21.01	15.85	11.0	90.30	62.26	E
	23	C	6.67	6.67	0	0	0	0	0	0	
	24	B	6.45	7.11	2.5	21.01	16.23	5.0	41.86	32.45	E
	24	B	6.67	6.67	0	0	0	0	0	0	
	25	B	7.78	7.78	2.5	21.10	16.19	5.0	41.86	31.57	W
	25	B	7.44	7.89	0	0	0	0	0	0	
	26	B	7.78	5.33	2.5	21.01	15.36	16.0	127.74	92.15	W
	26	1.73	8.33	8.77	2.5	11.01	7.96	7.0	30.57	22.29	W
	27	B	5.33	5.89	2.5	21.01	15.18	10.0	82.45	61.29	W
	27	1.50	6.67	7.22	5.0	15.36	12.00	10.0	30.25	24.00	E
	28	B	6.89	6.33	5.0	41.86	32.32	11.0	90.30	63.27	E
	28	B	11.11	11.44	2.5	21.01	16.40	7.0	58.32	45.69	W
	28	1.40	11.67	11.11	2.5	6.49	4.63	12.0	30.28	19.44	W
	29	A	7.11	7.78	2.5	2.80	2.24	13.0	14.07	9.70	E
	29	A	10.89	11.56	2.5	2.80	2.24	22.0	22.30	18.16	E
	29	A	6.67	5.33	2.5	2.80	2.15	22.0	22.30	17.71	E
Mar	1	A									
	1	A									
	1	A									
	2	B	10.89	11.67	2.5	21.01	16.43	15.0	120.53	82.16	W
	2	A	11.11	11.67	2.5	2.86	2.13	12.0	13.06	8.74	W
	3	C	7.22		2.5	96.39	66.08	23.0	795.58	635.35	W
	3	C	8.89	9.78	2.5	96.39	72.28	23.0	795.58	591.77	W
	4	C	11.11	11.11	0	0	0				
	4	C	7.89	9.33	0	0	0				
	5	C	6.22	5.56	15.0	552.99	373.18	27.5	905.97	663.44	E
	5	C	6.67	7.11	20.0	710.91	533.55	35.0	1,039.28	727.57	E
	6	C	6.67	6.33	2.5	96.39	62.92	14.0	519.23	343.19	E
	6	C	7.78	8.11	2.5	96.39	69.96	7.5	286.25	190.29	E
	7	B	7.89	7.56	5.0	41.86	30.56	19.0	148.41	112.60	E
	7	B	6.67	6.44	5.0	41.86	31.40	22.5	170.46	136.51	E

Table AII-I (continued)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Dir
Mar 8	B	10.78	11.44	5.0	41.86	32.37	11.5	94.19	62.42	E
8	B	11.11	10.78	2.5	21.01	17.09	8.0	66.45	47.85	E
9	2.34	4.44	4.00	2.5	22.69	16.34	18.0	153.02	112.07	E
9	2.34	5.56	5.89	2.5	23.43	171.94	17.0	1.21	0.65	E
10	B	7.89	8.22	15.0	120.53	100.64	31.5	214.79	167.73	E
10	B	11.11	9.56	15.0	120.53	86.07	31.5	214.79	139.86	E
11	B	7.11	7.44	2.5	21.01	15.91	13.0	105.67	83.32	E
11	B	6.67	6.33	2.5	21.01	14.88	16.0	127.74	94.68	E
12	B	8.33	7.89	5.0	41.86	32.91	25.0	184.66	135.01	E
12	B	7.78	7.44	2.5	21.01	16.63	16.0	127.74	98.98	E
13	B	6.67	7.00	15.0	120.53	99.64	31.0	212.84	128.11	W
13	2.00	5.56	6.00	15.0	90.79	64.72	35.0	170.63	134.24	W
14	B	8.89	8.44	0						
15	B	11.56	10.78	2.5	21.01	16.27	18.0	141.69	104.60	E
16	B	11.56	10.78	2.5	21.01	16.27	8.0	66.45	52.30	E
17	A	11.67	10.89	0	0	0				
17	A	10.00	8.89	2.5	2.80	1.96				E
18	B	9.00	8.56	5.0	41.86	31.97	11.5	94.19	67.60	E
19	B	10.78	10.00	0						
20	C	6.44	6.67	5.0	192.05	127.00	34.0	1,025.45	877.45	E
21	B	8.33	7.78	2.5	21.01	15.10	13.0	105.67	83.86	W
22	2.45	5.56	5.00	15.0	150.80	115.11	24.5	227.61	187.06	W
22	2.45	5.56	5.33	15.0	150.80	115.32	22.5	213.26	115.32	W
23	4.53	10.00	9.78	5.0	243.46	159.93	22.0	973.92	631.29	W
24	B	7.79	7.22	5.0	41.86	31.46	17.0	134.80	102.26	W
24	B	7.78	5.56	5.0	41.86	31.92	17.0	134.80	97.16	W
25	C	8.67	8.33	15.0	552.99	403.91	23.0	795.58	568.47	W
25	C	8.89	9.33	15.0	552.99	432.90	32.0	994.05	673.40	W
26	C	10.89	10.11	2.5	96.39	70.22	24.0	821.90	739.18	W
26	1.73	11.11	9.67	2.5	11.01	8.61	16.0	66.96	39.73	W
28	C	5.11	6.67	15.0	552.99	362.82	20.0	710.91	518.31	W
Apr 1	C	8.33	7.22	5.0	192.05	142.40	15.0	552.99	438.16	W
1	B	11.11	11.67	2.5	21.01	16.59	14.0	113.17	88.88	W

Table AII-I (continued)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Dir
Apr 2	B	10.56	10.56	5.0	41.86	31.86	10.0	82.45	59.33	W
2	B	9.44	10.11	0	0	0				
3	B	8.89	10.11	5.0	41.86	29.65	18.0	141.69	128.50	E
3	B	8.33	8.89	2.5	21.01	16.13	10.0	82.45	62.71	W
4	C	6.89	7.00	5.0	192.05	146.78	20.0	710.91	538.20	W
4	B	12.22	11.56	15.0	120.53	84.13	27.0	195.02	56.91	W
5	C	6.67	6.89	5.0	192.05	143.40	29.5	948.01	836.52	W
5	A	13.89	13.00	2.5	2.80	2.23	7.5	8.31	5.58	W/E
6	B	6.67	6.89	0			10.0	82.45	62.79	W
6	A	14.44	13.33	0						
7	A	9.44	9.44	2.5	2.80	1.96	5.0	5.57	4.31	W
7	B	9.44	10.33	2.5	21.01	15.44	18.0	141.69	98.79	W
8	A	10.00	10.00	2.5	2.80	1.95	7.5	8.31	6.43	W
8	B	10.78	10.00	5.0	41.86	34.59	32.0	216.66	151.35	W
9	B	8.00	8.89	2.5	21.01	15.83	10.0	82.45	63.30	E
9	C	8.33	8.33	2.5	96.39	70.37	5.0	192.05	146.61	W
9	B	11.89	12.78	0	0	0				
10	C	7.78	7.56	15.0	552.99	283.48	34.0	1,025.45	944.93	W
10	C	7.78	7.78	2.5	96.39	71.20	10.0	378.27	314.93	W
11	C	8.89	9.45	5.0	192.05	148.47	10.0	378.27	290.50	E
11	2.45	5.44	6.11	5.0	52.37	39.57	28.5	252.94	215.84	W
12	B	8.89	8.34	5.0	41.86	31.39	10.0	82.45	62.78	E
12	2.35	6.67	6.67	2.5	23.68	17.95	23.0	195.48	183.32	W
13	B	7.78	8.34	2.5	21.01	15.93	11.0	90.30	67.09	E
13	C	8.33	8.78	0	0	0				
14	B	5.56	6.11	5.0	41.86	32.81	10.0	82.45	66.84	W
14	B	10.00	9.33	5.0	41.86	32.10	20.0	154.95	120.74	W
15	B	5.56	6.11	15.0	120.53	91.15	20.0	154.95	124.57	E
15	B	10.89	10.00	5.0	41.86	31.53	13.5	109.44	78.29	E
16	C		8.89	5.0	192.05	147.07	20.0	710.91	563.26	E
16	B	8.89	10.11	0	0	0				
17	B	8.89	8.89	2.5	21.01	15.72	19.0	148.41	152.62	E
17	B	12.22	11.55	2.5	21.01	16.70	23.0	173.40	61.86	E

Table AII-I (continued)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	II	Angle °	Energy flux ft-lbs/ft-sec I	II	Dir
Apr 18	A	7.78	8.33	5.0	5.57	4.17	15.0	16.05	9.19	E
18	C	5.33	6.33	2.5	96.39	65.67	2.5	96.39	65.67	E
19	A	11.67	12.22	5.0	5.57	4.21	10.0	10.98	5.45	E
19	C	5.33	6.33	2.5	96.39	65.62	26.0	871.53	656.68	W
20	A	8.33	7.78	5.0	5.57	3.34	5.0	5.57	3.34	E
20	B	10.00	8.89	5.0	41.86	31.46	12.5	101.88	74.73	W/E
21	B	9.44	8.88	15.0	120.53	95.31	30.0	208.76	114.37	E
21	B	9.11	8.78	2.5	2.80	2.09	13.0	511.74	385.10	E
22	A	8.33	7.78	2.5	2.80	2.09	5.0	5.57	4.35	E
22	B	6.56	7.11	5.0	41.86	92.52	16.0	127.52	92.52	E
23	B	11.67	12.22	2.5	21.01	16.16	5.0	41.86	32.33	E
23	C	4.44	5.11	15.0	552.99	403.81	27.0	894.76	588.89	E
24	B	13.33	13.89	2.5	21.01	16.99	5.0	41.86	36.82	W
24	B	9.67	10.44	2.5	21.01	15.18	17.0	134.80	94.21	W
25	B	7.78	8.33	5.0	41.86	31.03	20.0	154.95	125.80	W
25	B	10.56	10.89	5.0	41.86	33.49	18.0	141.69	72.57	E
26	B	5.89	9.44	2.5	21.01	15.96	10.0	82.45	62.25	W
26	C	8.89	9.67	15.0	552.99	391.98	24.0	821.90	587.97	E
27	B		9.44	2.5	21.01	15.72	7.5	62.39	49.11	W
27	A									
28	A	14.67	13.33	5.0	5.57	4.35	12.0	13.06	10.16	W
29	C	8.33	7.78	6.0	229.95	198.60	5.0	192.05	141.85	E
29	A									
30	C	11.67	12.22	5.0	192.05	147.22	10.0	378.27	365.95	E
30	B	11.11	11.55	5.0	41.86	33.60	18.0	141.69	70.73	W
May 1	C	8.89	8.33	2.5	96.39	83.34	5.0	192.05	145.47	W
1	B	11.11	10.78	2.5	21.01	15.95	7.0	58.32	43.29	W
2	B	11.11	11.67	5.0	41.86	33.18	15.0	120.53	61.63	W
2	B	9.44	8.66	5.0	41.86	32.02	28.5	202.17	117.71	W
3	C	11.67	12.22	15.0	552.99	403.81	15.0	552.99	403.81	W
3	C	6.56	7.44	15.0	552.99	394.23				W
4	B	12.22	11.67	2.5	21.01	16.16	5.0	41.86	32.33	W
4	C	7.11	6.67	5.0	192.05	133.39	27.0	894.76	666.94	W/E

Table AII-I (continued)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Angle °	Energy flux ft-lbs/ft-sec I	Energy flux ft-lbs/ft-sec II	Dir
May 5	A	8.89	8.33	2.5	2.80	2.14	2.0	2.24	1.70	W
5	C	7.89	6.67	15.0	552.99	410.00	32.5	1,002.36	884.07	W
6	B	10.78	10.56	0	0	0				
6	B	11.67	12.22	2.5	21.01	16.16	5.0	41.86	32.95	E
7	B	8.33	8.89	2.5	21.01	15.68	5.0	41.86	33.15	E
7	B	10.56	11.11	2.5	21.01	15.79	18.0	141.69	101.51	W
8	B	11.67	10.89	5.0	41.86	32.86	18.0	141.69	105.63	E
9	B	10.78	10.00	5.0	41.86	31.35	23.0	173.40	135.13	E
10	B	7.56	7.78	0	0	0				
10	A	8.33	8.89	2.5	2.80	2.05	5.0	5.57	4.11	E
11	C	6.67	7.11	2.5	96.39	66.69	11.0	414.31	278.90	W
12	C	6.67	5.56	5.0	192.05	129.25	10.0	378.27	269.28	E
13	C	5.22	5.11	5.0	192.05	134.67	23.0	795.58	545.94	W
13	C	7.78	7.78	5.0	192.05	150.62	14.0	519.23	397.09	E
14	C	6.67	5.56	5.0	192.06	129.25	10.0	378.27	269.28	E
14	B	8.89	9.00	5.0	41.86	32.59	18.0	141.69	111.75	E
15	B	6.11	7.20	5.0	41.86	31.88	10.0	82.45	63.75	W
15	B	11.89	11.11	5.0	21.01	16.15	17.0	134.80	102.90	E
16	C	6.11	5.78	15.0	552.99	397.93	13.0	484.83	335.09	W
16	B	10.00	8.89	2.5	21.01	16.22				E
16	B	8.56	9.33	5.0	41.86	31.66	23.0	173.40	121.06	W
17	B	8.33	8.89	5.0	41.86	32.25	5.0	41.86	32.25	E
17	A									
18	B		8.33	2.5	21.01	16.47	5.0	41.86	32.07	E
18	A									
19	B	12.22	12.44	5.0	41.86	32.07	24.0	179.14	102.63	W
19	C	5.00	5.55	5.0	192.05	133.31	11.0	414.31	277.72	E
20	B	8.89	9.44	15.0	120.53	114.50	10.0	82.45	62.02	W
20	B	10.00	11.22	2.5	21.01	15.18	28.0	199.85	163.44	W
21	B	8.33	8.33	15.0	120.53	95.34	10.0	82.45	64.14	W
21	B	9.44	10.44	0	0	0	0	0	0	
22	C	8.33	7.78	5.0	192.05	141.85	9.5	360.07	272.36	E
22	B	8.89	9.33	0	0	0	0	0	0	

Table AII-I (concluded)

Date 1980	Wave ht	Period sec		Angle °	Energy flux ft-lbs/ft-sec		Angle °	Energy flux ft-lbs/ft-sec		Dir
					I	II		I	II	
May 23	B	10.56	10.89	2.5	21.01	16.75	18.0	141.69	78.15	E
23	A	9.44	9.44	2.5	2.80	2.35	10.0	10.98	7.24	E
24	A	8.33	8.89	5.0	5.57	4.29	10.0	10.98	7.50	E
24	C	6.17	5.44	5.0	192.05	136.52	17.5	634.37	447.95	W
25	B	10.00	11.56	0	0	0	0	0	0	
26	A	6.67	7.22	5.0	5.57	4.32	10.0	10.98	7.93	E
26	B	11.11	10.78	2.5	21.01	15.95	22.0	167.45	136.72	W
27	B	10.00	10.89	0	0	0	0	0		
27	A									
28	A	8.33	7.78	2.5	2.80	2.17	7.0	7.77	5.01	E
28	B	10.89	10.56	5.0	41.86	32.38	22.0	167.45	111.64	W
29	B	10.00	9.86	5.0	41.86	33.13	21.5	164.40	139.76	W
29	B	7.77	8.33	5.0	41.86	30.99	10.00	82.45	61.98	W
30	B	10.22	9.89	2.5	21.01	16.22	17.00	134.80	104.67	E

APPENDIX III

SUPPLEMENT

This appendix was written one month after the main part of the report for two reasons. Some beach profiles were made in July but were not analyzed in time to be included in the text. The results of that survey will be reported here. In this appendix I will also discuss further the measurements of the beach width.

Additional volume changes. A partial survey was done on 14 July 1980 with the help of Mr. Arthur Cooley and his students. The stations that were profiled were numbers 1, 8, 10, 13, 16, and 19. Between 29 May and 14 July the measured volume changes at these stations were as follows:

Station	Volume change (yds^3/ft)
1	36.3A
8	7.4A
10	8.9A
13	3.7A
16	6.5A
19	18.2A

Accretion occurred at all stations during this period. The most dramatic change occurred at Station 1. Over the study period from 4 October 1979 to 29 May 1980 this station had shown a net loss of 38.4 yds^3/ft. Between 29 May and 14 July, however, it gained 36.3 yds^3/ft and almost completely recovered from its erosional losses. Station 10 had also shown a net loss of sand up to 29 May. It recovered somewhat by 14 July but not completely; between 4 October and

29 May the net loss at Station 10 was 19.1 yds^3/ft and between 29 May and 14 July it regained 8.9 yds^3/ft, so the net loss here over the entire period was 10.2 yds^3/ft. The observed accretionary trend in the early summer probably occurred throughout the study area; we would expect the summer beach to be continuing to develop prior to the last survey. The net changes from 4 October 1979 to 14 July 1980 were as follows:

Station	Net change (yds^3/ft)
1	2.1E
8	8.1A
10	10.2E
13	9.1A
16	18.5A
19	43.9A

Comments on the beach width. The question was asked whether or not the beach was narrower in front of bulkheads and revetments than it was in other places. The measurements are not designed to answer this question because the station marker stakes were set at arbitrary distances from the shoreline so that the widths of the beach from the stakes to sea level can not be compared directly among stations. Nevertheless, further discussion of the data is appropriate. Typical changes in the position of the shoreline between surveys were about 40 feet. The largest excursions of the shoreline occurred during the winter and advances and retreats of almost 100 feet may occur in several weeks (e.g. Table V, Stations 16 and 18 between 18 January and 1 February, and Stations 3 and 4 between 18 December and 18 January). If we assume that the typical berm elevation is 8 feet and that the maximum foreshore slope is typically 0.175, then the narrowest, natural beach would have a width of 46 feet. To compare this value to undisturbed stretches we should measure the beach width in undisturbed sections from the foot of the dune. At Station 19, for example (see Fig. 4), there was little change in the beach surface to a distance of about 65 feet from the station marker. In front of the dune the beach changed seasonally and the minimum beach width was about 60 feet as measured on 18 January 1980 (Fig. 4). This is comparable to our prediction of the minimum width. In front of bulkheads (Stations 8 and 9) and in front of one revetment (Station 7) the beach reached a minimum width that was narrower than the calculated minimum value. The magnitudes of the changes at these stations, however, do not appear to be greater than the changes anywhere else along the beach. In fact, they seem to be slightly less. The narrow width is reached because the structure has prevented the natural beach profile from being formed landward of the structure as the shoreline receded.