W.P.

COASTAL STORM DAMAGE 1923 - 1974

Delaware Coastal Management Program

TECHNICAL REPORT NUMBER 4 SEPTEMBER 1977
DELAWARE COASTAL MANAGEMENT PROGRAM
DOCUMENT NO. 1003-78-01-05

Milton, DE
March 7, 1962

Massey's Ditch, DE
March 13, 1962

Rehoboth, DE
March 8, 1962

Rehoboth, DE
March 8, 1962

South Bethany, DE
March 13, 1962

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DELAWARE COASTAL STORM DAMAGE REPORT

1923-1974

A Chronicle of Coastal Storms Including
the Perceptions of Coastal Inhabitants
Regarding Their Reactions to the Threat of
Damaging Coastal Storms

With

Recommendations to Reduce the Impact of Future Storms
on Coastal Residents and Resources

Technical Report Number 4

Delaware Coastal Management Program

April 1977

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Dover, Delaware

Delaware Coastal Management Program

Never does Nature say one thing

and Wisdom another

Juvenal (C 60 - 130 A.D.) <u>Satires</u>

ADDENDUM

THE STORM OF OCTOBER 13-15, 1977

As this technical report was being prepared for printing the Delaware coast experienced a moderately damaging storm. The Delaware Geologic Survey has provided this addendum compiling data and observations of the October 13-15, 1977 storm.

The data presented represents information that the Delaware Geologic Survey was able to gather from the several sources acknowledged in the report. This is not a detailed study of the event, but rather a compilation of basic data that should prove helpful in assessing the nature and effects of the storm and in predicting the impact of similar future events.

This addendum was prepared by John H. Talley, Delaware Geologic Survey from field observations on October 14 and 17, 1977 and from data supplied by the U.S. Geological Survey, National Weather Service, U.S. Coast Guard, Delaware State Division of Highways, and private citizens.

This draft report has been prepared from observations made during the storm and from data collected within three days following the storm. This report, therefore, is subject to revision and modification as additional data become available.

The catagorizing of the degrees of coastal erosion as either minor, moderate, or severe is arbitrary and is based on our visual observations during and immediately following the storm.

I. Precipitation Data - October 13-15, 1977

Location	Latitude	Longitude	Period of Measurement	Amount (inches)
Yorklyn, DE	N39°48'	W75°41'	Total Storm	0.71
Wilmington, DE (NWS)	N39°40'	W75°36'	Total Storm	0.74
Dover, DE (DSHD)	N39°09'	W75°31'	Total Storm	1.16
Bridgeville, DE	N38°45'	W75°37'	Total Storm	0.92
Milford, DE	N38°54'	W75°28'	Total Storm	1.04
Georgetown, DE (U of D)	N38°38'	W75°27'	Total Storm	1.04
Lewes, DE	N38°46'	W75°09'	Total Storm	1.39
Selbyville, DE	N38°28'	W75°06'	Total Storm	2.50*

* Oct. 12-15, 1977

II. Selected Predicted High and Low Tides*(EDST), Oct. 14, 1977

	Indian R. Inlet (Bridge)	Indian R.Inlet (C.G. Station)	Breakwater Harbor	Murderkill Bowers	Woodland Beach
low	0300	0336	0341	0513	0722
high	1000	1007	1007	1103	1255
low	1533	1609	1622	1754	2000
high	2220	2227	2228	2324	--

* Taken from: U.S. Department of Commerce
Tide Tables 1977
East Coast of North and
South America
Including Greenland

III. Tide Gage Data, Indian River Inlet (U.S. Coast Guard Station) October 14-15, 1977.

Time (EDST)	Predicted Stage MLW datum (feet)	Actual Stage MLW datum (feet)	Actual Stage NGVD datum 1929 (feet)	Above Normal MLW datum (feet)
10/14/77				
0100	+0.7	+2.1	+1.3	+1.4
0200	+0.1	+1.6	+0.8	+1.5 (Est.)
0300	-0.3	+1.4	+0.6	+1.7
0400	-0.4	+1.7	+0.9	+2.1
0500	±0.0	+2.1	+1.3	+2.1 (Est.)
0600	+0.7	+2.4	+1.6	+1.7
0700	+1.4	+3.3	+2.5	+1.9
0800	+2.1	+4.1	+3.3	+2.0
0900	+2.5	+4.7	+3.9	+2.2
1000	+2.7	out of service		
* 1007				
1100	+2.5	+5.3	+4.5	+2.8
1200	+2.1	+5.2	+4.4	+3.1
1300	+1.4	+5.0	+4.2	+3.6
1400	+0.6	+4.3	+3.5	+3.7
1500	±0.0	+3.6	+2.8	+3.6
1600	-0.3	+3.1	+2.3	+3.4
** 1609				
1700	-0.2	+2.7	+1.9	+2.9
1800	+0.2	+2.9	+2.1	+2.7
1900	+0.9	+3.5	+2.7	+2.6
2000	+1.5	+4.0	+3.2	+2.5
2100	+1.9	+4.1	+3.3	+2.2
2200	+2.2	+4.2	+3.4	+2.0
* 2227				
2300	+2.1	+4.2	+3.4	+2.1
2400	+1.8	+3.4	+2.8	+1.6
10/15/77				
0100	+1.2	+2.6	+1.8	+1.4
0200	+0.5	+2.0	+1.2	+1.5
0300	-0.1	+1.2	+0.4	+1.3

Est. = estimated
* = high tide
** = low tide

IV. Wind Velocity and Direction at U.S. Coast Guard Station, Indian River Inlet on October 13-15, 1977.

	Time (EDST)	Direction	Velocity (knots)
October 13, 1977	0200	NNW	18
	0500	NNE	30
	0800	NE	25
	1100	NNE	22
	1400	NNE	20
	1700	NNE	22
	2000	NE	21
	2300	N	20
October 14, 1977	0200	NNE	35
	0500	NNE	32
	0800	NNE	40
	1100	N	40
	1400	NW	35
	1700	NNW	20
	2000	WNW	12
	2300	W	20
October 15, 1977	0200	W	25
	0500	W	20
	0800	W	20
	1100	W	20
	1400	W	15

V. Maximum Heights of Tide

	Height	Latitude	Longitude
A. Smyrna River at Rt. 13	+4.17 MSL	N39° 18'31"	W75° 36'34"
B. Murderkill River at Bowers	+7.18 MSL	N39° 03'30"	W75° 23'51"
C. Cedar Creek near Slaughter Beach	+4.96 MSL	N38° 56'06"	W75° 19'26"
D. Indian River at Oak Orchard	+4.76 MSL	N38° 35'45"	W75° 10'24"
E. Indian River Inlet at U.S. Coast Guard Station 1100 hrs., 10/14/77	+4.5 MSL	N38° 37'	W75° 04'

VI. Observed and Reported Road Flooding.

Portions of roads closed by Delaware State Division of Highways due to high water or reported to have been underwater.

A. Rd. 89, Port Mahon.

B. Rd. 349, Pickering Beach

C. Rd. 68, Kitts Hummock.

D. Rd. 18, Bowers Beach.

E. Rt. 36, north of Cedar Creek Bridge.

F. Rd. 203, off of Rt. 36 to Mispillion Light.

G. Rd. 501, South Shore Marina, Indian River Inlet.

H. Rd. 22, in vicinity of Masseys Landing.

VII. Breached or Washover Areas.

A. Northern end of townhouse complex at North Shores north of Rehoboth Beach.

B. Dewey Beach - minor washover at New Orleans Street.

C. Bethany Beach - minor washovers at 1st St., 4th St., Campbell Place, Hollywood St. at the Bethany Arms. Moderate to severe washovers at Ashwood St. and Cedarwood St. with streets under at least one foot of water.

D. South Bethany - along most of Ocean Drive which parallels the ocean.

SUMMARY

1. Strong, 40 knot northeastly winds, gusting to 60 knots coincided with a high tide in the morning of Friday October 14, 1977 resulting in minor to severe beach erosion from Fenwick Island to Cape Henlopen and along the western shore of Delaware Bay. More extensive damage and erosion were averted as the tide remained above normal for only one to one and one-half tide cycles. In addition, the strong N-NE winds which pushed waves onto the beaches and into the bays shifted to NW-W in the

afternoon and evening of October 14 and tended to push water out of the bays and away from the coast thereby preventing a second cycle of wave attack on the beaches and dunes.

2. The degree of beach erosion from Cape Henlopen to Fenwick Island was not consistent. That is, some areas experienced severe erosion while other areas remained relatively unaffected.

    a. Fenwick Island to Indian River Inlet - moderate erosion.

    b. Indian River Inlet to Old Coast Guard Station - severe erosion.

    c. Old Coast Guard Station to Key Box Road - moderate erosion.

    d. Key Box Road to Indian Beach - minor erosion.

    e. Indian Beach to South Rehoboth Beach - moderate erosion.

    f. Rehoboth Beach - minor erosion.

    g. Henlopen Acres, North Shore, and Cape Henlopen State Park - moderate erosion.

3. As in previous coastal storms, the areas which experienced breaches or washovers were concentrated for the most part in high density residential locations at South Bethany Beach, Bethany Beach, Sea Colony and Dewey Beach. The washovers were focused where the dunes are either relatively narrow and low in elevation or non-existent. The high and wide dunes in the undeveloped areas suffered minor to severe erosion depending upon their location along the coast; however, they were not breached.

4. The most severe property damage appeared to be concentrated along Ocean Drive in South Bethany Beach where bulkheads were damaged, fences were destroyed, parking areas were undermined, and septic systems were exposed.

5. Natural beach buildup and restoration processes were observed on Monday, October 17 along the Atlantic coast. Such processes are expected to continue at a relatively rapid rate. However, natural restoration of the dunes is a very slow process and they will have to be reconstructed for the most part by man.

6. The maximum height of tide recorded at the tide gage at the U.S. Coast Guard Station, Indian River Inlet, was 4.5' above MSL (NGVD 1929) or 2.8' above normal. This level was approximately one foot higher than the peak attained during the coastal storm of December 1-2, 1974. The maximum tide level at Oak Orchard was 4.76' above MSL or 0.06 feet lower than that recorded in December, 1974. The beach and dune system along the Atlantic Coast prevented the tide levels behind the barrier beaches from reaching the levels attained in the open Atlantic Ocean.

   Maximum tides in the Delaware Bay areas were only slightly below (1.38' to 0.63') those recorded in December, 1974. Nevertheless, several Delaware Bay communities were surrounded by high waters rising through the marshes. Roads to several of these communities were under water and were closed by the Delaware State Division of Highways.

7. The outgoing tides in the late morning and early afternoon of October 14 along with a change in wind direction from NE to NW-W prevented the water levels in the Rehoboth, Indian River, and Little Assawoman Bays from reaching areawide damaging flood levels.

8. Areas subjected to tidal flooding in the back-barrier bays included the South Shore Marina, the trailer park near the Old Inlet Bait and Tackle store along Rt. 1, and Rd. 22 near Masseys Landing. These areas are situated close to the Indian River Inlet - the channel through which ocean waters enter the back-barrier bays.

INTRODUCTION

One of the most important aspects of coastal management is the determination of areas subject to natural hazards. Development of many of Delaware's coastal communities has accelerated since the storm of March 1962 and a new generation of coastal dweller, unfamiliar with such events, has emerged. Moreover, it can be reasonably expected that without adequate information regarding the vulnerability of some areas to such natural phenomena the future potential for damage will increase substantially. This technical report provides the information necessary to properly manage the access to and development of coastal areas susceptible to wave action, tidal and other flooding phenomena.

The report has two major purposes; first, presentation of data describing the frequency of coastal storms in chronicle form and assessment of coastal community flooding and storm damage as a result of the March 1962 and December 1974 storms; and second, an assessment based on personal interviews, of individual perceptions of and behavioral reactions in response to the coastal storm phenomena.

Finally, the report presents conclusions and recommendations for future research needs, changes in public policy, and hurricane and coastal storm awareness activities.

This is Technical Report Number 4 prepared for the Delaware Coastal Management Program. The conclusions and recommendations included are solely those of the authors of the original manuscript and do not necessarily reflect the opinions or support of the Office of Management, Budget and Planning or the Office of Coastal Zone Management of the U.S. Department of Commerce.

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We wish to acknowledge especially those students and associates of the University of Delaware who ably conducted the field work, information gathering and data analyses. Specifically, Dr. Eric Muller who directed the 1975 field study interview program; George R. Irwin, Sharon Baynes and Curt Philipp for their help in the compilation of the storm damage chronicle; Deborah Dunlap, Daniel Reikes, Betsy Calhoun and Elizabeth Schellhardt, who helped the writers of this report collect and analyze the data from more than 800 individual interviews; and John Gorton and Edward Dunlop for their assistance with the computer analyses of the questionnaire responses.

Our sincere appreciation is extended to Mrs. Elizabeth Zimmerman for cheerfully typing the report under the usual hectic last-minute conditions.

*As of January 24, 1977, the State Planning Office became part of the Office of Management, Budget and Planning, Nathan Hayward III, Director.

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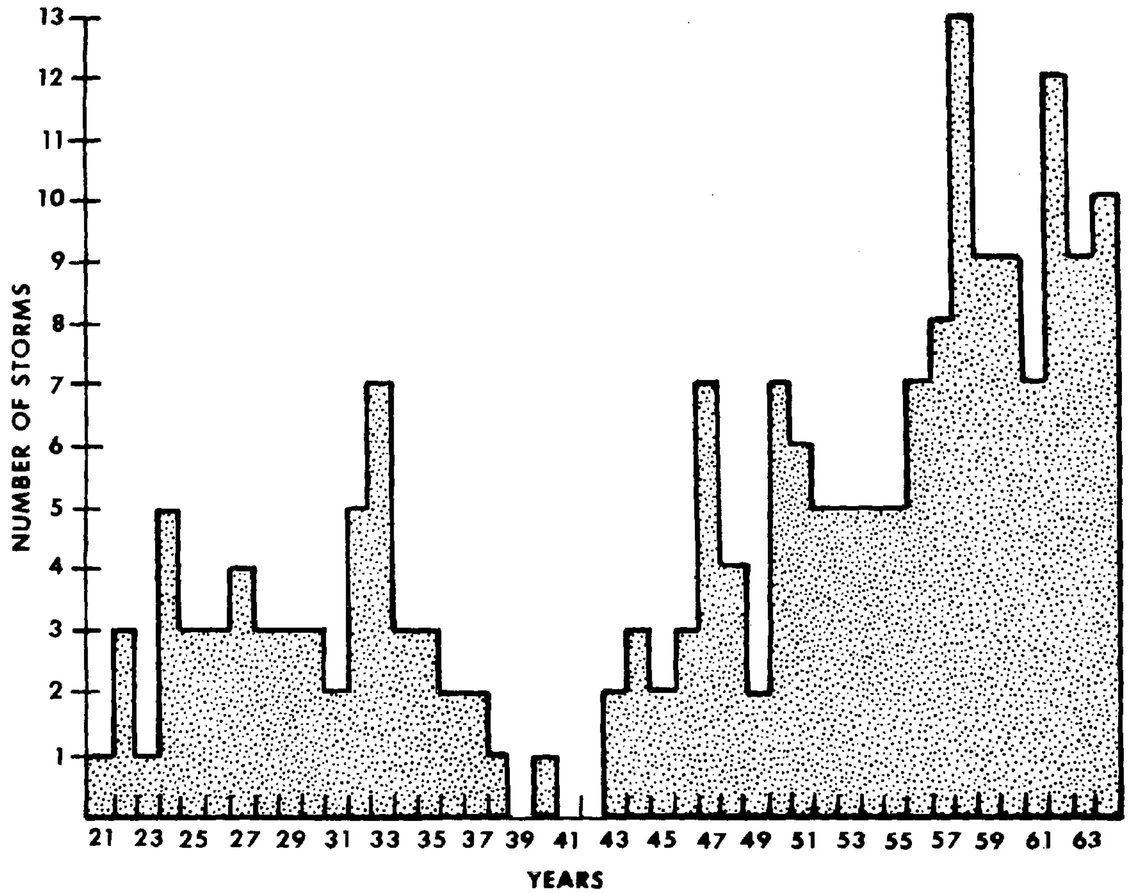
I. COASTAL STORM DAMAGE, 1923*-1974*

The period since World War II has been marked by an accelerating development of the coastal margins of eastern United States. Single family homes, condominiums, marinas, trailer courts, motels--nearly every possible type of dwelling along with the necessary stores and other commerical establishments--have all been built along the barrier island coast fringing the coastal plains of the eastern United States. Coastal dunes have been leveled to provide a better view of the ocean while marsh lands have been filled to provide land for additional homes. Myriads of canals and waterways have been cut into the coastal margins providing improved ways for floodwaters to move inland to the very heart of the coastal communities.

That the rapid, and, in large measure, haphazard development of the coastal margin has resulted in an increase in flood damage, seems to be borne out by a recent study of the frequency of coastal storms damaging portions of the eastern United States (Mather, et al., 1967). Figure 1 from that study shows a significant increase in the number of storms bringing damage since the mid-1940's. While the specific reasons for the rising trend are not completely clear (due to meteorological changes, better storm reporting or the human development of the coast), it is certain that there has been a rapid development of the coast. This factor, if not entirely responsible for the increase in the incidence of damaging storms, is certainly a significant contributing factor.

*For the purposes of this report, approximately the last fifty years of published records were selected for analysis. While numerous storms were recorded prior to 1923, data on them is sketchy as is information about the total number and frequency of damaging storms in earlier periods. Interested readers are encouraged to send information on pre-1923 damaging storms to the author or the Office of Management, Budget and Planning.

FIGURE 1
FREQUENCY OF COASTAL STORM DAMAGING THE EASTERN
UNITED STATES
(1921-1964)



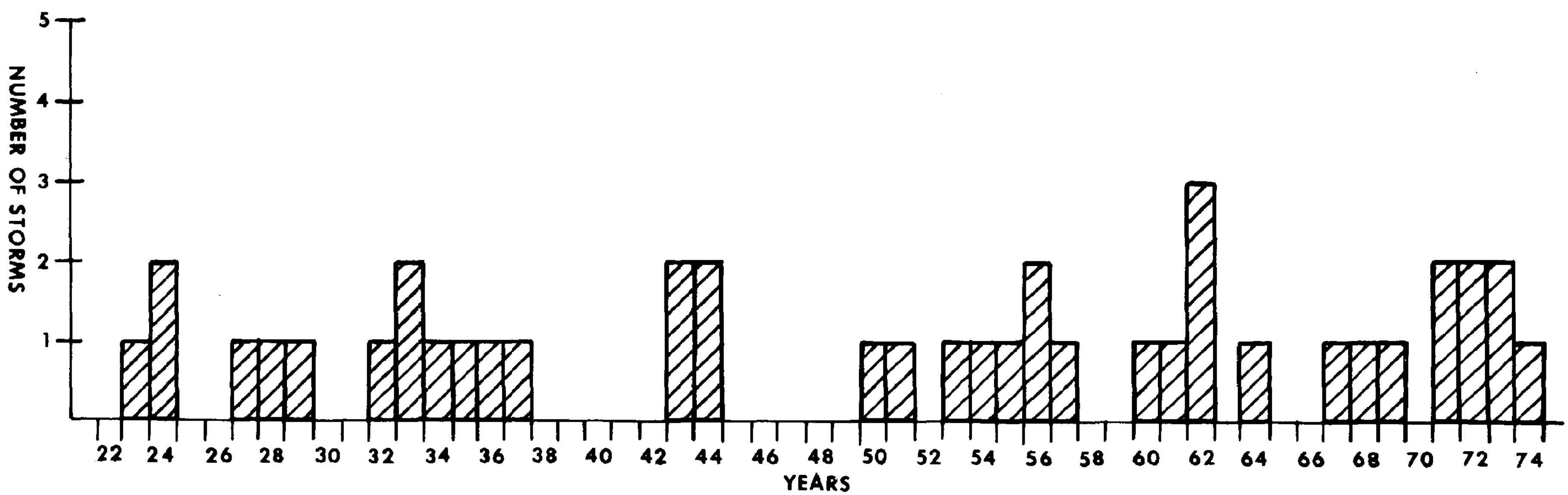
Courtesy of J. R. Mather

While the Delaware coastline has also experienced rapid development in the past few decades, there seems to be only a small increase in the frequency of coastal storms causing damage in this area. A graphical representation of the frequency of damaging coastal storms in Delaware is shown in Figure 2. Forty-one coastal storms of various types, all bringing damage to coastal communities with flooding and/or wave-action, have been documented during the fifty-one years from 1923 to 1974. During the past twenty-five years, twenty-four significant storms have occurred. The apparent increase in the frequency of storms causing damage is probably more related to the increased coastal development along with more accurate reporting and greater interest in these coastal areas than an actual increase in the number of damage-producing storms.

Even if the actual meteorological frequency and severity of storms should remain constant, the magnitude of damage will continue to rise as a result of increasing population and development of Delaware's coast. No trend has been found to indicate an increase in the actual number or severity of coastal storms in Delaware.

Based on studies of storm hazard potential for the entire eastern seaboard of the United States, Mather, et al. (1967), determined that the Delmarva Peninsula and the New Jersey coast have a "low" storm hazard potential. Figure 3 summarizes the regions of relative coastal storm damage hazard from 1935 through 1964. Occasional severe storms do occur within the "low" hazard coastal areas but relative to areas such as Cape Cod, Massachusetts, and the Cape Hatteras area of North Carolina, Delaware is less likely to experience severe or repeated storm damage.

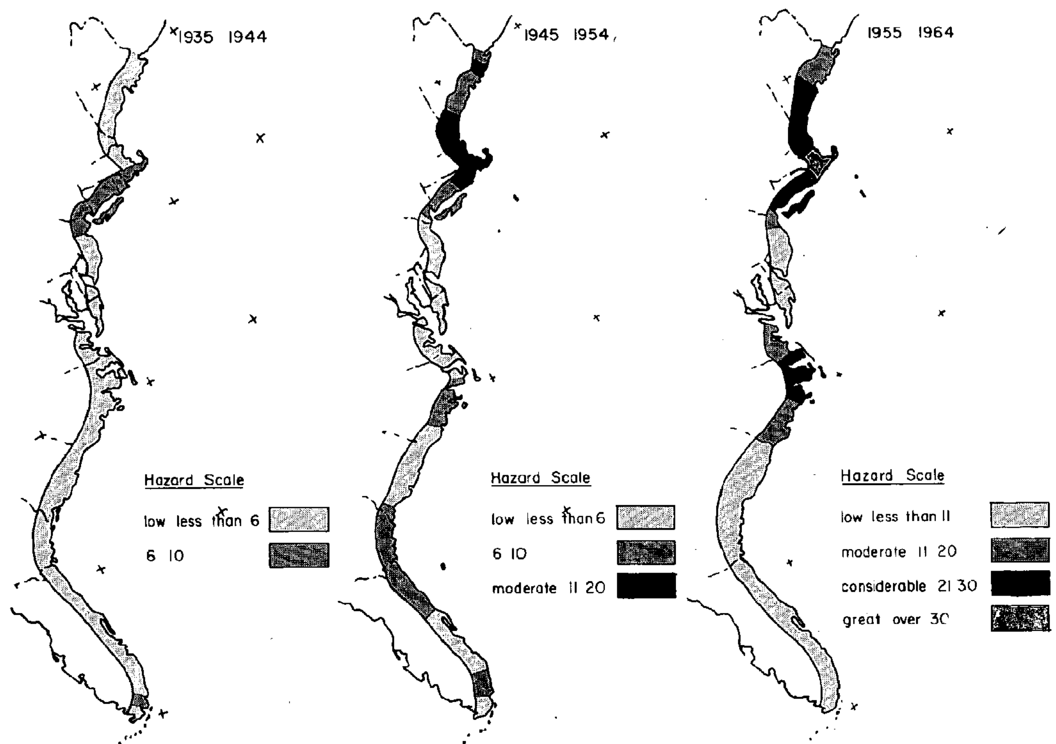
FIGURE 2
FREQUENCY OF COASTAL SOTRMS CAUSING SIGNIFICANT
DAMAGE TO THE COASTAL ZONE OF DELAWARE
(1923-1974)



Courtesy of J. R. Mather

FIGURE 3

REGIONS OF RELATIVE COASTAL STORM DAMAGE HAZARD



TOTAL NUMBER OF STORMS CAUSING SIGNIFICANT & HEAVY DAMAGE IN PERIOD, WITH HEAVY DAMAGE STORMS BEING GIVEN DOUBLE WEIGHT.

TYPES OF COASTAL STORMS

Storms of two basic types present a significant threat to Delaware's coastal zone.

Tropical storms and hurricanes, spawned over the warm ocean waters of the Gulf of Mexico and the Atlantic Ocean, are probably the best known and most feared storms. Hurricanes, characterized by winds of seventy-five miles per hour or greater, and heavy rains plague the Gulf and Atlantic seaboards in the summer and autumn.

Extratropical storms, often called "northeasters", present a particular problem to the Atlantic seaboard. Such storms may develop as strong, low-pressure areas and move slowly offshore into the Atlantic Ocean. The winds, though not of hurricane force, blow onshore from a northeasterly or easterly direction for sustained periods of time. The damage wrought by these storms may ultimately far exceed the destruction from a hurricane. The March 1962 "northeaster" proved that point decisively. Flood height and duration for extratropical storms have equaled or exceeded those of hurricanes brushing Delaware. Although hurricanes are significant to Delaware, the extratropical storms are equally important as damage and flood producing events.

Based on tide gage records, the average storm duration for all storms recorded at Breakwater Harbor (Lewes) from 1952 to 1973 was approximately forty hours. Storm duration defined on meteorological records would show a considerably shorter duration. The differences are due to the time lag between the passing of the storms and the continued elevation of the water along the shoreline. The return of normal tide levels often requires several hours or even days. Thus, even though the storm itself has passed, high water and coastal flooding may persist. By defining storm duration based on hydrographic (tide) data a more realistic evaluation of coastal flood duration is possible.

In Delaware from 1952 through 1973, twenty-six coastal storms of various magnitudes have been identified (Figure 4). Fourteen of these storms were extratropical storms (northeasters) occurring between the months of September and May. The remaining twelve storms were tropical storms or hurricanes.

Causes of Coastal Damage

The intensity and thus the damage-producing potential of coastal storms, is related to the following primary meteorologic correlations:

1. Winds - including velocity, direction, fetch and duration;

2. Storm track - including the direction of movement, position relative to the coastline and speed that the storm moves across the earth's surface;

3. Precipitation - including the volume, duration and rate of precipitation.

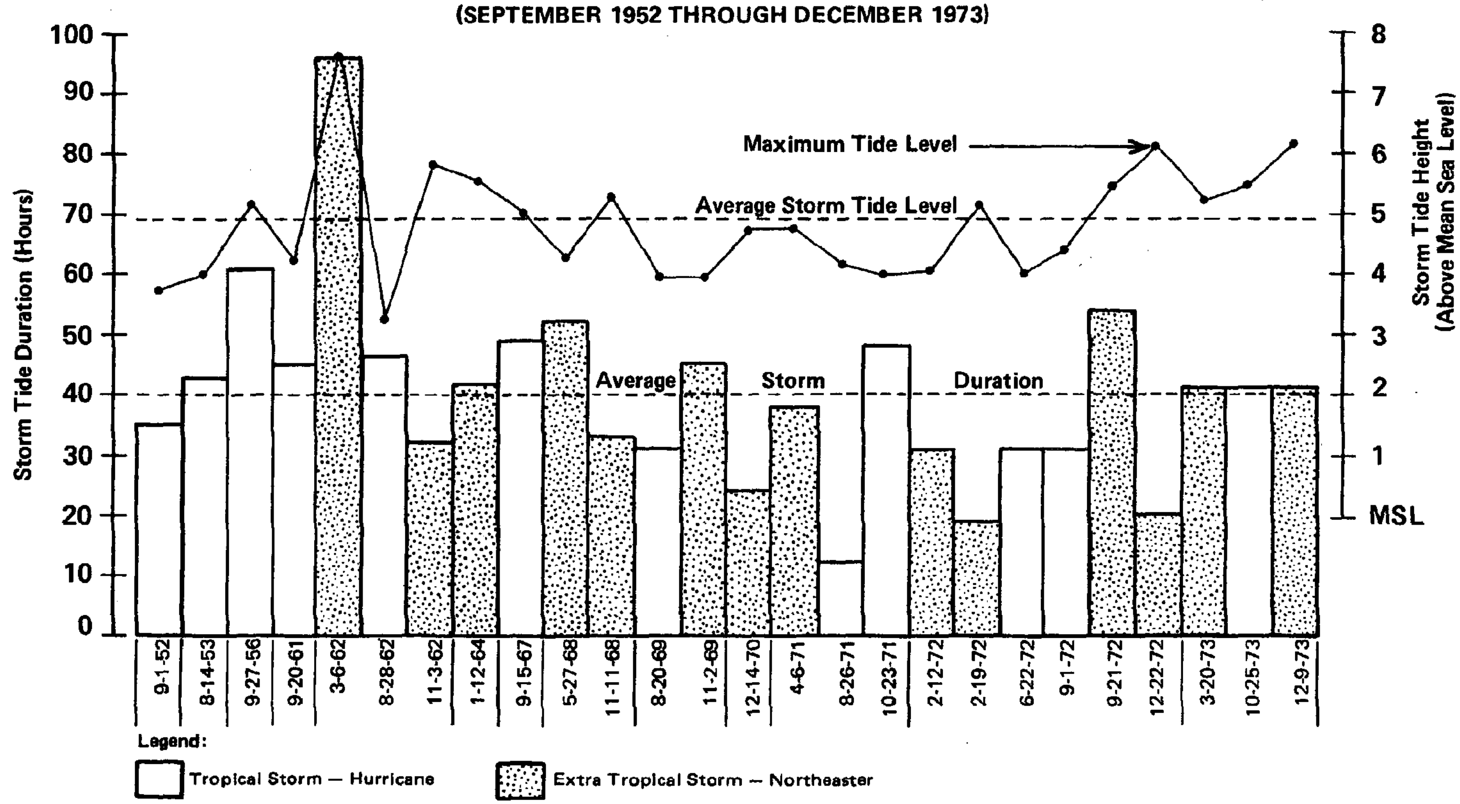
Although the factors above are the primary forces, they are not the major causes of damage or loss of life in the coastal areas. Those factors are the storm surge and wave action.

Storm surge - The magnitude of the surge involves the interaction between wind, the surface of the sea and the slope of the near-shore sea bottom. In shallow coastal waters, the storm winds can produce a surface current that flows in the direction of the wind movement. These currents are the product of the shear stresses at the ocean surface caused by the movement of air across the sea surface. The wind-produced current produces a "piling-up" of water, particularly in the shallow coastal estuaries, bays, canals and near-shore areas along the leeward coast. A significant rise in water level also accompanies the marked reduction in atmospheric pressure that occurs with tropical hurricanes. When the effects of winds or tides are removed, we find

FIGURE 4

HEIGHT AND DURATION OF COASTAL STORMS AT BREAKWATER HARBOR, LEWES, DELAWARE

(SEPTEMBER 1952 THROUGH DECEMBER 1973)



1) Storm Duration is defined as the period of time that tide level generated by each storm exceeded one foot (1 ft.) above the normal tide level.
2) Tide gauge records are incomplete during the 1952 to 1974 period. The tide gauge was destroyed in 1974 by fire and has not been replaced as of August, 1976.

that sea level rises thirteen inches for each drop of one inch of mercury in the barometer. Tropical storms and hurricanes may have barometric pressures well below 28.0 inches in the "eye" of the storm, or nearly 2.0 inches below normal sea level pressure of 29.92 inches. The result could be a sea level rise of twenty-six inches from this factor alone. An extreme example was provided by Hurricane Camille (1969) in which the central pressure was 26.61 inches of mercury. That pressure resulted in a forty-four inch rise in water level from this factor alone as the "eye" moved onto the Gulf Coast.

The term storm surge, when associated with a hurricane, includes the rise of water level due to both the wind stress on the water and the rise due to atmospheric pressure reduction. The effect of the storm surge on the coast depends on the interaction between normal tidal action and the storm-produced water level rise. For example, if the time of normal high tides coincides with the surge, the overall effect will be greater. If the surge occurs at low or falling tide, the impact will likely be lessened. Slowly moving "northeasters" may continue to build a surge that lasts through several lunar high tides. Such a condition occurred during the March 1962 storm. That storm lasted for five high tides with a devastating effect on the coast.

Wave action - Storm damage to a shoreline is primarily the result of wind generated waves riding landward on the elevated water surface (storm surge). Waves develop from the shear stress forces between winds and water. Huge destructive waves can be generated by extreme storms. As waves move into the shallow waters along the coast they steepen and "break", expending a tremendous amount of energy. Waves traveling at thirty to fifty miles per hour in storms are not uncommon. One cubic yard of seawater weighing in excess of 1,620 pounds and moving at thirty miles per hour presents an obvious destructive potential to beaches, houses, bridges, roads or other structures in its path.

The amount of energy in a wave is a function of the product of the wave length (horizontal distance between successive wave crests) and the square of the wave height. Thus the energy in three waves, one 4 feet high, one 8 feet high and one 12 feet high has been calculated as 33 foot-tons, 131 foot-tons and 295 foot-tons respectively. With a three-fold increase in wave height, there is nearly a nine-fold increase in energy. Offshore wave heights for the March 1962 storm were observed to be of the order of forty feet. The destructive potential of that storm is almost beyond comprehension.

Actual maximum wind velocity, mean wind direction and measured tide levels for Atlantic City, New Jersey and Breakwater Harbor, Lewes, Delaware are given in Table 1 for a thirty-year period between 1933 and 1963. The data are for eighteen separate storm periods.

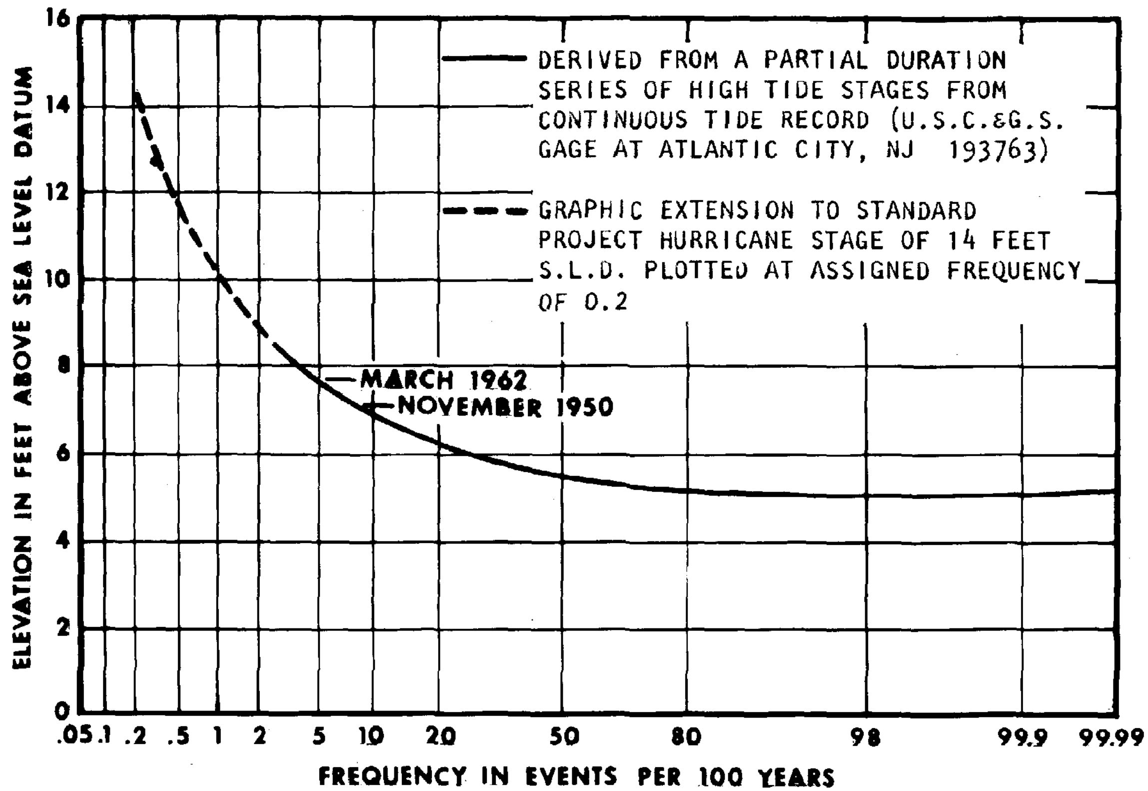
The U.S. Army Corps of Engineers analyzed tide gage records at Atlantic City, New Jersey, from 1937 through 1963 to calculate the statistical relationship between magnitude and frequency of storm tide levels. Figure 5 illustrates that the probability of a storm surge of the magnitude of the March 1962 storm is five times in each 100 years or a probability of once each twenty years. The "100-year" (still water level) tide level according to this graph is ten feet above the sea level datum of 1929.*

No realistic or useful definition of the "100-year coastal storm" is available because of the complexity of meteorologic and oceanographic

*The sea level datum of 1929 is now called the National Geodetic Vertical Datum of 1929.

FIGURE 5

ESTIMATED RECURRENCE INTERVAL OF VARIOUS STORM SURGE ELEVATIONS



Source: U. S. Army Corps of Engineers (1966) Beach Erosion Control and Hurricane Protection along the Delaware Coast.

TABLE 1

Storm Data at Atlantic City, New Jersey
and the Delaware Breakwater at Lewes

Date	Storm Name	Type of Storm	Maximum Wind at Atlantic City: Direction	Maximum Wind at Atlantic City: Velocity[1]	Highest Tide: Atlantic City	Highest Tide: Breakwater
				miles per hour	feet above mean sea level	feet above mean sea level
8/33	--	Tropical	E	76	5.0	6.1
11/35	--	Extratropical	NE	66	5.3	--
9/36	--	Tropical	NE	90	4.7	--
9/36	--	Tropical	W	72	4.1	--
9/44	--	Tropical	NE	91(G)	7.6	--
			N	82(V)		
11/50	--	Extratropical	E	72	7.0	7.2
10/53	--	Extratropical	N	29	6.1	6.0
11/53	--	Extratropical	NE	69(G)	5.0	5.4
			NE	65(V)		
8/54	Carol	Tropical	NE	57	4.4	3.7
9/54	Edna	Tropical	NE	65	4.6	--
10/54	Hazel	Tropical	SE	80(G)	4.6	4.6
			SE	66		
8/55	Connie	Tropical	S	65	4.0	4.4
8/55	Diane	Tropical	SW	49	3.6	4.1
10/55	--	Tropical	E	60	5.0	5.1
9/56	Flossy	Tropical	E	54	4.9	5.6
9/60	Donna	Tropical	WNW	83(G)	6.1	5.2
3/62	--	Extratropical	E	58(g)	7.2	7.9
10/63	Flora	Tropical	NE	30	4.0	4.0

[1]Generally fastest mile or highest 1-minute value. (G) denotes gust and (V) denotes 5-minute value.

SOURCE: Beach erosion control and hurricane protection along the Delaware coast, 1966. Beach Erosion Control Board, Philadelphia District, U.S. Army Corps of Engineers, Washington, D.C.

variables involved. Predictions of storm-generated tide levels without the added increment of wave height can be obtained from available empirical expressions. Table 2 lists the extremes of wind and waves predicted for the Delaware Bay and Delaware offshore areas for recurrence intervals of five, ten, twenty-five and fifty-year time periods.

TABLE 2

Extreme Winds

Delaware Bay Area

Mean Recurrence Interval	5 yrs.	10 yrs.	25 yrs.	50 yrs.
Maximum Sustained Wind	63 kts.	70 kts.	80 kts.	92 kts.

Offshore Delaware Bay Area

Mean Recurrence Interval	5 yrs.	10 yrs.	25 yrs.	50 yrs.
Maximum Sustained Wind	71 kts.	80 kts.	92 kts.	100 kts.

Extreme Waves

Delaware Bay Area

Mean Recurrence Interval	5 yrs.	10 yrs.	25 yrs.	50 yrs.
Max. Significant Wave Ht.	11 yrs.	14 ft.	17 ft.	22 ft.
Extreme Wave Height	20 ft.	25 ft.	30 ft.	35 ft.

Offshore Delaware Bay Area

Mean Recurrence Interval	5 yrs.	10 yrs.	25 yrs.	50 yrs.
Max. Significant Wave Ht.	37 ft.	41 ft.	47 ft.	53 ft.
Extreme Wave Height	60 ft.	70 ft.	85 ft.	95 ft.

SOURCE: Rower, et al., 1972

THE STORM CHRONICLE

The following storm chronicle consists of a chronological listing and synopses of the storms that have brought damage to the coast of Delaware during the period 1923 through 1974. Information on coastal damage was collected and summarized from numerous published and unpublished sources including Federal, State and local governmental agencies and departments as well as daily and weekly newspapers from the State. A listing of those newspapers and other published sources that provided significant information for this study are included at the end of the chronicle.

Although considerable information on storm damage is available, this chronicle is undoubtedly incomplete. Areas of unreported or undocumented damage and destroyed or lost records all contribute to defeat any attempt to reconstruct precisely the history of coastal storm impact in Delaware.

For the purposes of this report, coastal storms are defined as: "those storms, including hurricanes, "northeasters", tropical storms and cyclones that caused significant flooding and property damage in the communities located on the coastal zone of Delaware". Thus the definition as used does not limit storms mentioned to only those passing along the coast. Secondly, storms passing through the mid-Atlantic region that caused little damage or caused damage only from large amounts of precipitation and high winds were not included in this chronicle. Storms of low intensity that caused minor beach erosion but did not result in washovers, flooding, major erosion or wave damage to structures were also not included.

Appendix 4 contains a summary of tidal data available from the National Ocean Survey, Washington, D.C., from the four tidal gaging stations in Delaware during periods of coastal storm activity. The stations are located at:

1. Breakwater Harbor (Lewes, Delaware);
2. Reedy Point, Delaware (near the mouth of the Chesapeake and Delaware Canal);
3. Indian River Coast Guard Station;
4. Delmarva Power and Light Company (Indian River, east of Millsboro, Delaware).

Many of the comments which follow are excerpts from various published sources and newspaper accounts. Some have been paraphrased and combined. No attempt has been made to footnote each comment, however, the bibliography contains numerous references.

Storm Chronicle

1923

October 24, 1923 - East-northeast gale of 50 miles per hour and driving rain. Along the beach at Rehoboth much damage was reported to cottages and the Belhaven Hotel suffered from the buffeting of the waves. Large quantities of sand from the beach were washed up over the boardwalk. The tide was very high all along the coast.

1924

March 10-11, 1924 - The northeast winds caused the tides to back up in the Bay and creeks. Low lands were covered by several inches of water. No damage reported at Bowers Beach although the tides were higher than experienced there for many years and waves washed up on the beach within threatening reach of many of the cottages along the shore.

September 18, 1924 - Rehoboth Beach - At high tide the beach was covered and waves broke over the top of the pier of the Rehoboth Beach Angler's Club. The tide was so high that walking was impossible between the beach and the Lewes life-saving station. The marshes on the fringes of Rehoboth Bay were also covered.

1927

February 19-21, 1927 - At Delaware City the banks of the Chesapeake and Delaware Canal were broken in many places. Both entrances to the canal were badly damaged. Several hundred thousand dollars were needed to repair the damage. New Castle, Milford, Bowers Beach, Seaford, Lewes and Rehoboth were also flooded and damage was reported. The gale wind estimated at from 65 to 70 miles per hour caused the highest tides along the coast in 20 years and floated several wooden bridges along streams leading into Delaware Bay.

At Bowers Beach, 2 1/2 feet of sand was eroded from the beach. The seas at the height of the storm reached 20 feet. All the cottages built on floats were washed into the marshes.

At Slaughter Beach the tide washed over the beach into the marsh and tore down a section of the boardwalk. No cottages were destroyed.

At Lewes the wind created a storm tide of an unusually high level.

At Rehoboth, the end of the pier was washed away by waves. The steps leading from the boardwalk to the beach were washed away and considerable damage was done to the bulkhead which protects the boardwalk. The water in Rehoboth Bay rose and flooded areas 200 to 300 feet beyond the normal high water mark.

Another account of the storm reported:

Delaware suffers from the worst storm of the winter. . . tide highest since 1918, winds backed the water in the Mispillion, flooded the lumberyards of D.N. Hearn and Company and I.D. Short; water was within a few inches of reaching the top of the wharves near the community building. . . Sepples lumberyard was underwater. All of Clarence Russel's garages were flooded to a depth of several feet. Dr. William Marshall's garage was flooded. East Front Street in North Milford was under several feet of water. . . Draper, David and Company, fertilizer plant, was under three feet of water. Bowers Beach. . . almost all of area underwater, buildings were carried well up into the marshes along the public road leading to Bowers. Slaughter Beach. . . water broke the high beach line and washed over the marsh land into Slaughter Neck. The road leading to the beach was covered with water for several days. Wind direction carried the force of the storm away from Rehoboth. Delaware City and New Castle were hard hit. . . Heavy spring tides flooded the lower section along the river.

1928

September 20, 1928 - Outside of the damage done to shipping, Lewes escaped damage from the storm. At Rehoboth, water came up to the first floor of the Hotel Henlopen. Beach erosion occurred under the boardwalk but the boardwalk escaped damage. Some of the oceanfront lots were badly damaged by water washing the sand away.

1929

April 17, 1929 - During this gale the water was exceptionally high at Bowers Beach and Slaughter Beach. At Bowers Beach a bulkhead was destroyed.

1932

November 11, 1932 - At Delaware City there was "much damage" due to the storm. At Bayview Beach the water rose so high that it flooded the ground floor of many cottages; also, a 50 foot pier was washed away.

1933

January 26-27, 1933 - Bowers Beach - the entire town was inundated to a depth of more than a foot due to high tides and heavy rain. Slaughter Beach - the water reached to beneath the boardwalk. Rehoboth - the storm tide caused wash-overs but no damage was reported. Delaware City - the ten foot tide washed up over the lower end of Clinton Street to a depth of two feet and extended as far as the Robinson House. Rehoboth Angler's Club - half of the fishing pier was carried away by the waters ($1,000 damage). The water at times washed over the boardwalk. Bethany Beach - several hundred feet of the boardwalk were washed away when water reached the first floor of the Seaside Inn but caused no damage.

August 22-23, 1933 - Wind velocities at Breakwater Harbor reached 75 miles per hour, as estimated by Weather Bureau officials. At Bethany Beach the boardwalk and streets were severely damaged and the drainage systems filled with sand. Rehoboth Beach suffered severe loss of beach and damage to shore structures. Total estimated damage in the area was $40,000, exclusive of damage due to loss of beach and damage to State roads (U.S. Corps of Engineers).

The storm lasted 24 hours. The National Guard Camp at Bethany Beach was flooded. In Rehoboth - water flooded the streets, Silver Lake was flooded and water entered in the lower floor of Henlopen and Belhaven hotels. . . most of area between Rehoboth and Lewes was under water. Seawater traveling inland between Kitts Hummock and Lewes destroyed crops. People had to be removed from second-story windows in Kitts Hummock. Fort Saulsbury north of Slaughter Beach was flooded and Bowers Beach was completely underwater. Basin Road between Newport and New Castle was damaged by flooding according to the Delaware State Highway Department.

1934

June 20, 1934 - Bayview Beach was flooded and many seawalls were washed away, but none of the cottages were seriously affected.

1934

November 18, 1935 - Lewes and Rehoboth were the hardest hit by the 60 mile per hour gale (declared worst in 30 years). Fear was felt for the safety of the summer cottages along the Bay as waves pounded high over the beach. The Lewes Coast Guard Station was marooned and damaged with water within ten inches of the first floor. Water washed up over the floor of Queen Anne's

Pier. At Rehoboth, the water washed over the boardwalk. Waves washing over Angler's Pier were reported as high as ten feet.

Another source reported:

The boardwalk at Rehoboth was damaged. Ocean Boulevard between Rehoboth and Bethany was also damaged. The road from Lewes Beach was under ten inches of water for a quarter of a mile. The dunes at Silver Lake were breached. The road between Bethany Beach and National Guard Camp was under several inches of water.

<u>1936</u>

September 18-19, 1936 - Lewes - two sections of the Queen Anne pier (about 70 feet in all) were washed away. The boardwalk was partly demolished and about 100 feet of the structure was carried away by waves. Rehoboth - waves washed up over the boardwalk but the structure was not damaged. Waves nearly 15 feet high were breaking as far inland as Surf Avenue. Bethany Beach - a large section of boardwalk was washed away. Bowers Beach - water about the Bowers Beach Hotel was knee-deep. Ocean Boulevard between Rehoboth and Bethany Beach was closed.

<u>1937</u>

April 27, 1937 - At Lewes waves washed under the boardwalk at high tide. The surf was also swirling around cottages at Dewey Beach. Delaware Bay resorts suffered more than those on the ocean front. Bowers Beach was under water as waters washed far inland past the town and residents of the low sections of Bowers Beach took refuge in a general store in the higher, northernmost end of town. Slaughter Beach also was flooded and took a severe battering from waves that washed in under the boardwalk and breached the dune at the southern end of town.

1943

October 1, 1943 - Waves about 20 feet high battered the beachfront at Rehoboth Beach and sent water tumbling over the boardwalk. An unusually high tide caused a section of road between Lewes and Lewes Beach to be under more than a foot of water.

October 27, 1943 - At Rehoboth Beach waves were washing under the boardwalk. Some residents of Lewes Beach were isolated during the high tide with more than a foot of water covering the highway between the beach and the mainland. At Bowers Beach water washed under cottages and over the boardwalk in some places but did not enter any homes, since most of the cottages were erected on piling several feet above the ground. Slaughter Beach was flooded and a section of the boardwalk was washed out during the height of the storm. High tide covered the beach and threatened cottages.

Another source reported:

The Ocean Highway between Rehoboth and Bethany Beach was flooded and the road from Lewes to Fort Miles was under 12 inches of water. Twelve inches of water covered the highway between Lewes Beach and the mainland. Water flooded the roads at Broadkill Beach, Leipsic, Kitts Hummock and Woodland Beach.

1944

September 14-15, 1944 - A hurricane passed about 50 miles east of the Delaware Coast. The ocean front suffered severe damage. Wind damage was high. Gravel streets were washed out and sand was deposited on streets and property adjacent to the beach. In Bethany Beach and Fenwick Island every building was damaged and several were destroyed by the combination of winds and high seas. No estimate of damage was given. The ocean completely enveloped the one-half mile length of boardwalk at Bethany Beach and destroyed large sections of it.

The Ringler Theater at Bethany Beach was among the buildings destroyed along with a large number of summer homes and year-round residences. The Ocean Highway between Bethany Beach and Rehoboth was washed out in places by the high waves. Lewes also suffered from the storm and residents in cottages along the beach had to be evacuated. Many residents of towns along the Delaware Bay (Bowers Beach, Woodland Beach, Big Stone Beach, Kitts Hummock and Slaughter Beach) were evacuated and returned to find some damage. At Rehoboth Beach a freighter was blown ashore and broken in half by 10 foot waves. Waves swept over the boardwalk at Rehoboth damaging large portions of it and sweeping away a section near the Hotel Henlopen. A pavilion was also swept away. Boardwalk damage was estimated at $30,000. Many stores along the boardwalk were damaged by the water. The lobby of the Hotel Henlopen was flooded and many windows in Rehoboth buildings were shattered. Streets were flooded by high waves in an area one block back of the boardwalk.

Losses were estimated at $125,000 at Rehoboth and $100,000 at Bethany. There was no estimate for Lewes. The U.S. Army Corps of Engineers reported damage estimates at $206,000, exclusive of damage to the beach.

October 21, 1944 - 50 miles per hour northeast wind accompanied by heavy rain. A pounding surf at Rehoboth tossed water over the boardwalk.

1950

November 25-26, 1950 - This storm was termed "the worst storm since 1912". At Kitts Hummock water entered nearly every cottage. Flood waters were reported as far inland as one mile. Damage was estimated at $25,000.

The storm brought severe damage to Pickering Beach, a summer resort less than one year old. Damage to cottages along the beach was estimated at between $10,000 and $15,000, a figure which does not include the loss of the sand beach. The beach was entirely washed away.

In Rehoboth the gale was less intense than it was further north. The only damage was to the north end of the boardwalk. Wind-driven tides were five feet above normal. At Slaughter Beach water cut a hole in front of Wilson's Restaurant and covered the road to Cedar Beach. Most of the damage here was due to high tides. The road to Port Mahon was covered with four feet of water. The Christina River flooded many roads in Wilmington. Water was a foot deep in Woodland Beach ($40,000 damage). Damage at Kitts Hummock was estimated at $25,000.

1951

October 4, 1951 - In the Rehoboth area winds of 32 to 35 miles per hour were reported and when water breached the boardwalk at high tide.

1953

August 15, 1953 - This storm was termed the worst storm since 1944. Waves 12 to 15 feet high pounded the coast and washed over the boardwalk at Rehoboth. Residents of Fenwick Island and Bethany Beach were evacuated. Despite the force of the wind there was only minor damage. Power failure and the tie-up of telehone lines were the most serious results of the storm.

1954

September 1, 1954 - Hurricane Carol. Winds of 50 miles per hour were reported in the vicinity of the Lewes Coast Guard Station. Although much damage was reported in New Jersey and northward, little damage was recorded in Delaware.

October 15, 1954 - Hurricane Hazel. Rehoboth reported the worst blow since the hurricane of 1944. Waves were 15 to 20 feet high and were approaching the beach from a south by southeasterly direction. Damage here was mainly due to winds. Winds were measured at Wilmington at a one minute maximum sustained velocity of 58 miles per hour with gusts up to 98 miles per hour and broke all previous records.

1955

August 13, 1955 - Hurricane Connie. Damage in the Bethany Beach area was caused by "twisters". Tides were higher than normal but minimal coastal damage reported. Winds were recorded at 70 miles per hour.

August 19, 1955 - Hurricane Diane spawned torrential rains which flooded many homes and highways in northern Delaware.

1956

September 28-29, 1956 - Hurricane Flossy. Lewes road crews placed an estimated 500 tons of broken concrete, gravel and boulders onto the beach in an effort to hold back the high sea. At Broadkill Beach winds and high tides created a situation similar to that at Lewes Beach. Residents here said that while the groins protect the south end of the beach, the north end of the beach is exposed and houses there are always in danger during a heavy storm. The Ocean Highway between Bethany Beach and Dewey Beach was flooded where the ocean breached the dunes. At Rehoboth Beach the ocean removed thousands of tons of sand from the beach. Waves were reported splashing over the boardwalk at high tide but there were no reports of serious damage to the town. Governor Boggs inspected damage at Lewes and Broadkill. While it was too early to issue an estimate of the damage in Sussex County, it was expected that "it would probably total many thousands of dollars".

Another source reported:

The highway from Bethany Beach to Dewey Beach was closed as the ocean had broken through at many points. The area just north of Indian River Inlet was extensively flooded. Riverdale, Oak Orchard and other communities along Indian River were damaged by tidal water. Tides three to five feet above normal were reported at Indian River Yacht Club. A survey by the chief engineer of the State Highway Department determined that beaches south of Rehoboth were severely damaged.

October 19, 1956 - High tides and waves again battered the dunes along Ocean Highway which were severely damaged three weeks before by Hurricane Flossy.

1957

October 7, 1957 - The gale force northeast winds had a strong effect on tides. On the eastern side of the Delmarva Peninsula tides were abnormally high, flooding many coastal roads. At Broadkill Beach, one resident reported that he had never seen a higher tide. It lifted one cottage off its pilings and pushed it back six feet. Damage was estimated at $1,000.

1960

September 13, 1960 - Hurricane Donna. High tides broke through the barrier at both the north and south ends of Slaughter Beach. At Broadkill Beach the causeway was breached by water. At Lewes some cottages were damaged, but authorities said damage would have been much worse if Donna, with peak winds of 110 miles per hour had hit at high tide. The Rehoboth boardwalk was pounded by the ocean and threatened until the wind shifted in late morning. The ocean broke through between the Indian River Inlet and Bethany Beach but the breakthrough was not considered a serious one.

1961

October 23-24, 1961 - Northeast winds up to 50 miles per hour and tides five feet above normal closed roads, washed away thousands of tons of sand and kept coastal residents on the alert. Wind-whipped waters breached a sand barrier erected by the Highway Department at Broadkill Beach. About two-thirds of the road from Dewey Beach to Fenwick Island was under an estimated one to three feet of water at the height of the flooding. The ocean also broke through in the Bethany Beach area. At Broadkill Beach waves undermined the foundations of homes along the shore. Lewes Beach had water to a depth of two feet as the Bay washed under waterfront cottages. Storm waves destroyed the north Indian River Jetty light (valued at $10,000). At least half a dozen Bethany Beach streets were impassible from flooding. The shoreline from Broadkill Beach to Ocean City, Maryland was severely eroded by the heavy seas. The storm demolished bulkheads and thwarted attempts by highway department crews to rebuild sand dunes.

1962

March 6-8, 1962 - Hundreds were evacuated as a vicious northeaster lashed Delaware with 60 mile per hour winds, heavy rains and snow plus high tides and floods. The coastal areas of the State bore the brunt of the storm. Seventeen Slaughter Beach homes were destroyed. The sea breached the dunes at numerous points along the Ocean Highway including Savage's Ditch and Coin Road. Residents of Bethany Beach reported that an estimated two feet of water covered their town and the boardwalk had been ripped apart in several places from the wind and tides.

March 8, 1962 - Governor Carvel estimated the damage to be 50 million dollars and asked that the Delaware Coast be declared a federal disaster area.

From Bowers Beach to Fenwick Island nothing escaped damage. The oceanfront at Rehoboth Beach was a shambles. The entire boardwalk was ripped away; the Hotel Henlopen dining room, a one story wing of the four story building was underwater; the wall of the east wing of the hotel collapsed, exposing rooms on each floor; the oceanfront wall of the Atlantic Sands Motel also collapsed. Six children drowned in the flood at Bowers Beach. Twenty-eight of 29 beachfront homes in Bethany Beach were reported destroyed. Approximately 300 feet of the beach had been eroded. Many of the new homes on South Bethany Beach were destroyed. Waves up to 40 feet high eroded about 30 feet of the beach at Rehoboth. Most of Dewey Beach was underwater. Flood waters in Bethany Beach were up to five feet deep in places. The boardwalk was totally destroyed and the famous Holiday House, built in 1932, was demolished. Waves four feet high were rolling into the grove at Oak Orchard according to residents. They said that the entire shoreline had been washed away. From three to four feet of water surrounded the shore front cottages of Riverdale.

March 9, 1962 - Governor Carvel declared a state of emergency after a two-day survey of Delaware's Coast. It was his opinion that this was the worst catastrophe Delaware had ever suffered. A total of seven Delawareans died in the storm.

Table 3 provides a brief summary of the estimated damages suffered at various places along the Delaware Coast in 1962.

TABLE 3

Damages Resulting from Storm of March 1962
Cape Henlopen to Fenwick Island
(July 1962 Prices)

Location		Estimated Damages
North of Indian River Inlet		
Fort Miles		$ 270,000
Fort Miles to Rehoboth Beach		640,000
Rehoboth Beach		3,530,000
Dewey Beach		3,140,000
Dewey Beach to Indian River Inlet		890,000
	Total Damages	$8,470,000
South of Indian River Inlet		
Indian River Inlet to Bethany Beach		$ 630,000
Bethany Beach		2,390,000
Bethany Beach to Fenwick Island		3,110,000
Fenwick Island		2,060,000
	Total Damages	$8,190,000

SOURCE: Delaware Coast Beach Erosion Control and Hurricane Protection. General Design Memorandum, Phase I, Department of the Army, Philadelphia District, Corps of Engineers

Damage Summary By County, March 1962 Storm

New Castle County - New Castle - Homes along the Strand flooded, the Battery and other waterfront areas were covered with water. Buttonwood area damaged by high water. Delaware City - Three homes evacuated, some streets flooded, large areas of open land covered with water. Bay View Beach - Waterfront flooding, some damage recorded.

Kent County - Bowers Beach - Hardest hit Kent community. In addition to flooding, some homes were washed 500 yards inland; others were ripped from their foundations. Kitts Hummock - Battered by tides with some homes washed from their foundations. Woodland Beach - Flooded, but homes not as badly damaged as in other communities because land is generally higher and wave fetch is very short.

Sussex County - Rehoboth Beach - Hardest hit large Sussex community. Oceanfront properties were damaged and ruined, little damage to inland properties. From the Henlopen Hotel to Rehoboth Avenue the shorefront buildings were undermined by water and were tumbling onto pilings which had supported the boardwalk. Dewey Beach - High waters washed from the Ocean to the Bay at some points. On the Bay side several shops and restaurants seemed to have survived the onslaught. Boardwalks at Wilson's Yacht Basin were underwater. Sand had been deposited to the second floors of several cottages. Indian Beach - Covered with water. Bethany Beach - Cottages strewn in topsy-turvy manner. South Bethany Beach - Only occasional large summer homes were untouched by the sea. Middlesex Beach was dotted with overturned buildings and debris. Fenwick Island - Only the lighthouse and surrounding structures were spared from destruction. Water covered the ocean side of the tiny resort and washed across Route 14 to the foot of high ground where the lighthouse stands. Lewes Beach - Flooded, but damage to cottages not extensive. The Lewes and Rehoboth Canal had overflowed its banks and damaged many canal side structures.

November 5, 1976 - (Northeaster) - Shore damage was estimated at $250,000. At least two resort communities suffered considerable damage from the high winds and flood tide which eroded thousands of cubic yards of fill placed along the oceanfront following the March disaster. Winds peaked at 50 miles per hour and tides were 3 1/2 feet above normal. Gaps about 50 feet wide were opened in the new dune line at two points between Fort Miles and the Indian River Inlet. A portion of Route 14 between Dewey Beach and the Inlet was covered with an estimated six inches of sand and was closed until the flood tide had receded.

Rehoboth was the hardest hit by the storm. Mayor Stamper estimated the loss of fill along the resort beachfront at about $175,000. Sand was washed away under the newly rebuilt, mile-long boardwalk along its entire length. Surf Avenue and other low lying streets were covered by the sea.

Bethany Beach was also hit hard by the storm when heavy seas flooded at least five streets and swept away nearly all of the fill placed under its new boardwalk during the summer. At other places only escarpments remained where there was a gentle slope of sand before the storm. An unofficial estimate placed the loss at no less than $70,000. Breaks along the new dune line occurred a few hundred yards north of the Indian River Inlet and just north of Rehoboth at North Shores.

There was no damage to the boardwalks at Rehoboth or Bethany Beach. Route 58 near Fenwick Island was flooded.

November 12, 1962 - Winds up to 75 miles per hour lashed the Delaware and Maryland coast, leaving freak damage in their wake. Damage to property was caused primarily by winds since high tide and peak wind velocity did not coincide. The tide was low just before the storm peaked and by the time of high tide the wind had shifted to the south.

November 28-29, 1962 - The storm stripped Rehoboth of its shoreline protection when flood tides swept to sea all of the remaining fill placed on the beach front during the previous summer. Rehoboth City Manager Frank Buck said the beach had lost all 300,000 cubic yards of sand dumped there following the March storm at a cost of about $330,000. The storm failed to damage other areas of the beachfront. At Fenwick Island sand drifts blocked several streets to a depth of three feet and the main thoroughfare along the beach was covered with sand. Rehoboth and Bethany Beach were the hardest hit by the storm. The two resort communities lost nearly $500,000 in fill as a result of flood tides and waves.

1964

January 13, 1964 - The morning tide ran as high as four feet above normal and breached the dunes at Dewey, Bethany, Slaughter, Rehoboth, Big Stone and Broadkill beaches and Fenwick Island. The tide broke through at the south end of Slaughter Beach in the same location as the 1962 storm, but there were no cottages there this time. All were carried away in 1962. The water cut a swath 150 feet wide through the three foot high dune and flooded 500 feet inland. Three cottages at Broadkill Beach were menaced and the beach road flooded. The tide at Rehoboth broke through north of the Henlopen Hotel and at the end of the boardwalk. City police reported flooding under the boardwalk. About 20 feet of sidewalk was washed out in two stretches in the Henlopen Hotel area, and five feet of sand was washed away along some sections of the beach.

According to another source:

Water was reported flowing down Ashwood Avenue, Pennsylvania Avenue and Girard Parkway in Bethany Beach as well as under the Blue Surf Motel. Route 58 between Bayville and Fenwick Island Bridge was also flooded.

1967

September 18, 1967 - Hurricane Doria - reduced to tropical depression - damage along the coastline was limited and was confined primarily to broken tree limbs and windows. There were relatively few interruptions of telephone and electric service. Some streets in Bethany Beach were flooded and State Police closed Delaware 14 between Rehoboth and Bethany for a short time after water reached its edges.

1968

May 27-28, 1968 - Northeaster - High winds with six foot seas and tides two to three feet above normal caused local flooding.

November 11-12-13, 1968 - Northeaster - Gale winds and flooding were accompanied by four foot tides. The areas most affected were Woodland Beach, Big Stone Beach and Bowers Beach. Fifty people evacuated from Bowers Beach. An oil barge went aground on Rehoboth Beach and leaked oil. Damage from high wind was reported high in oceanfront sections.

1969

August 20, 1969 - Hurricane Camille - High tides from Rehoboth to Fenwick brought minor flooding.

November 2, 1969 - Northeaster - Minor flooding along coast caused by 2.5 foot tides and 70 mile per hour maximum winds. Little or no damage was caused as the storm skirted Delaware. Water reached the Rehoboth boardwalk.

1971

April 6, 1971 - Northeaster - Three to four foot tides driven by gale force winds caused flooding and beach erosion. Flooding was reported at Broadkill Beach, Rehoboth Beach, South Shore Marina, Indian River Inlet, North Bethany Beach, Bethany Beach, near Fenwick, Fenwick-Bayville Road, Dagsboro, Millsboro and Frankford. Dune-line beaches occurred at the south end of Broadkill Beach, the south end of Delaware Seashore Park and north Bethany (Wellington Avenue). Minor beach erosion was reported at Bethany and Rehoboth.

August 26-28, 1971 - Hurricane Doria - Tides two to four feet above normal and 60 mile per hour winds caused minor damage. Flooding was reported at Bowers Beach, Rehoboth (Wilmington Avenue), Route 14. Wind however, was the primary cause of damage. Twenty-five people from Bethany, 150 from Henlopen State Park and 72 from other areas had to be evacuated.

September 2-3, 1971 - Hurricane Ginger - No significant coastal damage.

September 12, 1971 - Hurricane Heidi - No significant coastal damage.

September 23-26, 1971 - Northeaster - Tides 1.5 foot above normal were recorded at Indian River. No major flooding was reported.

1972

February 12-13, 1972 - Northeaster - Beach erosion and minor flooding were reported.

May 14, 1972 - Northeaster - Minor flooding in some coastal areas.

June 20-22, 1972 - Hurricane Agnes - Most of the flooding from this storm occurred in upland regions of northern Delaware. Tides, however, were two feet above normal and minor flooding was reported in the Bowers Beach, Bethany Beach and Lewes areas.

September 21, 1972 - Tides two to four feet above normal caused minor flooding and beach erosion.

December 22, 1972 - Northeaster - Tides running 3.5 feet above normal caused minor flooding and beach erosion. The Lewes/Rehoboth Canal overflowed its banks.

1973

October 25-26, 1973 - Hurricane Gilda - High tides and a heavy surf caused minor beach erosion.

December 9, 1973 - Northeaster - High tides, 30 knot winds and 8 to 13 foot seas again caused minor beach erosion.

1974

December 1, 1974 - Northeaster - East and northeast winds up to 80 mile per hour driving 10 to 12 foot storm waves caused significant beach erosion and moderate flooding. The Delaware Coast was fortunate that the brunt of the storm occurred at low tide. Prior to high tide the winds suddenly shifted and diminished in intensity. Without this turn of events this storm could have caused major damage to structures and beaches.

The areas reporting significant damages included: South Bethany Beach, Broadkill Beach, Slaughter Beach, Whiskey Beach, Dewey Beach, Indian River Inlet, Fenwick Island, Pickering Beach, Rehoboth Beach, Lewes and Prime Hook.

Damage to the dune line occurred at South Bethany Beach, Indian River Inlet, Dewey Beach, Whiskey Beach, Lewes, Slaughter Beach, Big Stone Beach, Bowers Beach and Kitts Hummock. The storm also required the evacuation of about 800 coastal residents including many from Dewey Beach, South Shores Marina and trailer parks at Indian River Inlet, Pickering Beach, Bowers Beach, Kitts Hummock and Upper Perins Neck.

South Bethany Beach suffered the most significant damage, primarily because of substantial development seaward of the primary dune. Moderate beach erosion was recorded from Lewes to Fenwick Island, but severe erosion was experienced at most Delaware Bay beaches. At the south end of Slaughter Beach 30 to 40 feet of beach was lost and bulkhead, which withstood the March 1962 storm, was destroyed. A major breach of the dune occurred at McKinley Street in Dewey Beach and caused flooding in the vicinity. Previous beach fill at Bowers and Kitts Hummock prevented substantial damage, however, a large quantity of this sand was lost offshore. Rehoboth Beach and Lewes experienced minor flooding and a few sections of the Rehoboth boardwalk were damaged.

Damages along the Delaware Coast were estimated to be $2,250,000, including $150,000 for repair of the Rehoboth boardwalk and $500,000 for beach restoration between Lewes and Fenwick Island.

Storm Data - December 1-2, 1974

I.	Maximum Heights of Tide	Height*
A.	Measured at:	
1.	Smyrna River at Route 13	+5.11' MSL
2.	Murderkill River at Bowers	+8.56' MSL
3.	Cedar Creek near Slaughter Beach	+5.59' MSL
4.	Indian River at Oak Orchard	+4.82' MSL
5.	Indian River Inlet at U.S. Coast Guard Station	+3.5' MSL**

*Above Mean Sea Level.
**As computed by National Ocean Survey

B.	Estimated from high water marks observed by Delaware Geological Survey on 12/2/74:	
1.	Woodland Beach, estimated above each of two 8' bench marks but below 10' contour	about +9' MSL
2.	Bowers-Main Street and Hubbard Avenue, estimated approximately 2' above location of 6' bench marks	about +8'MSL
3.	Bowers at Murderkill River, estimated 2' above location of 6' bench marks	about +8' MSL

II. Observed Highway Flooding:

A. Route 9 at Dragon Creek, north of Delaware City - estimated high water just above level of road.

B. Route 9, 0.4 mile north of Port Penn - maximum high water approximately 1' above level of road.

C. Route 9, 0.5 mile south of Augustine Beach - maximum high water approximately 1' above level of road.

D. Route 9 at Silver Creek - highest tide over top of highest bridge railing.

E. Route 9 at Appoquinimink River.

F. Route 9 at Smyrna River of 0.5 mile south of Flemings Landing.

G. Route 9 at Roads 321 and 82.

H. Route 9 at Taylors Gut.

I. Route 6 at Mill Creek, 1.6 mile east of Smyrna - maximum high water at crest of road.

J. Route 6 at Woodland Beach - high water mark approximately 0.85 mile east of Route 9 at lane to south.

K. Route 9, north end of Leipsic - maximum high water just over road.

L. Route 9, Little Creek, north of Little River - maximum high water over highest part of bridge.

M. Road 69, Port Mahon - high water mark approximately 0.9 mile east of Route 9 - location of destroyed 6' bench mark covered by water.

N. Road 349, Pickering Beach - high water mark 1.3 mile east of Route 9 along road.

O. Road 68, Kitts Hummock - high water mark approximately 0.7 mile west of Kitts Hummock along road.

P. Route 18, west of Bowers - maximum water level approximately 2.5' over road.

Q. Route 16 at Broadkill Beach - maximum high water at level of road.

R. Route 14 at Dewey Beach - washover from ocean - no permanent cover.

S. Road 501, south of Indian River Inlet - maximum high water approximately 2' above level of road.

T. Route 54, west of Fenwick Island - over road.

U. Bayside communities in South Bethany and Fenwick Island - many roads covered with up to at least 1' of water.

III. Breached Barrier Beach Areas

A. Dewey Beach - along beach front for several blocks including McKinley Street and Dickinson Street.

B. Bethany Beach - sporadically along several blocks of beach front including First and Third Streets, Campbell Place, and Ocean View Parkway.

C. South Bethany - along most of beach front and especially between North Fifth and South Second Streets.

SOURCE: Delaware Geological Survey

D. North Shores - at site of recently constructed groin immediately south of State property.

E. Rehoboth Beach - at Deauville Beach between parking lot and Henlopen Acres.

F. Bethany Beach to Indian River Inlet - numerous locations between Ocean Village and Cotton Patch Hills.

G. South Bethany - between North Fifth Street and Middlesex Beach.

H. Fenwick Island to South Bethany - about three breaks between Fenwick Towers and South Bethany in the vicinity of the old shooting range.

SOURCE: Mr. Robert Henry, Beach Preservation Section, Department of Natural Resources and Environmental Control, State of Delaware.

TABLE 4

Storm Data: Duration and Maximum Tide Height
For Coastal Storms (1952 - 1974)

	Duration (hours)*		Maximum Tide Height (Feet Above MLW)	
Date	Breakwater Hbr. Lewes	Indian River Coast Guard	Breakwater Hbr. Lewes	Indian River Coast Guard
9/5/52	35		5.6	
8/13/53	44		6.0	
9/26/56	62		7.1	
9/19/61	45		6.2	
3/6, 3/8/62	96		9.5	
8/27/62	46		5.2	
11/2/62	33		7.7	
1/12/64	43		7.5	
9/15/67	49		7.0	
5/26/58	52		6.3	
11/10/68	34		7.1	
8/19/69	31		5.8	
11/1/69	45		5.9	
12/13/70	24		6.6	
4/5/71	37		6.7	
8/26/71	13		6.3	
11/23/71	48		6.0	
2/11/72	31		6.1	
2/17/72	19		7.1	
6/20/72	32	44	5.9	3.6
9/1/72	32		6.4	
9/19/72	54	55	7.4	4.5
12/21/72	20	58	8.1	4.9
3/20/73	42		7.2	
10/24/73	42	57	7.4	4.5
12/7/73	42	53	8.0	4.6
12/1/74		67		4.9

Breakwater	Mean	Standard Deviation
Duration	40.42 hours	16.07 hours
Height	+6.77 feet (MLW)	.95 feet (MLW)
Indian River Coast Guard Station		
Duration	55.67 hours	7.47 hours
Height	--	--

*Duration is defined as the total time period in whcih the storm tide level exceeded a height of one foot above the predicted normal (astronomical) tide level.

Sources frequently used in compiling the Storm Chronicle were:

Delaware State News, Dover, Delaware

Eastern Shore Times, Ocean City, Maryland

Delaware Coast Press, Rehoboth Beach, Delaware

Maryland Coast Press, Ocean City, Maryland

The Chronicle, Milford, Delaware

Evening Journal, Morning News, Wilmington, Delaware

Storm Data, Environmental Data Service, N.O.A.A., Washington, D.C.

II. COMMUNITY FLOODING STUDIES

METHODOLOGY

The purpose of these studies was to collect information regarding flood damage and the human perception of flooding hazards along the bay and ocean coasts of Delaware. Several different approaches were employed to accomplish these goals. These included the use of a detailed questionnaire, study of maps and aerial photographs of each area and interviews with community officials or members of any group who were likely to have information regarding flood damage in their particular community.

QUESTIONNAIRE

The questionnaire (See Appendix I) consisted of three separate parts - personal information, attitudinal questions and requests for more specific information about the damage done to an individual's property. There was also a section of open-ended questions which covered topics that were not adaptable to questionnaire form.

Part I (Personal) provided basic background information which established if the respondent was an owner or renter, whether he or she was a permanent or non-permanent resident and the number of years that he or she had been living in or visiting that particular community.

Part II (Attitudes) attempted to explore individual attitudes toward flooding, as well as the extent of each person's knowledge about flooding in general. Because of interest in discovering the respondents' definitions of flooding, as well as their suggestions for coping with floods, it was important that the questions be phrased as objectively as possible to avoid influencing the answers. In most cases no responses were suggested. However, for some questions (e.g., No. 12, definition of flooding) it was desirable to obtain a reaction to a variety of possible answers and, therefore, selection of choices was read to respondents. The questions were ordered so that changes in attitude towards flooding as a result of answering the questionnaire could be detected.

Part III (Specific Damages) was given to those people who were owners of property or permanent residents, as well as to those people who were neither owners nor permanent residents, but who had been coming to the area for so long that they were likely to have valuable information regarding past flood damage. In Part III the word "flood" was deliberately avoided when asking about the damage incurred on the respondent's property, since each person's perception of a flood would be different. Instead of "flood", the term "sea and/or bay water" was used. The questions about damage were structured in such a way that they might provide a better indication of the actual causes of damage by differentiating between the effects of standing water, running water, wave action, salt or freshwater and the presence of sand and/or mud. This helped to pinpoint the areas which felt the full impact of the storm and the areas which experienced only some of the storm's effects. Occasionally a problem arose because of the respondent's confusion concerning the difference between standing water resulting from seawater encroachment and standing water resulting from a heavy rainstorm. Certain information gained from these questions, such as type of damage and depth of water level, were transferred to a map to provide a better idea of what had actually occurred during the storm(s).

In addition to the structured questionnaire a number of open-ended questions were asked. Notes were taken on any information which a respondent could provide that was not covered by the questionnaire. These open-ended questions attempted to collect more specific information on the damage which had occurred, such as dollar estimates of personal loss and detailed descriptions of what had been damaged. Included were damages to boats and cars as well as grounds and structures. The respondent's knowledge of community-wide damage was also recorded. Individuals who had lived in the community for a long time often had an opportunity to observe marked changes in the beach area or the community as a whole as a result of flooding. If they recommended particular solutions to reduce flood damage and beach erosion, this was also noted. These open-ended questions often provided some of the most valuable information. Respondents were also asked to suggest other members of the community who might know more about flooding.

In an attempt to gain a more comprehensive understanding of each community's experiences, interviews were conducted with various mayors, city managers, Civil Defense officials and representatives of groups who were likely to know about flooding in their community, especially fire and rescue squads and volunteer agencies. Respondents were randomly selected on the street or beach or questioned in their homes through door-to-door canvassing. No one under fifteen years of age was interviewed.

MAPS

Large scale maps and aerial photographs were used extensively by all interviewers while in the field. These maps were constructed from various sources. For Bowers Beach, for example, copies were made of a street map prepared by the State Highway Department. The scale was 1:3600. Maps of

Broadkill Beach and Slaughter Beach were constructed from enlargements of topographic sheets prepared by the U.S. Geological Survey. The scale of both maps was 1:6856.

Any information which respondents could provide (i.e., areas under water, depths of water, dry areas and source and direction of floodwaters) was transferred directly to the maps. Later, the information from each interviewer's maps was consolidated onto one map of the area. Occasionally this would present problems when contradictory information appeared on the composite map. In such cases either a return trip to the community was made to clarify the situation or the conflict was resolved on the basis of what was known (or what would be logical or consistent with other information) about the community.

Aerial photographs were also used where possible, since they often made it easier for respondents to explain and demonstrate what had occurred during a flood. For most communities aerial photographs were available from flights conducted in 1954, 1961 and 1968. Using these photographs, land development maps were constructed to illustrate the changes that had occurred in each community. It had been hoped that contour lines could be transferred from the aerial photographs to the land development maps, but the expense of this operation and the quality of the photographs precluded this. In Fenwick Island, Bethany Beach and South Bethany Beach contour lines were obtained from sewer district maps. The 1, 3, 5, 10 and 15 foot contours were transferred onto the large aerial photographs to provide accurate topographic control.

Two acetate overlays were drawn at a scale of 1:2400 for each community; one showing land development and the other showing inundation and flood damage. For seven communities overlays were made showing the extent of sand and water coverage. The information was obtained from a set of aerial photographs taken on March 8, 1962, immediately following that devastating storm. Overlays were also constructed for selected communities showing damage and flood conditions resulting from the December 1, 1974, storm.

LAND DEVELOPMENT OVERLAYS

The information for the land development maps was obtained from an analysis of panchromatic aerial photographs taken at a 1:20,000 scale by the U.S. Department of Agriculture. Communities for which a damage/inundation overlay was prepared for the March 1962 storm have accompanying maps illustrating land development information interpreted from the 1960-61 aerial photographs. The community of Bowers Beach has a storm damage/inundation map drawn for the December 1, 1974, storm. Land development information was obtained from 1973 aerial photographs with the same specifications as listed above. Slaughter Beach has damage maps drawn for both the 1962 and 1974 storms with accompanying land development maps based on the 1960-61 and 1963 aerial photographs.

The following information is shown on the land development maps:

Developed Areas - Those portions of the community where development (residential and/or commerical structures including mobile home parks) can be noted from the aerial photographs; and

Corporate Limits - Community boundary lines for incorporated communities.

DAMAGE MAPS

All information on the flooding/storm damage maps for each community was obtained from information provided by respondents in the course of the field surveys. Three types of damage were distinguished: structural, interior and grounds. First, the houses which suffered damage were indicated on the map.

Zones were drawn around those areas having a majority of one type of damage. Zone A indicates an area where structural damage was dominant, Zone B represents the area of primarily interior damage, while Zone C includes the areas that had only grounds damage or where no damage was reported. The arrows on the maps indicate only the source and direction of water flow. A long arrow does not indicate a greater magnitude of water than a short arrow, but merely that the path of the water flow as greater. The numbers on the damage map show the depth that the water reached at that point. The depths were categorized in groups from one to two feet, two to three feet and greater than three feet above ground level.

SMALL SCALE MAPS

Small scale base maps were prepared for each community for inclusion in the text. All the information from the large scale damage map was drawn directly on this base map, except the individual structures and the depth of inundation. This was done to provide an overview of the damage zones and the direction and path of water flow in each community. The extent of sand coverage as indicated by the March 1962 aerial photographs was shown on the map where such information was available.

SPECIAL AERIAL PHOTOGRAPH MAPS FROM STORM OF MARCH 1962

Special maps were made from a series of aerial photographs taken March 8, 1962, immediately after the storm that brought so much damage to the east coast of the United States. The maps showed: 1) the inland extent of sand coverage and washover; 2) the areas of inundation in each community; and 3) the areas where structural damage occurred if such information could be derived from the aerial photographs. The available aerial photographs only included North Shores, Henlopen Acres, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany and Fenwick Island.

The following information has been included on the maps:

Sand Line - A solid brown line indicates the boundary or inland extent to which sand was washed by waves and currents in the community. A dotted brown line indicates some uncertainty in determining exactly where the sand stopped. The sand line is also a rough indicator of where the strong wave and current action dissipated. Some of the communities were, of course, inundated by a combination of water flowing across the shoreline from the ocean and water overflowing into the community from the Bay. Brown arrows show specific places where a breach in the coastal dunes occurred.

Water Line - A solid black line indicates the parts of each community covered by floodwaters. A dashed black line shows where positive evidence was difficult to obtain but where flooding was implied. Often it was not possible to distinguish the source of floodwater.

Damage Area - A red, cross hatched line indicates where structural damage could clearly be interpreted from the 1962 aerial photographs because a house had collapsed, or was washed from its original position with only its foundation remaining. Cross hatched areas generally denote one house with structural damage but longer lines may represent two or three houses. Symbols shown in red indicate damage identified during the course of the interviews (in some cases damage was further verified by the interviewer from field evidence).

III. COMMUNITY DAMAGE PROFILES

BOWERS BEACH

Bowers Beach is an incorporated community on the western shore of Delaware Bay, approximately ten miles southeast of Dover. It is situated on Pleistocene and alluvial deposits between the St. Jones and Murderkill Rivers. Bowers Beach covers an area approximately three miles square, three-fourths of which is occupied land. Within the last decade (1960-1970) the town has experienced a decline in permanent resident population of 17.3 percent. Housing in Bowers Beach includes cottages, trailers and old, multi-story homes.

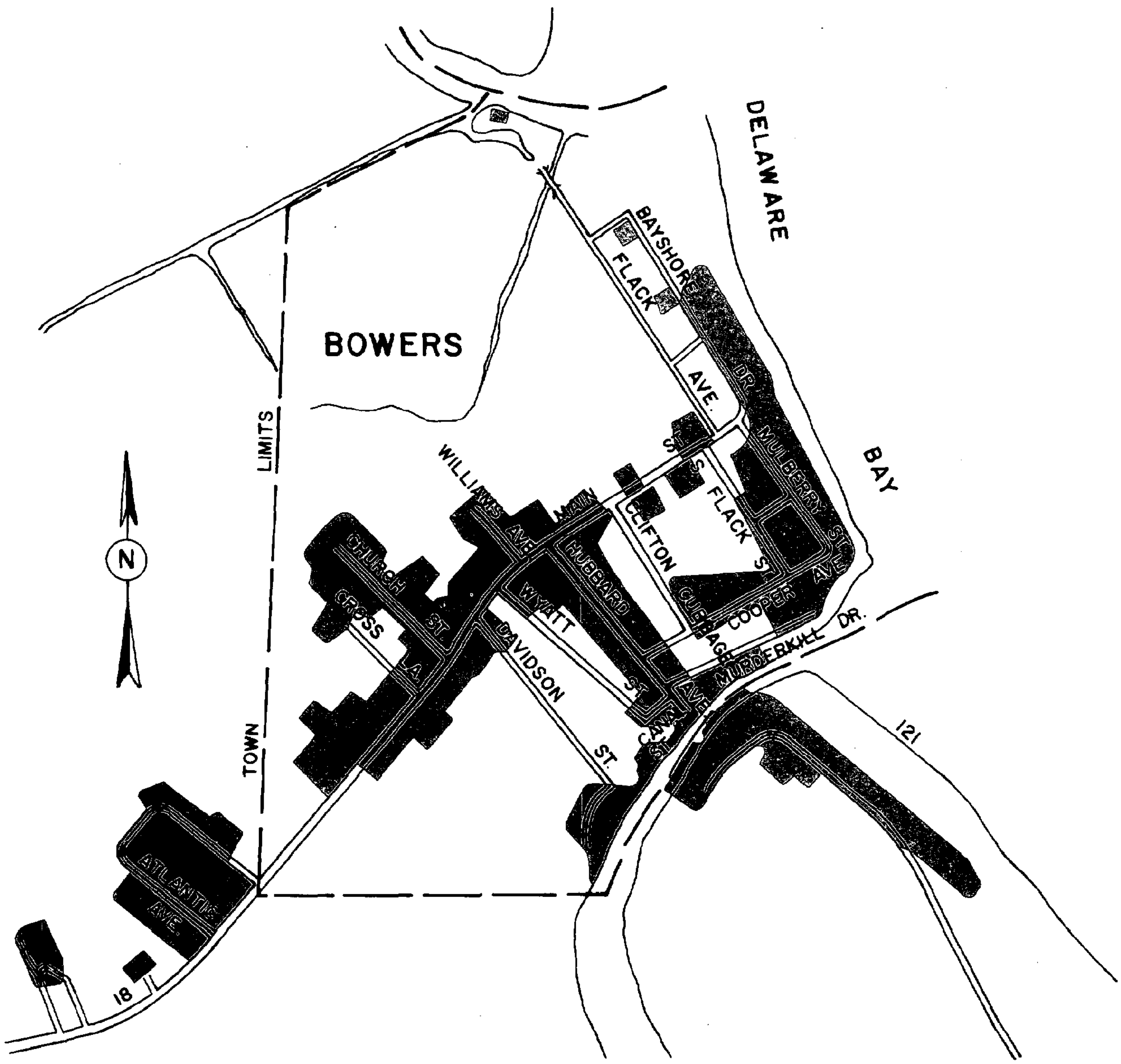
The study area also included South Bowers, a summer community situated on the south bank of the Murderkill River. There are approximately forty-five summer cottages extending for three-quarters of a mile along the Bay and one-quarter of a mile along the river.

The Bowers Beach-South Bowers area along the Murderkill is protected by bulkheads on both sides. Development along the south bank consists of private homes and docks. Development along the north bank is primarily docks, charter fishing operations and associated commercial facilities. The northern shore also has a public launching ramp with an adjacent parking lot. The property value in this area was estimated to be $530,000, while property along the the two beachfronts were valued at $164,000 (U.S. Army Corps of Engineers, 1966).

Bowers Beach and South Bowers are situated on land below ten feet MSL. The beach at Bowers is forty feet wide with a slope of 1:8. The dunes are thirty feet wide at the base and range from nine to eleven feet above mean low water. In South Bowers the beach is also forty feet wide, but the slope is 1:16. Marsh lands surround both Bowers Beach and South Bowers.

Figure 6

DEVELOPED AREA OF BOWERS BEACH 1973



LEGEND:

DEVELOPED AREA IN 1973

0 800 1600 2400

SCALE 1" = 800'

Twenty-nine interviews were conducted at Bowers Beach. Seventy-five percent of the respondents owned their own homes and 72 percent were permanent residents. More than half of the respondents have lived there for more than ten years. Dwelling types included 23 percent single story, 49 percent multiple story and 20 percent trailers. Flood insurance policies had been required by 50 percent of the property owners interviewed.

Sources of Flooding

Flooding is a common event in Bowers Beach for several reasons. The proximity of the St. Jones and Murderkill Rivers provides a troublesome source of floodwater, particularly because they are no longer dredged periodically as they were in years past. This dredging increased the holding capacity of the rivers and also helped to build up the banks. The Murderkill River causes particular problems in the community because high tides frequently inundate Hubbard Avenue. North Flack Avenue is the primary recipient of floodwaters from the St. Jones River (See Pocket Map A).

The ditch system, which was built as part of a mosquito control program, extends throughout the marsh area and also contributes to flooding problems. The ditches provide extensive inland access to floodwaters that might otherwise be confined to a smaller area.

Erosion of the beach is also a major problem. The State of Delaware initiated a flood control project for the beach area of Bowers Beach in 1972. The purpose was to widen the beach and construct a new dune line for protection of homes along the beach from storm damage. These dunes, however, proved to be very unstable and did little to protect homes during the December 1974 storm.

Strong winds are also an important factor which affect flooding. The wind can, in a sense, "pile up" the water inland and keep it there until the wind changes. This is the type of flooding that occurs most often in Bowers Beach, and flooding was the result of both river and bay overflow.

In 1962 dunes were breached, resulting in combined river and bay flooding. During this storm, flooding was more severe on the bay front than it usually is. In 1974, although the dunes were breached somewhat, bay flooding was not as extensive. Residents attributed the main source of floodwaters to rising river water.

Bowers Beach was covered by floodwaters in December 1974. The areas along the bay and the river had about two to three feet of water. Further inland the depths were ususally less, averaging about one to two feet in depth.

Flood Damage

This section will outline the flood damages that residents of Bowers Beach have experienced as a result of the storms in March 1962 and December 1974. Emphasis is on these two storms because they have been the most serious ones in recent history. Residents of Bowers Beach were able to recall much more about the 1974 storm.

a. 1962 Storm

Five interviews were conducted outside the corporate limits of Bowers Beach on the southwestern loop of Atlantic Avenue. Residents here recalled that flooding from the 1962 storm forced people in this area to evacuate their homes, although the extent of damages was not noted. The area of Williams Avenue and Main Street received some flooding in 1962, but no specific damage was mentioned. Three respondents were interviewed north of

Main Street in the vicinity of North Flack Avenue and Bayshore Drive. They made no mention of specific damage, but they did recall that three children that lived in the area were drowned while evacuating.

On the southern side of Main Street, along South Flack Avenue to Cooper Avenue, five interviews were conducted. Here the storm of March 1962 was remembered especially because of the damage it did to numerous beach front cottages south of Main Street. Most of these cottages were washed off their foundations and into the marsh areas. One respondent also reported that a boat washed into the marsh area from the beach. Only one resident specifically recalled damage to interior finishings and grounds.

Four interviews were conducted along Hubbard Avenue. The two respondents who had lived there in 1962 recalled damage that they suffered as a result of the storm. In one case, the grounds and interior furnishings of a trailer were ruined. The hotel located on this street had structural damage to the foundation and the fireplace. Interviews conducted along the north bank of the Murderkill River failed to provide any detailed information. Respondents agreed that structural damage was extensive, but they were unable to provide specifics.

The same held true for the two respondents interviewed in South Bowers. The interviews established that the damage had been considerable in 1962, but it is not possible to pinpoint or describe it on the basis of the questionnaire data. The Corps of Engineers estimated the damage at Bowers Beach and South Bowers Beach to be $620,000 (1962 prices, U.S. Army Corps of Engineers, 1966).

b. 1974 Storm

A more detailed picture of the December 1974 storm can be outlined. Property damage in the Atlantic Avenue area was reported by four out of five respondents. There was considerable ground damage, including plants killed by saltwater and large deposits of trash, sand and mud. One respondent reported water inside the house which did damage to interior furnishings. Another individual reported structural damage caused by moving water. She had to pay for a new water pump which cost $250. In addition, a man leaving Bowers had his car filled with water, totally destroying it. The cost of repairing damage ranged from that required for cleaning up to one case where it was so expensive that the family never moved back. Further inland five interviews were conducted at Williams Avenue and Main Street. Standing water, moving water and mud caused extensive ground damages and interior damage in three cases. One respondent estimated she had experienced $600 worth of interior damage.

According to three respondents in the area of North Flack Avenue and Bayshore Drive, the December 1974 storm caused extensive damage. Along the Main Street border of this area, both grounds and interior furnishings were damaged, as well as a boat and a car. Damages were estimated to be $2,000. Another house suffered structural damage.

Five interviews were conducted along South Flack Avenue to Cooper Avenue. People reported structural damage as well as damage to interior furnishings and grounds. Minor structural damage was concentrated at the south end of Flack Avenue and was caused by floodwaters from the Murderkill River.

Two of the four respondents on Hubbard Street mentioned specific damage from the December 1974 storm. One house lost almost all of the furnishings on the first floor. The second case involved a car which had been ruined by standing water.

The final area surveyed in Bowers Beach was the north bank of the

Murderkill River. All of the respondents reported damage to grounds and interior furnishings. The damage suffered by the restaurant on the docks was particularly extensive. Other losses included between 200 to 300 rabbits, several mowers damaged by standing water inside the shed and a water pump. Sand and mud covered much of this area, requiring a time-consuming cleanup. The dock along the river was badly damaged by wave action from the storm.

The two South Bowers' respondents reported ground damage. Both also had their cars destroyed by floodwaters. One respondent estimated a total of $700 in damages.

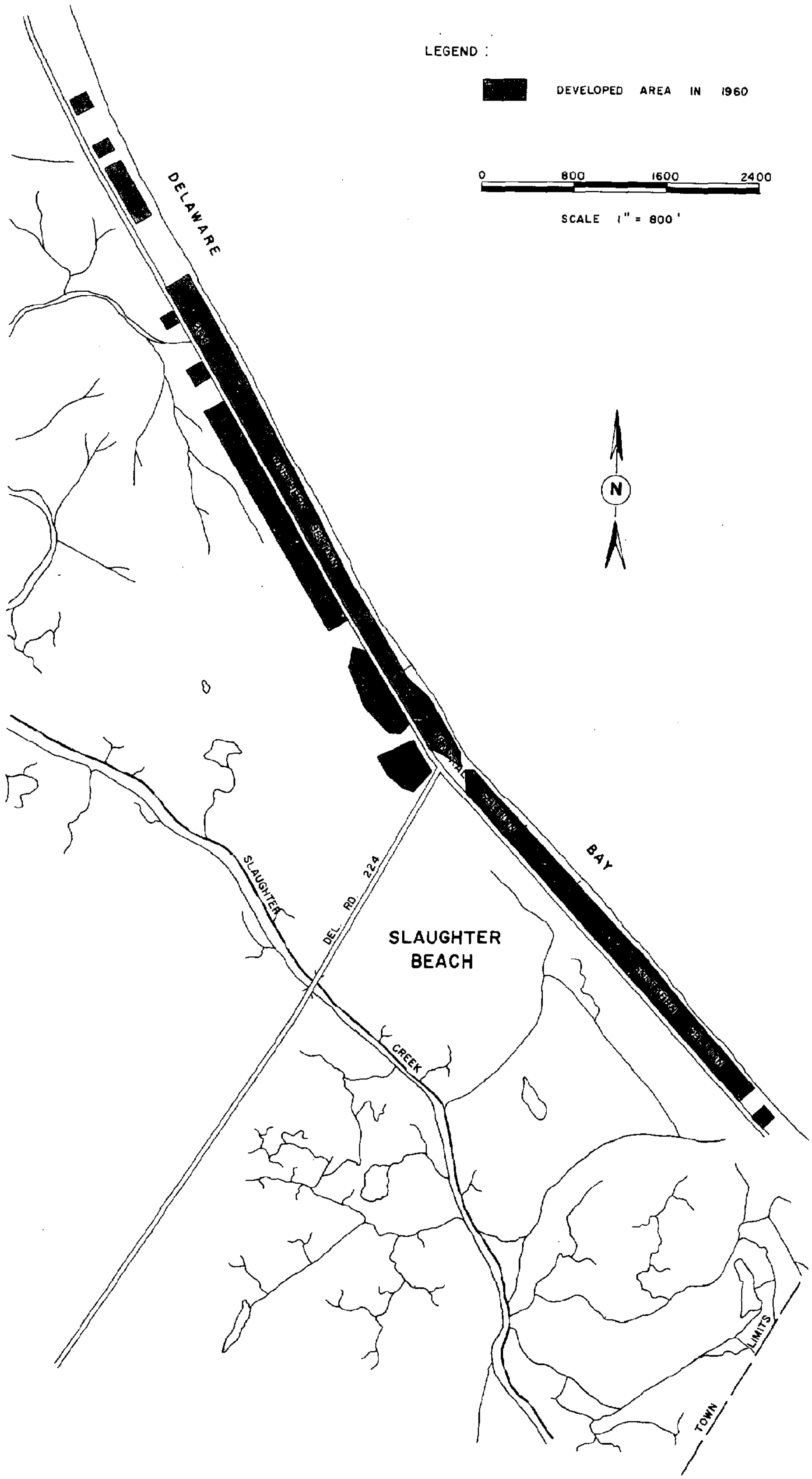
It was difficult to delineate different damage zones from the December 1974 storm, even though damage was extensive. This is due to the fact that all of Bowers Beach is less than ten feet above MSL and that it is surrounded by the Delaware Bay, the Murderkill River and the St. Jones River. The two rivers played a major part in the 1974 flood, since floodwaters were carried inland and caused structural and interior damages there as well as along the Bay. Only two areas in Bowers Beach (one on Williams Avenue and one on Church Street) were reported to be on higher ground, and therefore, less prone to damage.

SLAUGHTER BEACH

Slaughter Beach is an incorporated community of Sussex County, located on the coast of Delaware Bay below the Mispillion River. The town lies between two other coastal communities; Cedar Beach to the north, and Primehook on the south. According to a 1965 population estimate, 130 permanent residents live in Slaughter Beach (U.S. Army Corps of Engineers, 1966). The population

Figure 7

DEVELOPED AREA OF SLAUGHTER BEACH 1960



increases during the summer months to 430 residents. This influx is due to private homeowners for the most part, because there are no commercial hotels or motels for summer residents. Slaughter Beach had an estimated property value of $910,000 in the mid-1960's. The beachfront property alone was worth $400,000 (U.S. Army Corps of Engineers, 1966).

There is 8,000 feet of beach frontage in Slaughter Beach, all privately owned. The developed area extends along the beach for 1.5 miles and contains approximately 115 houses in the beachfront section. On the west side of the main road that runs parallel to the Bay, there are an additional thirty-five houses which back up to the marsh area. This beach, which includes a berm of thirty feet, is approximately 100 feet in width. It has a slope of 1:10. On its western side Slaughter Beach is bounded by wetlands that extends three to four miles until it reaches Slaughter Creek.

Slaughter Beach has received help from the State and Army Corps of Engineers for the preservation and protection of its beachfront. The community has a groin system that extends over the major part of the community beach. This system includes twenty individual groins placed at regular intervals along the beach. In 1961, 165,000 cubic yards of beach fill was deposited on the beach (U.S. Army Corps of Engineers, 1966). After the 1962 storm this area was declared by the State to be in a "state of emergency" and aid was given to rebuild the beaches. Since 1962, approximately forty feet of the beach at Slaughter has eroded. In 1975 the road in Slaughter Beach was raised and ditches enlarged in an attempt to deal with flood problems.

Thirty-five individuals were interviewed in Slaughter Beach. Property owners made up 83 percent of the sample, but only 43 percent were permanent residents. Forty-six percent of the property owners had flood insurance policies. The dwellings were 40 percent single-story and 60 percent multiple-story or split level. Over half of those interviewed (57%) had been in Slaughter for ten years.

Sources of Flooding

Patterns of flooding in Slaughter Beach are fairly uniform throughout the community. All of the respondents mentioned both bay flooding and back flooding of the marshes and Slaughter Creek. Those directly on the beach-front experienced wave action on their property in some instances. There were breaks in the dunes both in 1962 and 1974. In 1962 the dunes broke through the north and south sections, while in 1974 the problem seemed to be concentrated in the south section.

According to information supplied by informed citizens and a town official, the source of flooding begins in the bay and then travels to the marsh and creek. This back flooding then becomes the major problem as the waters continue to rise. Many respondents felt this was the situation, especially in 1974 when wave action caused less damage than the overflow of Slaughter Creek into the marsh. Residents in the southern beachfront portion were concerned about the condition of the beach and its relation to damage from the storm. One resident attributed the damage in the southern section to the abrupt end of bulkheads and groin structures at the south end, allowing water to wash onto properties. Another resident of this section compared damage between the two storms in light of beach conditions. This respondent said that in 1962 the beach was wide with a good grade, so the majority of the water was from the marsh area; however, in 1974 the beach had eroded considerably, which made it easy for bay water to wash over. In an effort to protect themselves from storms, several residents in the south section had sand pushed up around their houses. However, the 1974 storm destroyed these embankments and made them more vulnerable than ever.

Flood Damage

The community of Slaughter Beach has suffered severe damage from two major coastal storms within the past two decades. Many of the individuals interviewed described damage that occurred during both the storm of March 1962 and of December 1974. Descriptions of damage which occurred concentrated mainly on the respondents' personal property loss, but also included some information regarding damage received by other residents in the community, as well as public areas of the community.

The following summary of this damage information is organized in terms of location. The community has been divided into north, central and south sections with the intersection of the main street and Delaware Road 224 acting as the central element. These sections are further separated by the main road into beachfront houses on the bay side and houses on the opposite side which are bordered by the marsh areas.

a. 1962 Storm (See Pocket Map B)

In the March storm of 1962 Slaughter Beach received an estimated total of $473,500 in damage (at July 1962 prices, U.S. Army Corps of Engineers, 1962). This estimate includes a total of seventeen destroyed houses. Of these, thirteen were beachfront homes that washed into the marsh or out into the Bay.

At the northern end of Slaughter Beach houses from the beachfront section were carried into the marsh and creek. This section was described in the Army Corps of Engineers report as the one which suffered the most extensive damage within the community. One house in the northern beachfront section (not located on the map) was totally destroyed by wave action, and the movement of the water carried parts of it into the Bay. This structural damage resulted in the death of a woman who had not been evacuated from the house during the storm. Of the respondents interviewed in this section, north of the first groin structure, only two were there in 1962. The one farther north received only ground damage. The other house had interior damage to both the basement and garage. Farther south, below the first two groin sections, the amount of damage information was more substantial. One beachfront house had water damage in the garage from the nine inches of water. This same respondent also lost three boat ramps due to structural damage. Total estimated damage for this property was $4,000. The next beachfront house also received structural damage which cost an estimated $500 to repair.

The central portion of Slaughter Beach, in the vicinity of the intersection between the main street and Delaware 224, experienced less significant damage in the beachfront section. Two houses immediately north of the intersection received structural damage. In both cases wave action was responsible for the shifting and breaking of structural elements. In this same area another house received only ground damage. On the south side of the intersection one respondent reported that the only damage resulted from the three to four inches of sand that was deposited underneath the cottage. The garage at the next house was flooded, but there was no appreciable monetary damage done.

The last beachfront section, at the south end of Slaughter Beach, is situated below the groin portion of the beach. Six people interviewed in this area were homeowners at the time of the March storm and only two of these experienced damage to their houses. Southward from the end of the last groin, the first four houses received only ground damage in the form of debris, sand and mud. At the southernmost end one house received interior damage that amounted to approximately $300. The last house at the southern tip of Slaughter Beach experienced structural damage to bulkheads due to erosion and wave action. The respondent also lost two boats in the storm having a combined value of $1,700.

On the opposite side of the road the houses lie adjacent to the marsh area. None of the respondents interviewed in the northern end above the groin section were there at the time of the 1962 storm. Farther south below the third groin, one householder reported interior damage from the flooding that amounted to an estimated $1,000. The respondent also had a small boat in the yard that was ruined by mud and water. In the central section of the community one house to the immediate north of the intersection received interior damage. No monetary estimate was given for the damage, which also included ground damage. South of Delaware 224 there are no houses located on the marsh side.

During this storm the main street in Slaughter Beach was covered with an average of three feet of water. The movemement of this water caused extensive damage to the road and made costly repairs necessary. Several feet of beach, much of which had been deposited as beach fill in 1961, were eroded by the storm. Approximately 56,629 cubic yards of emergency beach and dune fill were replaced along a 5,000 foot stretch of beach after the storm (U.S. Army Corps of Engineers, 1963).

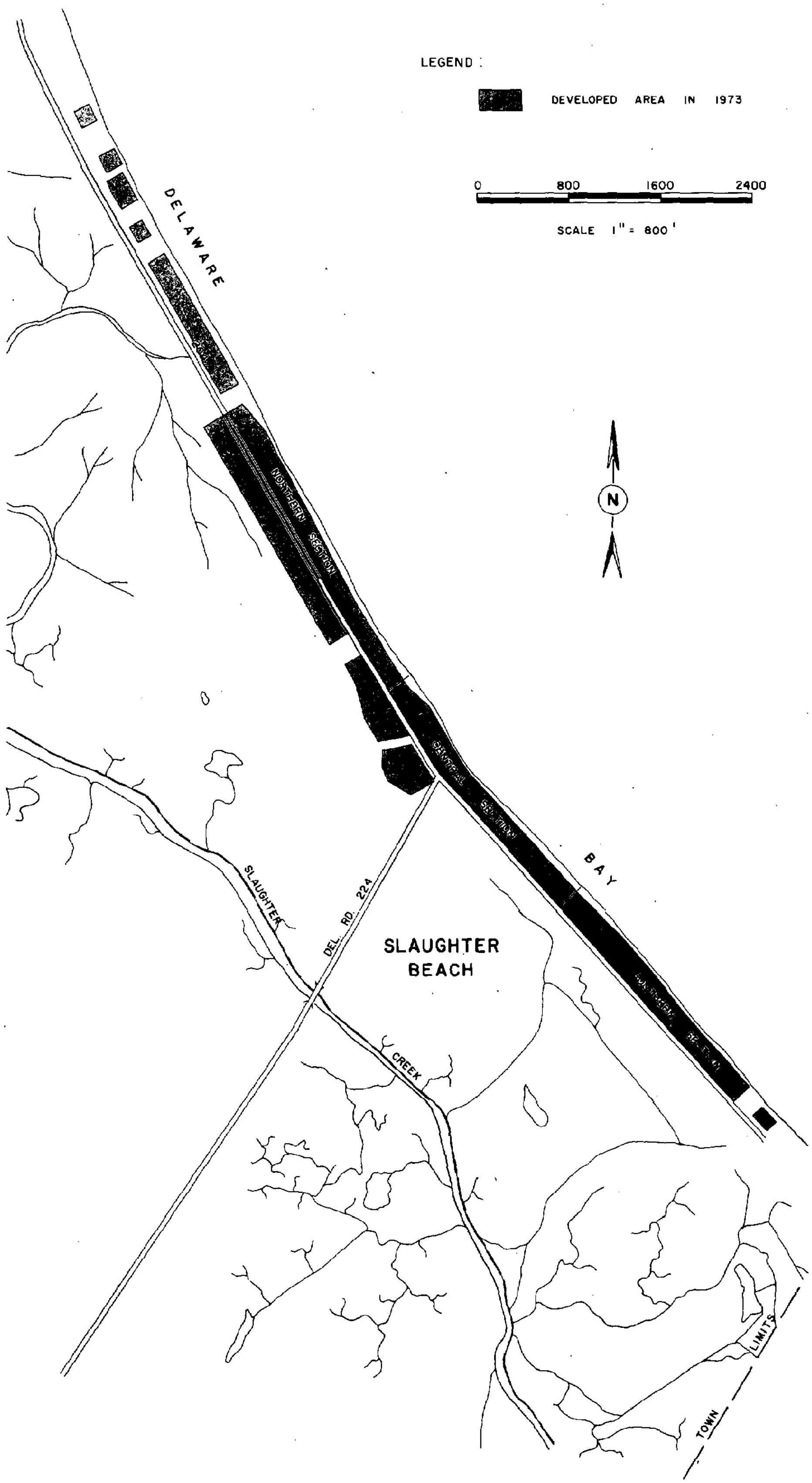
b. 1974 Storm (See Pocket Map C)

Slaughter Beach suffered less extensive damage in the December 1974 storm. The section of beachfront north of the groins had only one house that received more than ground damage. This house experienced some interior damage caused by three feet of water in the basement. Cost of damage was estimated at $700. Ground damage was suffered by one house in this section. South of the first two groins, there is a section of houses where five interviews were conducted. One resident in this group suffered structural damage to his pier, costing $2,500 to repair. There was also some ground damage at this residence, but no interior damage. Two other respondents reported water on their property, but only minor ground damage occurred.

In the central area on the northern side of the intersection one house experienced interior flooding and ground damage, totaling an estimated $300. Three other houses in this area reported no damage from the storm. On the south side of the intersection, before the end of the groin section, four residents were interviewed, and three of the four reported major damage. The first of these had no damage inflicted on the house, but the driveway washed out. The next house received

Figure 8

DEVELOPED AREA OF SLAUGHTER BEACH 1973



interior damage including a half-inch of sand in the house. The house next door had more than $3,200 in structural damage. The last house in this section suffered structural damage to its boardwalk and bulkhead. In addition this respondent also lost a car during the storm.

The southern section of Slaughter Beach received minimal damage from the storm. Of the six respondents interviewed in this area only one had experienced damage to anything other than grounds. In this one instance the house located at the southernmost end received structural damage to its bulkhead, because the storm eroded the sand around it. The bulkhead on this property has had to be replaced three times at a total cost of $30,000.

For those houses bordering the marsh area the damage from this storm was not too severe. Only one respondent in this section reported both interior and ground damage to his residence. All other residents reported only ground damage.

The roads in the community were flooded during the storm and severe damage resulted. In the northern section, between a tributary of Slaughter Creek and the Bay, part of the road was undermined. Areas of beach were also eroded by the storm. One groin was considered lost because the storm had covered it with sand. The Marina at the northern edge of the community also recieved extensive damage from the storm.

BROADKILL BEACH

Broadkill Beach is located on the Delaware Bay above five miles north of Lewes, Delaware. Route 16 enters Broadkill from the southwest. The main road, Bayshore Drive, interesects Route 16 and runs parallel to the shoreline.

Table 5 illustrates the rapid growth of Broadkill Beach between 1954 and 1973. Both the developed beachfront and the total number of homes increased fourfold during that time. The estimated property value of Broadkill Beach in 1966 was $550,000. The beachfront alone was valued at $440,000 (U.S. Army Corps of Engineers, 1966).

TABLE 5

Broadkill Beach, Delaware

Year	Length of Developed Beach	Number of Beachfront Homes	Number of Set Back Homes	Total Homes
1954	.55 mi	46	28	74
1960	1.1 mi	75	43	118
1968	1.3 mi	95	55	150
1973	2.6	179	112	291

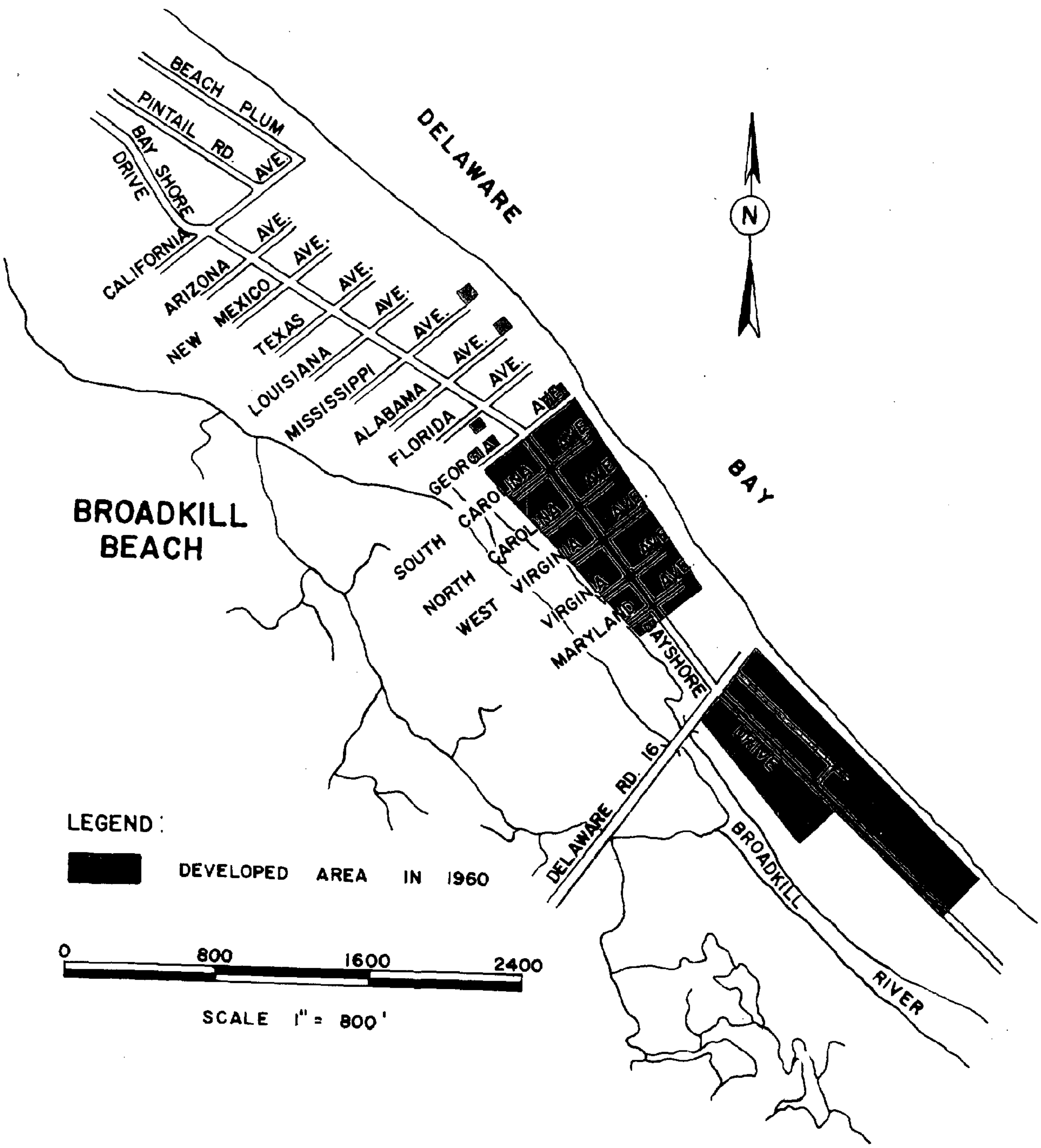
Thirty interviews were conducted in Broadkill Beach. Eighty-seven percent of those interviewed owned property there, but only 43 percent considered themselves permanent residents. Flood insurance had been taken out by one-third of the owners. Half of the dwellings in Broadkill Beach were single-story, one fourth were multiple-story, and trailers made up 14 percent of the sample. Thirty-six percent of the people interviewed had been coming to Broadkill for more than ten years.

The beach is approximately seventy feet wide. The dunes are thirty feet wide at the base and ten to twelve feet above mean low water. They separate the beach from an extensive marsh area, which lies to the west. These marshes contain many small creeks and drainage ditches. Most of the land in Broadkill Beach is less than ten feet above mean sea level.

Before the Broadkill Inlet Jetty cut off Broadkill Sound from the Delaware Bay, the land between the Sound and the Bay was experiencing accretion. This partially explains why Broadkill Beach protrudes farther

Figure 9

DEVELOPED AREA OF BROADKILL BEACH 1960



towards the Bay than the rest of the coastline. The March 1962 storm caused the formation of the Broadkill Sound Inlet, which connected Broadkill Sound with the Delaware Bay. This Inlet has since been closed by littoral drift and wind-blown sands.

Sources of Flooding

Flooding in Broadkill Beach comes from the Delaware Bay as well as inland from the marshes and Broadkill Sound. The Bay flooding is caused by high winds and tides. Floodwaters from the marsh occur only when there are exceptionally high tides and when the Bay breaks through into the marsh.

In 1962 the Bay and the marsh were responsible for flooding. There was a natural inlet south of Broadkill Beach (Broadkill Sound Inlet) which was said to have caused water to rise behind the barrier, but this has since filled in. In 1974 flooding came from the Bay only and covered Bayshore Drive and parts of Route 16.

Flood Damage (See Pocket Map D)

The total damage in Broadkill Beach by the storm of March 1962 was estimated to be about $450,000 (U.S. Army Corps of Engineers, 1966).

Most of the people interviewed in Broadkill Beach were not there for the storm of March 1962. Two respondents from the northern section were there, but received no damage. These houses were located on Beach Plum Street and North Mexico Street.

The central section of Broadkill Beach was the most severely damaged in 1962. This section, between Alabama Street and Route 16, had six houses with interior and/or ground damage. One home experienced $800 worth of structural, interior and ground damage.

Zone B was established around the central section and indicates primarily an area of interior damage. The rest of Broadkill Beach was included in

Zone C, because those few people who had been there in 1962 had received no damage. The majority of the people north of Georgia Street had not been there in 1962. Not many interviews were conducted in Zone C south of Route 16, but those who had been there in 1962 had received no damage.

Although the Corps of Engineers survey conducted in April 1962 found an estimated $450,000 total damage for Broadkill Beach, the present survey did not find as much damage because most people who were interviewed had not been there in 1962.

b. 1974 Storm (See Pocket Map E)

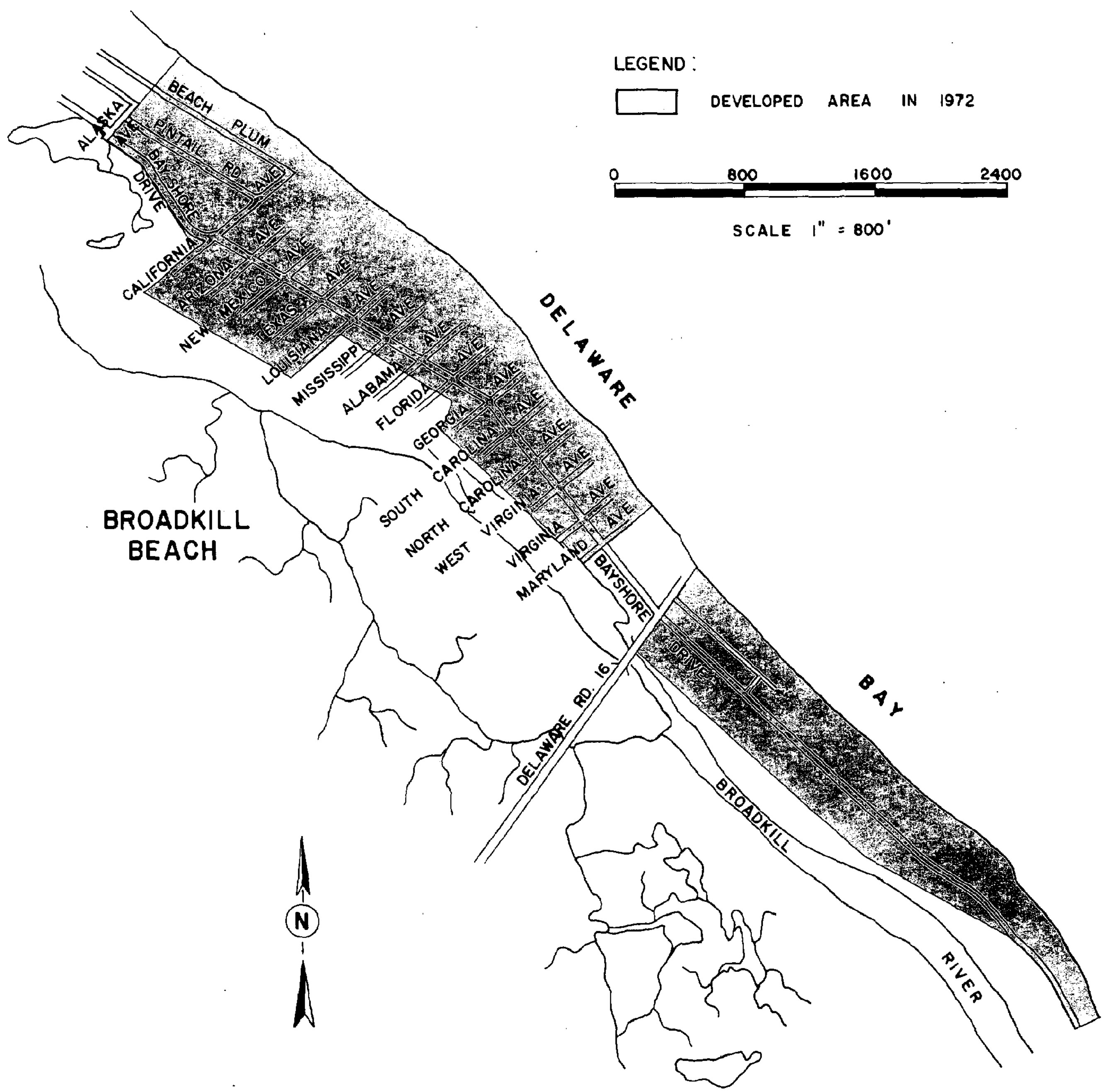
Most of Broadkill Beach received little damage in the 1974 storm with the exception of the southernmost part. In the northern section north of Arizona Street, six houses which were there in 1974 were surveyed. Two of these had experienced ground damage. In the section from Alabama Street to Arizona Street the five houses surveyed had received no damage. The section from Route 16 to Alabama Street had seven respondents and only two reported ground damage caused by bay water covering the property.

In the area extending south from Route 16 none of the four respondents interviewed had any damage, but one had water on his property. There were five respondents in the southernmost section of Broadkill Beach, which included the unpaved portion of Bayshore Drive. Three houses had received ground damage. One house experienced damage to a bulkhead totaling $4,000. Another person reported $100 worth of interior damage as well as $100 worth of damage to a boat. The other house experienced ground damage amounting to only $50.

The properties which were covered with Bay water in 1974 were those situated adjacent to the Delaware Bay. The houses further inland had no problem with flooding.

Figure 10

DEVELOPED AREA OF BROADKILL BEACH 1972



All of Broadkill Beach was delineated as Zone C for the flood of December 1974, since there was only one case of interior damage and seven cases of ground damage.

NORTH SHORES, HENLOPEN ACRES, REHOBOTH BEACH, DEWEY BEACH

These communities occupy the northern reach of the baymouth barrier complex that extends along the Atlantic shore from Whiskey Beach south to the Delaware-Maryland border (Delaware State Planning Office, 1976). For the most part, the shoreline fronting these communities is a straight, narrow sand beach backed by low dunes. The city of Rehoboth Beach itself is situated on a Pleistocene headland, which has elevations exceeding twenty feet above mean sea level. This site offers a measure of protection to most of this community from all but the most extreme storm waves and tides. Over the long term these headlands and beaches recede landward particularly during storm activity. A system of man-made groins built along this shoreline, however, has apparently stabilized the beach. The Delaware State Planning Office reported (1975) that between 1929 and 1954 no net recession was recorded at Rehoboth Beach.

North Shores and Henlopen Acres to the north and Dewey Beach to the south of the City of Rehoboth Beach are located on a barrier beach. These communities, built in part on washover deposits, were flooded during the recent storms of 1962 and 1974. Their topographic position and lower elevation leave them more vulnerable to storm waves and flooding than the higher, more protected Rehoboth Beach area. One can be certain that breaching of the small, remnant dunes by storm waves will occur during future storms.

Should additional dwelling units be constructed near the dune line, a considerable increase in damage will result. North Shores and Henlopen Acres are also subject to flooding from the Lewes and Rehoboth Canal and Dewey Beach is subject to flooding from Rehoboth Bay.

North Shores, Henlopen Acres

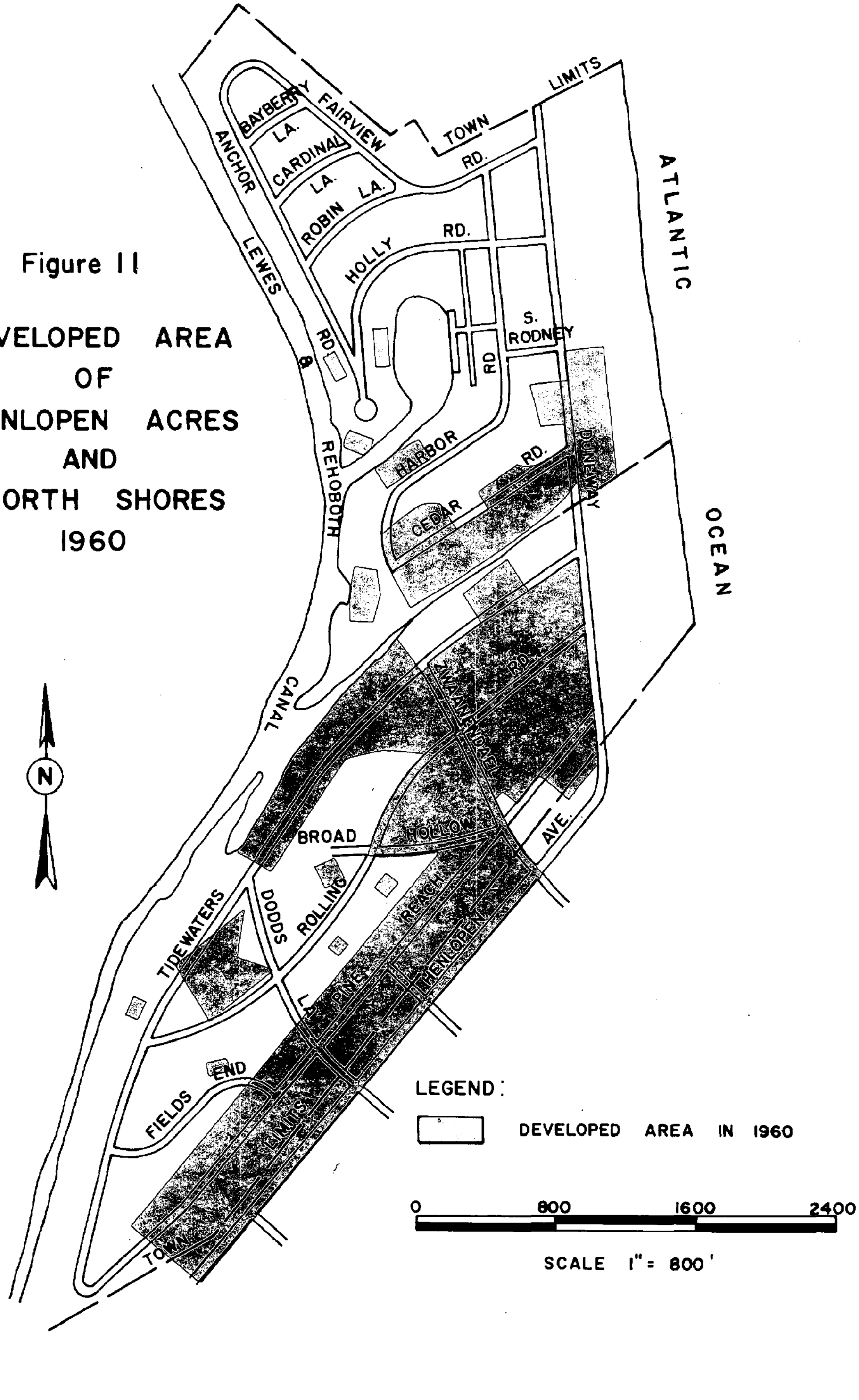
The communities of North Shores and Henlopen Acres lie between the city limits of Rehoboth Beach and the southern boundary of Cape Henlopen State Park. The combined length of their beaches is 2,000 feet. The beach consists of a wide sandy berm and low lying dunes which separate the Atlantic Ocean from tidal marshes to the west. Both communities are bordered on the west by the Lewes and Rehoboth Canal. This canal is connected to a small lake in the center of North Shores.

Henlopen Acres is an incorporated town with a permanent population of 124 (U.S. Department of Commerce, 1975), while North Shores is not incorporated and primarily a summer community with only a very small permanent population. Henlopen Acres consists, for the most part, of single family homes, while North Shores contains single family homes, cottages, townhouses and condominiums. The area of North Shores is situated on filled marshland and is reportedly subsiding.

The beach in Henlopen Acres is wide, and is protected by groins and sand fence. After the 1962 storm the dunes and sand fences along the entire beach between Cape Henlopen State Park and Rehoboth Beach were replaced by Operation Five High. Approximately 69,377 cubic yards of sand fill were replaced along 5,000 feet of beach. The sand used was salvaged

Figure 11

DEVELOPED AREA OF HENLOPEN ACRES AND NORTH SHORES 1960



from the original dunes (U.S. Army Corps of Engineers, 1966). As of 1966 the beach was in good condition and had an irregular line of sand dunes behind the high water line.

The entire area of North Shores is below ten feet (msl). Approximately two-thirds of Henlopen Acres is ten feet or higher.

A total of thirty-nine people were interviewed in Henlopen Acres and North Shores. The two communities were combined for the computer analysis section and called Henlopen Acres. Slightly more than one-half of those interviewed had been coming to these communities for over ten years, but only one-third were permanent residents. Almost 80 percent owned property in the community.

a. Sources of Flooding

During the 1962 storm North Shores and Henlopen Acres both experienced flooding from the canal and from the ocean.

The ocean breached the dunes in several places in Henlopen Acres. The oceanfront blocks along Pine Reach, Rolling Road and Tidwaters Road were inundated by ocean water which reached depths of about four feet.

Henlopen Acres was also flooded by water from the Lewes and Rehoboth Canal, especially between Broad Hollow and Zwaanendael Road and along Tidewaters Road. The canal water was not as deep as the ocean water; in most cases it covered yards, but did not flood homes.

The dunes in North Shores were in poor condition at the time of the 1962 storm. As a result the ocean easily breached them and inundated the community in the vicinity of Cedar, South Rodney, Harbor and Holly Roads. Along Cedar Road water reached a depth of five to six feet. Rising Canal water met ocean water at Cedar and Harbor Roads.

In 1974, water rose from the Canal at the Henlopen Acres Yacht Basin. Ocean water broke through the dunes at the end of Fairview Road in North Shores and covered Duneway with a few feet of water. The Snug Harbor complex at the end of Cedar Road in North Shores had water from the Canal on the sidewalks.

b. Flood Damage

1. 1962 Storm (See Pocket Maps F and G)

The area between Fort Miles and Rehoboth Beach, which includes both Henlopen Acres and North Shores, received an estimated $640,000 in damage (July 1962 prices) from the March 1962 storm (U.S. Army Corps of Engineers, 1966).

Henlopen Acres experienced damage in the oceanfront blocks. All those respondents between Zwaanendael Road and the ocean who had been there in 1962 had received damage. Four had interior damage and one had ground damage. One of the respondents with interior damage estimated his loss at $3,000. Another had $500 worth of interior damage to a refrigerator and a water pump. She also had mud deposited on her property from the Canal.

Between Dodds Lane and Zwannendael Road six respondents were interviewed who had been there in 1962. One person along the Canal had no damage while one had ground damage due to canal water on the property. The Yacht Basin along the Canal was also flooded. A respondent on Tidewaters Road had his back porch washed away. Ground damage was experienced by a person on Zwaanendael Road from debris deposited by receding canal waters. The total damage estimate was between $100 and $200. A respondent farther back from the Canal on Zwaanendael Road had no damage, and a person between Broad Hollow and Rolling Road also reported no damage.

Five people were interviewed in the area west of Dodd's Lane who had been there in 1962. None had experienced any damage.

The oceanfront section of Henlopen Acres was included in Zone B because most of the damage was interior. The low-lying sections along the Canal were also marked as Zone B as a result of extensive Canal flooding. The rest of Henlopen Acres was designated as Zone C, an area of ground damage and no damage. This area is higher in elevation than the low-lying area in Zone B.

In North Shores only one respondent was found on the oceanfront (between Duneway and the ocean) who had been there in 1962. Her house was on pilings and she received ground damage due to the deposition of ten feet of sand on her property. Information obtained from other respondents indicates that little damage occurred on the North Shores oceanfront because the homes were elevated on pilings.

Three respondents along Cedar Road reported interior damage while one reported structural damage. The respondent with structural damage estimated a $5,000 loss. The foundation was ruined and furniture and rugs were damaged. An oil tank, shower and boardwalk were carried away by water, and most of the foilage was destroyed by salt water. One person with interior damage estimated about $1,500 in damages to rugs, books and insulation. According to other respondents in North Shores, one house along Duneway between Cedar Road and Harbor Road had structural damage.

No one interviewed on Harbor Road had been there in 1962, although one home in this area was reported to have suffered interior damage.

The northern end of North Shores had not been developed in 1962, therefore, it was not possible to describe the flooding that occurred there.

All of North Shores, except the northern section, was designated as Zone B, since the largest number of respondents reported interior damage. All of North Shores is low-lying and therefore, there are no high points on which one may be relatively safe from severe flooding.

2. 1974 Storm

Although there was canal flooding in Henlopen Acres, no one reported any damage. There was also canal flooding in North Shores, and the ocean broke through the dune at the end of Fairview Road. This caused one reported case of interior damage to a house on Robins Lane and Fairview Road.

3. Interpretation of Aerial Photographs - March 1962 Storm

After the completion of the field survey, a set of aerial photographs taken of the Atlantic Coastal margin of Delaware immediately following the March 1962 storm became available. Copies of these photographs were obtained and examined in detail to determine: 1) the inland extent of sand coverage and washovers; 2) the areas of inundation in each community; and 3) any areas where structural damage could be observed. Since these photographs were not examined until after the field survey and the construction of the damage zone maps, the information from the photographs, when compared with the results of the survey, provided a very useful check and verification of the information gathered thirteen to fourteen years after the storm in question.

The photographs showed a nearly continuous line of breached sand dunes in Henlopen Acres and North Shores. Since there are no streets which run perpendicular to the beach, as in many of the coastal communities, the sand did not show the typical pattern of dune breaches at the street ends. Instead, Duneway, running parallel to the ocean, was entirely covered by sand. The sand extended from 24 feet to 600 feet west of Duneway. The furthest inland extent of the sand occurred in North Shores, but these washover fans showed no trace of debris from damaged homes.

It is difficult to determine what parts of Henlopen Acres and North Shores were flooded in March 1962, since much of the water had receded before the photographs were taken. Some of the streets seemed to have water still on them because they appear darker than other streets. From this information it would seem that the flooding in Henlopen Acres was limited to low-lying areas along the Lewes-Rehoboth Canal and a section adjacent to the beach. All of North Shores experienced floodwaters.

There were no visible structural damage areas in Henlopen Acres and North Shores. The line of floodwater coverage from the storm photographs corresponds well with the zone of interior damage obtained from the survey. Those areas of Henlopen Acres which, according to the photographs, did not appear to be flooded, also did not receive any interior or structural damage according to the survey.

Rehoboth Beach

Rehoboth Beach is the largest population center on Delaware's Atlantic Coast. It is located north of Rehoboth Bay and south of Cape Henlopen. The community covers an area approximately 1.1 square miles and has a total ocean frontage of 1 2/3 miles

Rehoboth Beach is an incorporated municipality with a permanent population of 1,614. Since it is a popular beach resort, the population swells to an estimated 52,000 during the summer (U.S. Army Corps of Engineers, 1966). There are numerous commercial establishments located here to serve vacationers. Many hotels, restaurants and stores line the mile-long boardwalk and main streets. Aside from these establishments, Rehoboth Beach is primarily composed of single family homes.

In 1966 the property value of the entire town was estimated to be $32,044,000. The figure given for the beachfront alone was $3,410,000. The March 1962 storm caused an estimated $3,530,000 in damages (U.S. Army Corps of Engineers, 1966).

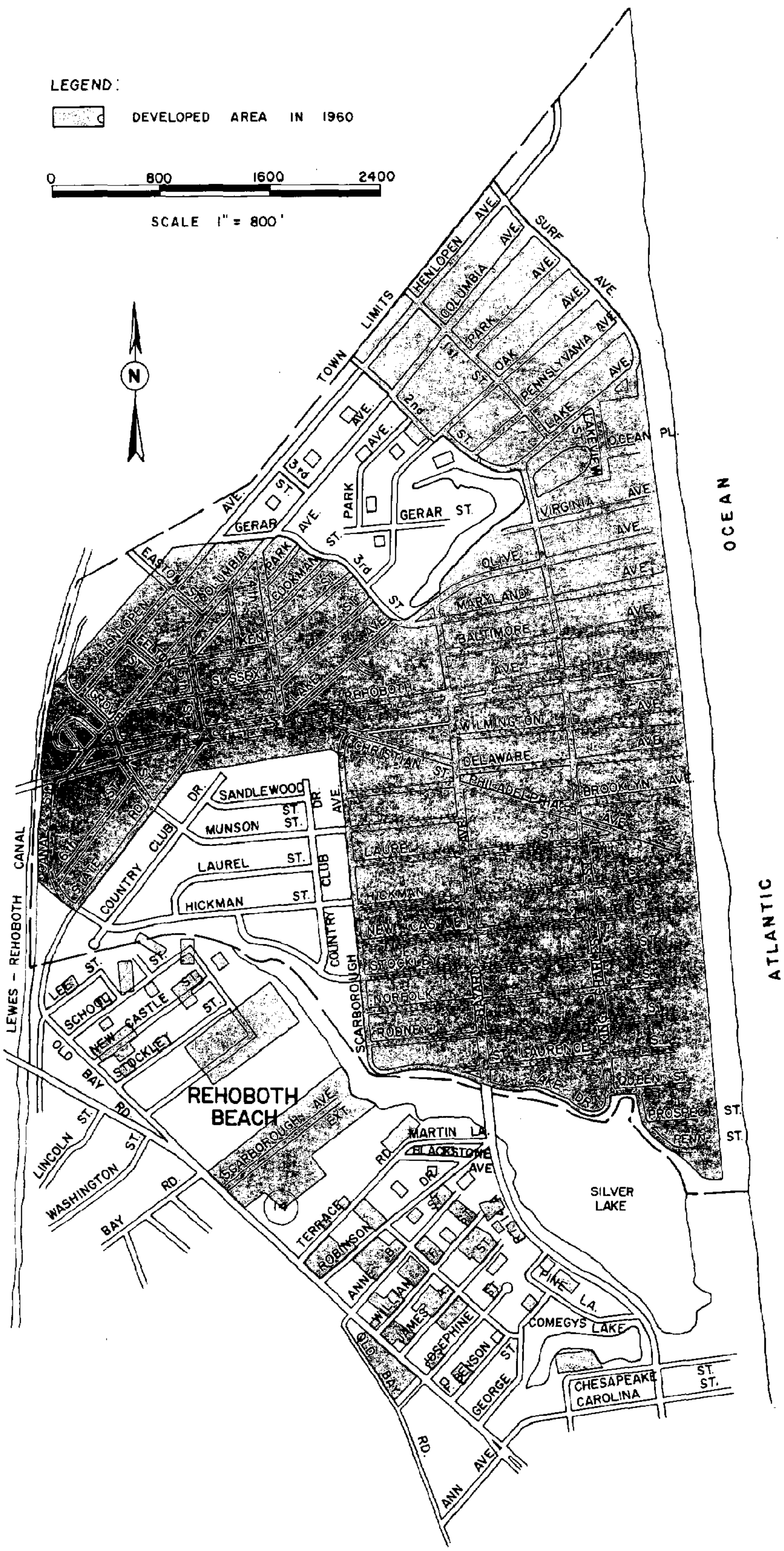
The beach in Rehoboth is about 100 feet wide between the sea and boardwalk and it has a slope of 1:10. There are also two inland lakes in Rehoboth -- Lake Gerar and Silver Lake. Lake Gerar, located at the northern end of the community is the smaller of the two. Silver Lake, located in the southern section of town, has 1,200 feet of shoreline along the back side of the barrier beach. The beach and the lake absorb and dissipate wave energy and reduce flooding effects from storm tides and thus protect inland property.

Rehoboth Beach is located on a Pleistocene highland. Most of the town, therefore, is higher than 10 feet above mean sea level and a large portion is higher than twenty feet. Consequently storm damage is primarily confined to a relatively narrow strip of land adjacent to the ocean. The Lewes/ Rehoboth Canal poses no flood threat here.

Many projects to prevent beach erosion have been undertaken in Rehoboth. Between 1922 and 1962 seventeen groins, mostly of timber, were constructed

Figure 12

DEVELOPED AREA OF REHOBOTH 1960



along the beach. The State is responsible for the maintenance of these groins. The State also protects the dunes by periodically planting dune grass and providing crossovers for beach users. In spite of these measures the net annual volumetric sand loss from Rehoboth Beach is 144,500 cubic yards (U.S. Army Corps of Engineers, 1966).

The surveys conducted in Rehoboth Beach were divided into two separate groups. Rehoboth survey 1 is composed of 250 people found on the beach or the boardwalk while the sixty-seven respondents of Rehoboth survey 2 were interviewed in their homes. The Rehoboth survey 1 sample is considerably different from all the other communities included in this study. Only 9 percent of those interviewed owned property in Rehoboth, and only 3 percent were permanent residents. In fact 61 percent spent only two weeks or less there. Thirty-five percent of this sample had been coming to Rehoboth for more than ten years. Rehoboth survey 2 shows that 85 percent own property there, while 50 percent are permanent residents. Almost 75 percent of this sample had been coming to Rehoboth Beach for more than ten years.

In addition to these questionnaires some of the local businessmen were interviewed, particularly those whose establishments were close to the beach. They provided considerable information regarding damage and flood patterns in Rehoboth.

a. Sources of Flooding

High tides and winds from the northeast were the causes of the March 1962 storm damage. Since Rehoboth Beach is located on a Pliestocene highland, the immediate beachfront was the only area impacted by waves and floodwater. The beachfront of Rehoboth was flooded from Pennsylvania Avenue south to Hickman Street.

The ocean breached the dune at Silver Lake which resulted in elevated lake levels and flooding to depths of one to two feet around its perimeter The floodwaters from Silver Lake covered parts of Lake Drive and Route 14A which parallels the shoreline. King Charles Avenue, extending northward from Silver Lake, is a low-lying street and was flooded as far inland as Laurel Street.

The storm of December 1974 was also a northeaster, however, it lacked the duration of the March 1962 storm. Flooding, therefore, was not as severe. Flood damage occurred along the northern section of the boardwalk in the vicinity of Henlopen Hotel.

Surf Avenue, which tends to flood on unusually high tides, was also under water.

b. Flood Damage
1. 1962 Storm (See Pocket Map H)

It is estimated that the storm of 1962 caused $3,530,000 worth of damage to Rehoboth Beach. Most of this damage was concentrated along a narrow strip next to the beach, extending about 100 feet west of the boardwalk.

The following is a summary of the location, type, and cost of damages in Rehoboth Beach. The first section will deal with the oceanfront strip from Pennsylvania Avenue to Silver Lake and the second section will cover damage around the perimeter of Silver Lake. The portions of Rehoboth Beach not covered in these two sections either suffered no damages, or no respondents could be found who had been in the area in 1962 (See Pocket Map H).

The first section had ten buildings with structural damage and three with ground damage. Two homes along Surf Avenue, between Pennsylvania

Avenue and Lake Avenue were destroyed and another one on the beach at Lake and Surf Avenues was washed away. The house on the corner of Pennsylvania Avenue and Surf Avenue remained standing but was extensively damaged. A garage behind the house also received some damage. The second house back on Pennsylvania Avenue experienced ground damage. The owner said that a barrier was created by the destroyed home on Surf Avenue and Pennsylvania Avenue which reduced the damage to her own home. The seawall along Surf Avenue was also demolished.

The Henlopen Hotel between Lake Avenue and Virginia Avenue received structural damage. The front section of the east wing was destroyed.

Stuart-Kingston Galleries, next to the Henlopen Hotel, was totally destroyed. Damage amounted to $250,000. The structure had not been built on pilings, but merely on concrete foundation. The VIA (Village Improvement Association) house, located behind Stuart-Kingston Galleries received no damage due to its location on higher ground even though it was only 100 feet from the boardwalk. The Surf Apartments at the foot of Olive Avenue were completely destroyed by the undercutting of the ocean waves and tides.

The east wing of the Atlantic Sands Motel, between Baltimore Avenue and Maryland Avenue, was destroyed. Dolle's, on Rehoboth Avenue, also received severe structural damage. The front section of the Belhaven Hotel on the southern side of Rehoboth Avenue was demolished. Playland, located between Delaware and Wilmington Avenues, had structural damage, especially to its front section.

The first place that the ocean broke through was at Philadelphia Avenue where a home at the end of the street received structural damage.

The last home in this section, located on Penn Street, suffered ground damage due to the encroachment of ocean water. A tennis court and driveway were also washed away. In addition, 6.5 feet of sand were washed away in front of the house.

The storm caused about twelve feet of beach erosion. The federal and State governments funded a project, Operation Five High, which replaced much of the sand lost from the beach to make it ready for the summer tourist season. Approximately 216,189 cubic yards of sand were replaced along a 5,000 foot stretch of beach (U.S. Army Corps of Engineers, 1963).

The second section deals with the area around Silver Lake. In the area north of the Lake there were two reported cases of basement flooding between Bayard Avenue and the ocean. One of these respondents (on Norfolk Street) had interior damage to a freezer. The rest of the respondents in this area (five) reported no damage. Between Scarborough Avenue and Bayard Avenue none of the respondents had been living there in 1962, so no information was obtained. The area between the Lewes-Rehoboth Canal and Scarborough Avenue had not been developed in 1962 and, therefore, flooding information was unavailable.

In the area south of the lake between the Lewes-Rehoboth Canal and Scarborough Avenue Extended, there were three respondents who reported no damage in 1962. Between Scarborough Avenue Extended and Route 14A one home experienced interior damage and one, on Martin Lane, suffered basement flooding. There was one case of ground damage on Pine Lane. Three other respondents on Pine Lane had water on their properties, but no damage. Three respondents farther back from Silve Lake had no damage.

On the basis of the above information, two zones were drawn on the Rehoboth damage map. Zone A extends along the ocean front strip from Pennsylvania Avenue to Hickman Street and indicates an area of structural damage. This is the area which bore the brunt of the storm's waves and floodwaters. The rest of Rehoboth was marked as Zone C, an area of ground damage or no damage. Although in some sections there was flooding from Silver Lake and Lake Gerar, damage was generally confined to grounds and basements.

2. 1974 Storm

The only severe damage to Rehoboth during the December 1974 storm was a loss of part of the boardwalk from the Henlopen Hotel to Baltimore Avenue. The damage was estimated to be $75,000.

3. Interpretation of Aerial Photographs - 1962 Storm

Sand inundation in Rehoboth Beach was generally limited to the streets within one block of the beach. The sand inundation in these sections is an indication of floodwaters from the ocean, which at the time of the photograph had receded. The sand reaches fartherest inland along Rehoboth Avenue where it extends 400 feet west from the boardwalk. There is also an inland sand extension that crosses from the beach into Lake Gerar. Fingers of sand inundation also occur from Penn Street to New Castle Street and from Brooklyn Avenue to Wilmington Avenue which could be related to weak or unprotected areas at the ends of these streets.

A unique feature in Rehoboth Beach is the occurrence of a sand ridge along with the sand inundation line. A solid yellow line is used to indicate this ridge. The ridge extends intermittently along the beach from the first street below Silver Lake north to Oak Avenue. There are a few areas that have a ridge of sand backed by a zone of further inundation. This indicates major breaches of sand dunes at these points. Areas that include these features occur at: 1) the first block south of Silver Lake; 2) the end of Rehoboth Avenue; and 3) Virginia Avenue to the Henlopen Hotel.

The aerial photographs indicate visible damage to the boardwalk along its entire expanse from Brooklyn Avenue to the Henlopen Hotel. Structural damage areas are also evident from the aerial photographs along the ocean-front strip next to the boardwalk.

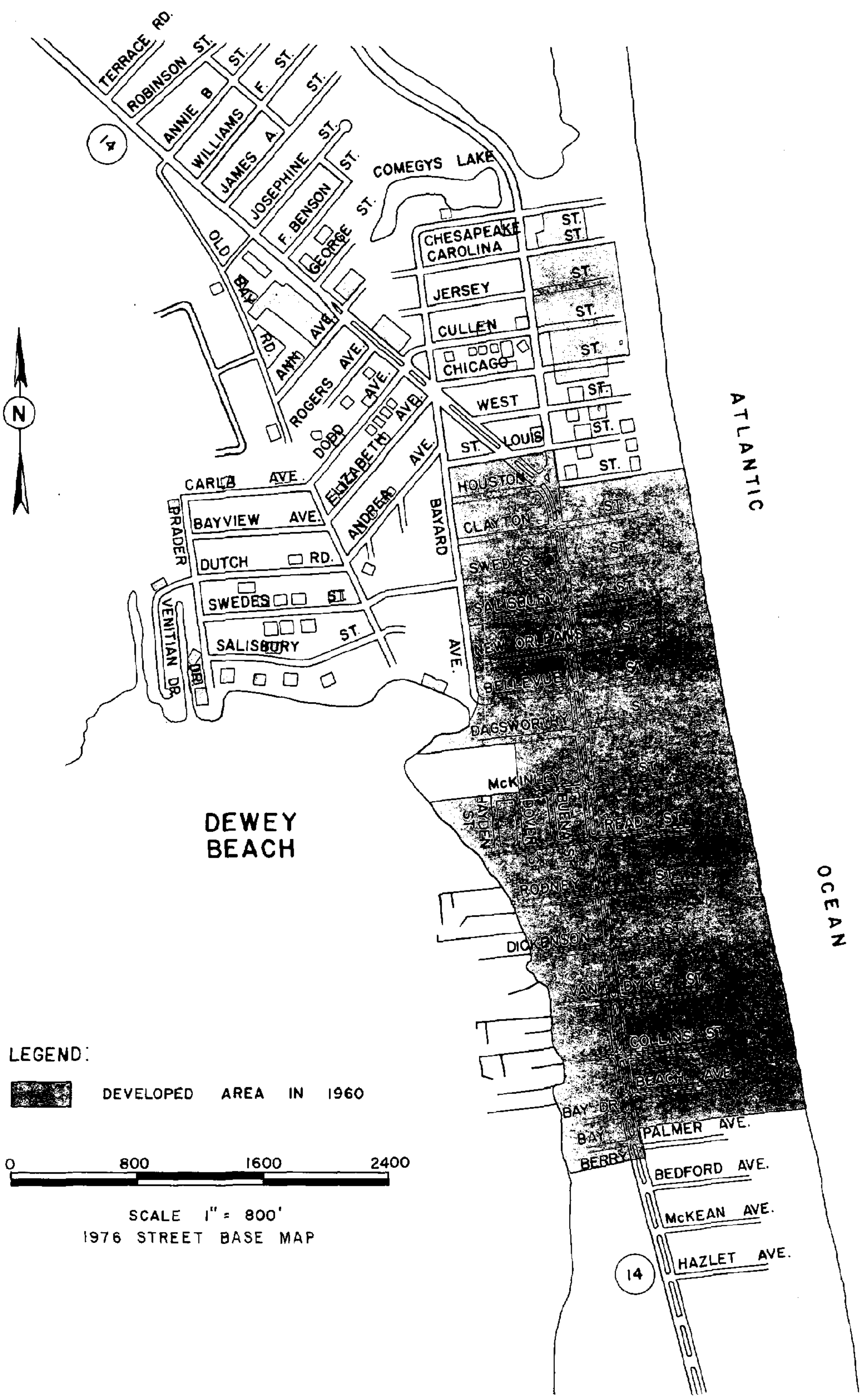
Water inundation, other than the wave action that produced the sand outline, is limited to a small area surrounding Silver Lake. These flood-waters are found on the streets from Silver Lake north to Stockley Street along King Charles Avenue. According to the survey information some basement flooding as well as grounds and interior damage occurred in this area.

Dewey Beach Area

The Dewey Beach Area lies adjacent to the southern edge of Rehoboth Beach and is approximately five miles north of Indian River Inlet. The 1970 population for this area was estimated to be 330 permanent residents, and 3,000 summer residents (U.S. Army Corps of Engineers, 1972). Property value for the entire town has been estimated at $2,420,000. For the beach front the figure is $1,912,000 (U.S. Army Corps of Engineers, 1966). This area is composed of three unincorporated sections. Extending south from Silver Lake to Bellevue Street lies the section called Rehoboth-by-the-Sea. This

Figure 13

DEVELOPED AREA OF DEWEY BEACH 1960



community spreads out on either side of Route 14 and is composed primarily of single family homes. This section is generally higher than ten feet above mean sea level and has an ocean exposure on the east side.

Sea Breeze, the community which lies to the west of Bayard Avenue, is situated directly north of Rehoboth Bay. This community is also composed of single family homes, which are, for the most part, located on high ground more than ten feet above sea level. At the western edge of the community there are two canals extending inland. The area directly along the Bay has been privately bulkheaded by the owners of these properties. A new building code applied to the bay front section of Sea Breeze requires that all new houses must be built on pilings.

The third and major section is the community of Dewey Beach. There are several commercial establishments along Route 14, including motels and stores. The Rehoboth Bay Marina is on the bay in Dewey Beach. The rest of the community is residential, consisting of trailers, cottages, single homes and apartment houses. Dewey Beach lies on a barrier beach between the Atlantic Ocean and Rehoboth Bay and is about 1/4 mile wide. Route 14 runs north-south bisecting the community into an ocean side and a bayside section. The land here is mostly less than ten feet above mean sea level except for some sand dunes.

The whole Dewey Beach Area has about 1.3 miles of ocean frontage. The beach is about 150 feet wide from the seaward edge of the dunes. After the storm of 1962, Operation Five High was instituted to replace some of the sand which was washed away from the coast. The Dewey Beach Area received 82,050 cubic yards of sand fill along a 4,700 foot stretch of beach in August 1962 (U.S. Army Corps of Engineers, 1963).

There were thirty-nine interviews conducted in the Dewey Beach Area. Property owners made up 82 percent of the sample and 38 percent were permanent residents. Thirty-three percent of the property owners had federal flood insurance policies. Seventy-one percent of those interviewed had lived in the area for over ten years.

a. Sources of Flooding

The storm of March 1962 caused ocean water to break through several of the dunes in the Dewey Beach Area. It was reported that in the late 1950's the dunes, at the ends of the streets running to the ocean, were flattened because many people desired a better view of the ocean. Therefore, the ocean was more likely to breach the dunes in these areas in 1962. The streets fronted by particularly low, weak dunes were New Orleans, Bellevue, Dagsworthy, McKinley, and Read Streets water depth in this area averaged two feet. Other areas where the dunes were breached include Carolina, Cullen, West and Houston Streets. Water depth in this area, however was only 0.5 feet. The first break in the dunes occurred at Rodney Street, where the water level reached four feet. The water also broke through the sand barrier in front of Silver Lake, causing the lake to rise and flood Route 14.

Waves crashing on Dewey Beach caused extensive dune destruction as well as beach erosion. One source noted that the beach has eroded 250 feet since 1949.

Water from the ocean washed over to Rehoboth Bay, which rose and caused back flooding to depths of three to four feet. At New Orleans Street water from the ocean washed down the street and emptied into the bay. The ocean also entered Indian River Inlet, five miles south of Dewey Beach, causing the bay to rise. On some streets the floodwater from the bay met floodwater from the ocean. Residents particularly mentioned water from the bay and the ocean meeting at Rodney and at Bellevue Streets. Thus, in 1962, the major portion of Dewey Beach was flooded from both the bay and the ocean. The Rehoboth-by-the-Sea section received mostly ocean flooding, but it also had some lake flooding. The Sea Breeze section experienced floodwater only from rising bay waters.

In December 1974, the ocean water broke through some of the dunes and flooded streets and properties, but did little damage. The dunes at Dagsworthy, McKinley, Rodney and Dickinson Streets were breached. Flooding was also experienced at Cullen, Swedes, New Orleans and Read Streets. Route 14 also experienced some washover from the ocean. On the bay side of Bellevue Street the water level was reported to be one to two feet deep. The water in the bay rose and washed up in this area which is less than three feet above sea level.

b. Flood Damage

To organize this material the Dewey Beach Area is divided into the three sections. The first section, from Silver Lake at Chesapeake Street south to Bellevue Street (Rehoboth-by-the-Sea), consists of an ocean side east of Route 14 and a bay area west of Route 14 to Bayard Avenue. The second section consists largely of a development called Sea Breeze and lies on the north shore of Rehoboth Bay west of Bayard Avenue. The third section is the community of Dewey Beach and extends from Bellevue Street south to Clayton Street near Indian Beach.

1. 1962 Storm (See Pocket Map I)

Rehoboth-by-the-Sea received flooding from the ocean as well as from the bay and to a lesser extent from Silver Lake. On the ocean side of Rehoboth-by-the-Sea, five people were interviewed between Chesapeake Street and Houston Street. Four of these had experienced no damage while one respondent on St. Louis Street near Route 14 had ground damage due to two to three feet of water on the property; the water came up to the doorway of the house. The property was covered by silt and mud and damage occurred to the well pump when it was covered with water. Of those who received no damage, two respondents, one on West Street and another on Cullen Street, had water on their property. Both dewellings were within a half block of the ocean.

Between Houston Street and Bellevue Street on the ocean side, three residents who were there in 1962 were interviewed. One on Salisbury Street experienced no damage while two suffered interior damage. The structures fronting directly on the ocean at the end of Salisbury Street were destroyed. Five houses and one hotel were replaced because of extensive structural damage. One property on the south side of New Orleans Street had fourteen inches of water inside the house. It cost $370 to replace the heating system and remove the sand. The respondent felt that this house was protected from the storm by a debris barrier that was created in front of the house. One house on the beachfront at New Orleans Street was totally destroyed. At the end of New Orleans Street, facing Route 14, a building received interior damage. On Bellevue Street the respondent interviewed had interior damage and ground damage from sand and saltwater. Toward the beachfront, there were two houses between Bellevue Street and New Orleans Street that residents noted as having experienced structural damage.

On the west side of Route 14 the damage in the Rehoboth-by-the-Sea section was minimal. From Chesapeake Street to Bellevue Street only one respondent had damage. The house, located at the intersection of Salisbury Street and Bayard Avenue, received interior damage estimated to be $500 as a result of the bay water rising to a level of about 3.5 feet. Bay water traveled up Bayard Avenue as far as Clayton, but the other respondents interviewed in this section of Rehoboth-by-the-Sea received no damage or water on their property.

East of Bayard Avenue along the northern end of Rehoboth Bay individuals in the first two blocks of the Sea Breeze section were interviewed. Two residents on Swedes Street were there in 1962 and had no damage to their property. Both respondents noted the higher topography of this area as the reason for not receiving damage. Another respondent who was there in 1962 was located on Salisbury Street facing the bay. This house, and the two houses on either side, received water on their properties, but no damage occurred. The last house on Salisbury Street before Bayard Avenue received interior damage due to bay water in the first floor of the house.

The main portion of Dewey Beach is found south of Bellevue Street extending to Collins Street. The community extends from the ocean on the east of Route 14 to Rehoboth Bay on the west side. On the ocean side of Route 14, between Bellevue Street and Read Street, damage information was collected from four respondents who had experienced the 1962 storm. On the south side of Bellevue Street one house, located midway on the ocean block, received interior damage. There were six to twelve inches of water inside the house which resulted in about $150 worth of damage. Dagsworthy Street, the next street south, received extensive damage from the storm.

The dunes were torn down at the end of this street, causing structural damage to three properties, interior damage to two properties and grounds damage to one property. On the north side of Dagsworthy Street two mobile homes were located in the middle of the block. The one closest to the ocean received structural damage because the force of the moving water from the ocean shifted its foundation. The second mobile home received grounds damage due to the presence of sand and debris. On the south side of Dagsworthy Street the property closest to the ocean at the end of the street received structural damage. The next house inland had interior damage due to two feet of water in the house. The third house from the ocean had structural, interior and grounds damage caused by wave action and moving water. Exterior fixtures were broken and sand and saltwater damaged interior furnishings as well as the grounds. The last house on the south side of Dagsworthy Street received interior damage as a result of one foot of water inside the house. Between Dagsworthy and McKinley Streets two houses facing the ocean received structural damage. The damage to one of these houses was estimated to be between $7,000 and $8,000. An ocean front property between McKinley and Road Streets was completely destroyed. Directly off Route 14, between Read and McKinley Streets, a series of five cottages received interior damage from ocean flooding. Another house, located at the intersection of Route 14 and Read Street, experienced structural damage when moving water shifted its foundation. Damage to the entire complex amounted to almost $6,000.

From Rodney Street to Collins Street three residents were interviewed who had experienced the 1962 storm. Information gathered in this section included the mention of eleven homes along the ocean front that were completely destroyed. These residents also noted structural damage to one building, interior damage to another, and four cases of grounds damage. On the beachfront between Read and Rodney Streets, five houses were washed out to sea. One-half block from the ocean on the north side of Rodney Street, one house experienced grounds damage. On the south side of Rodney Street the house facing the ocean, received structural damage. The house behind this on Rodney Street had grounds damage to the property. Between Rodney and Dickinson Streets on the beachfront one house was completely destroyed and the house behind it received grounds damage. On Van Dyke Street the ocean broke through the dunes carrying sand and water down the street and most houses along the street suffered interior damage. On the oceanfront many of the houses were totally destroyed. A home on the north side of Van Dyke Street, facing the ocean, was completely destroyed when the dunes washed out. The cost of rebuilding this house was over $30,000. The house behind it on the north side of Van Dyke Street only received grounds damage because sand and debris created a protective barrier. On the south side of Van Dyke Street near Route 14 one property, which includes both a house and a shop, received $4,000 in interior and grounds damage. At the end of Van Dyke Street and along the oceanfront to Collins Street five homes were completely destroyed.

The final section is the bay side portion of Dewey Beach west of Route 14. Some shops and restaurants in this section were damaged, and the boardwalk at Wilson's Yacht Basin was underwater. Four feet of water was inside the Bottle and Cork and sand was piled up to the second floor of several cottages.

More specifically, there were thirteen homes which received damage in this section. Eleven of these suffered interior damage and two had structural damage. One respondent on Bellevue Street reported interior damage worth $3,000. Between McKinley and Read Streets two respondents reported their homes received interior damage. One house facing McKinley Street had water four feet high in the house, which resulted in $3,000 in damages. The house facing Read Street had interior and grounds damage that amounted to $14,000. Between Read and Rodney Streets six houses had interior damage and one had structural damage. The house with structural damage also had interior and grounds damage totalling almost $1,500. The walls in this home were fractured and sand was evident on the property. Three structures between Dickinson and Rodney Streets were owned by one respondent who reported $5,000 in damages. The two cottages received interior damage and the trailer had structural and interior damage.

The flood damage in Dewey Beach during the March 1962 storm was caused by a combination of ocean and bay flooding. The cost of this damage has been estimated at $3,150,000 (1962 prices, Corps of Engineers, 1966).

Structural damage occurred primarily along the oceanfront. Although the land there is generally ten feet or higher above sea level, there was severe flooding due to the fact that several dunes were breached. In a few cases houses located in the ocean block behind the beachfront properties received only grounds damage because the houses in front acted as a barrier to the force of the waves. Houses which were situated more than 400 feet inland tended to receive interior damage as opposed to structural damage. The land there is less than ten feet above sea level. In particular, the homes on the bay side west of Route 14, were more likely to receive interior rather than structural damage.

2. 1974 Storm (See Pocket Map J)

The December 1974 storm caused flooding in the streets and water on some properties in the Dewey Beach Area, but caused little property damage.

In the Rehoboth-by-the-Sea section, several respondents noted that the ocean came over the dunes and flooded some of the streets, including Cullen, Swedes, and New Orleans. A few respondents in the oceanfront area said they received water on their property, but only one person reported damage. The respondent who reported grounds damage lived on Swedes Street; the damage was caused by sand on the property.

None of the residents in the Sea Breeze area received damage from the 1974 storm. There was no mention of any water on their property. The private bulkheads placed along the homes facing the bay provided protection from floodwaters.

The portion of Dewey Beach below Bellevue Street suffered flooding from the ocean and the bay, but only minor damage was reported. On the east side of Route 14 one respondent along the oceanfront on Dagsworthy Street reported grounds damage to a fence when the ocean washed over the property and under the house. The sea broke through the dunes at the end of Rodney Street causing flooding of the streets. On the bay side west of Route 14 some damage did occur, but most areas just experienced water on the property. The Boat House Restaurant between Bellevue and Dagsworthy Streets had its dock washed away and there was one to two feet of water in the surrounding block. A house between McKinley and Read Streets received flooding on the property, but not in the house. The group of houses on the ocean between Rodney and Dickinson Streets experienced water on the properties because the sea broke through the dunes at the end of Rodney Street, but there was no property damage to homes in the area.

The total damage from the storm included one dock washed away and two cases of grounds damage, although flooding of the streets may have caused minor cleanup problems.

3. Interpretations of Aerial Photographs - 1962 Storm

Floodwater in the community of Dewey Beach appear to have inundated the town from both ocean and bay. The northern boundary of water inundation occurred at Chicago Street, where the ocean seems to have reached as far west as Route 14. Route 14 continues to mark the boundary of the inland extent of water inundation south to Swedes Street. At this point ocean water combines with bay floodwaters and the entire community between the bay and the ocean shows evidence of water inundation. The only areas of the community where a definite water boundary could be distinguished were in the streets of the back bay area. Water flooded Bayard Avenue up to Swedes Street and then closely followed the bay along the first parallel street. The community south of New Orleans Street was completely underwater, but it is difficult to distinguish bay water from ocean water. The path and direction of water flow as reported by our survey respondents corresponds well with the area of floodwater coverage on the aerial photograph.

The sand inundation line, which covers the length of the community from Route 14 to the beach, indicates the areas most significantly influenced by ocean flooding. Sand inundation reaches 640 feet inland at Van Dyke Street. The pattern of sand inundation is irregular in shape, with the most obvious inland extensions indicating breaks in the dunes. These breaches in the sand dunes usually correspond to streets perpendicular to and terminating at the beach. Some of the major breaches occurred along McKean, Bedford, Van Dyke, Read, McKinley, and Salisbury Streets. There are also smaller breaches evident on each street from Salisbury north to Chicago. In the area between Read and Beach Streets the identification of the sand inundation boundary was difficult because the tonal contrasts of the pattern were not as clear. This effect was most likely due to the presence of water still in this area when the photograph was taken.

The areas of the aerial photographs that could be identified as breached dunes at the ends of the streets closely correspond to the survey information. Even in areas where well defined dune breaching was not visible in the aerial photographs, the extent of the sand inundation was highly correlated to the damage reported in the survey information.

One structural damage area was visible on the aerial photograph between Salisbury and Swedes Street. Although this area is not directly related to any specific damage reported from the survey, it does correspond to the outline of the structural damage zone established by the survey.

The general outline of damage in the community from the survey information does seem to be highly correlated to the information from the aerial photographs. The sand inundation line from the beach includes almost all the structural damage areas reported in the survey. The interior damage zone, extending from the first ocean block to the bay, is also in agreement with the areas in the aerial photographs that show water inundation.

Oak Orchard - Riverdale

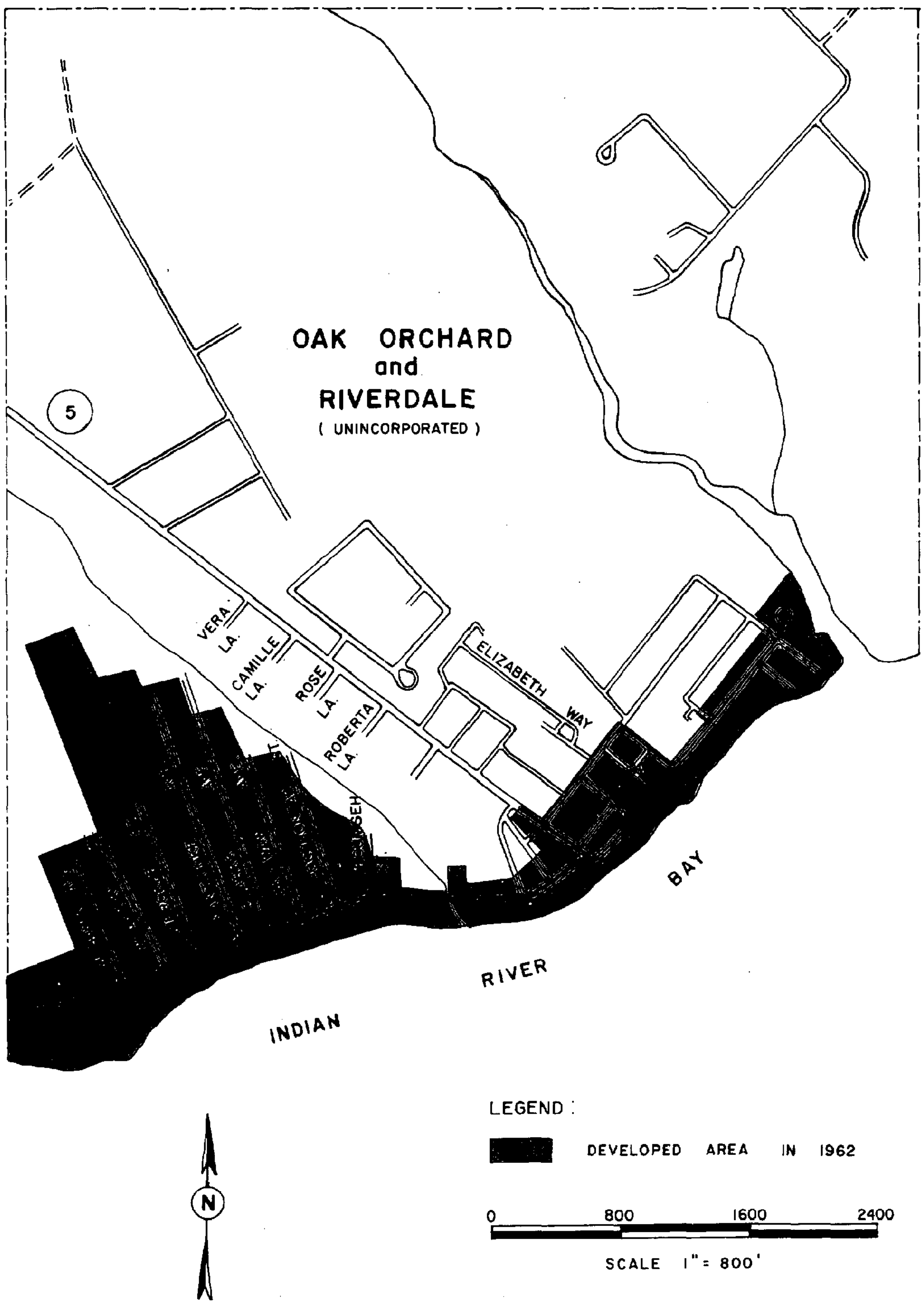
Oak Orchard is located on the north shore of the Indian River about halfway between Millsboro, Delaware and the Indian River Inlet. Riverdale, an adjacent community, lies to the west of Oak Orchard, also along the Indian River. Surface elevations in Oak Orchard are generally less than ten feet above mean sea level, while Riverdale lies on somewhat higher land with portions of this community situated above ten feet (MSL).

Both towns are unincorporated, primarily residential communities with few commerical establishments. Approximately sixty families live in Oak Orchard on a permanent basis.

Twenty-four respondents were interviewed in Oak Orchard and Riverdale. Eighty-three percent of these respondents owned dwellings and property, but only 54 percent considered themselves to be permanent residents. Flood insurance had been obtained by 30 percent of these property owners. More

Figure 14

DEVELOPED AREA OF OAK ORCHARD AND RIVERDALE 1962



than half (54 percent) of the people interviewed had been in the area for more than ten years. The mix of dwellings owned by respondents was 43 percent single story, 52 percent multiple story, and 5 percent trailer.

Sources of Flooding

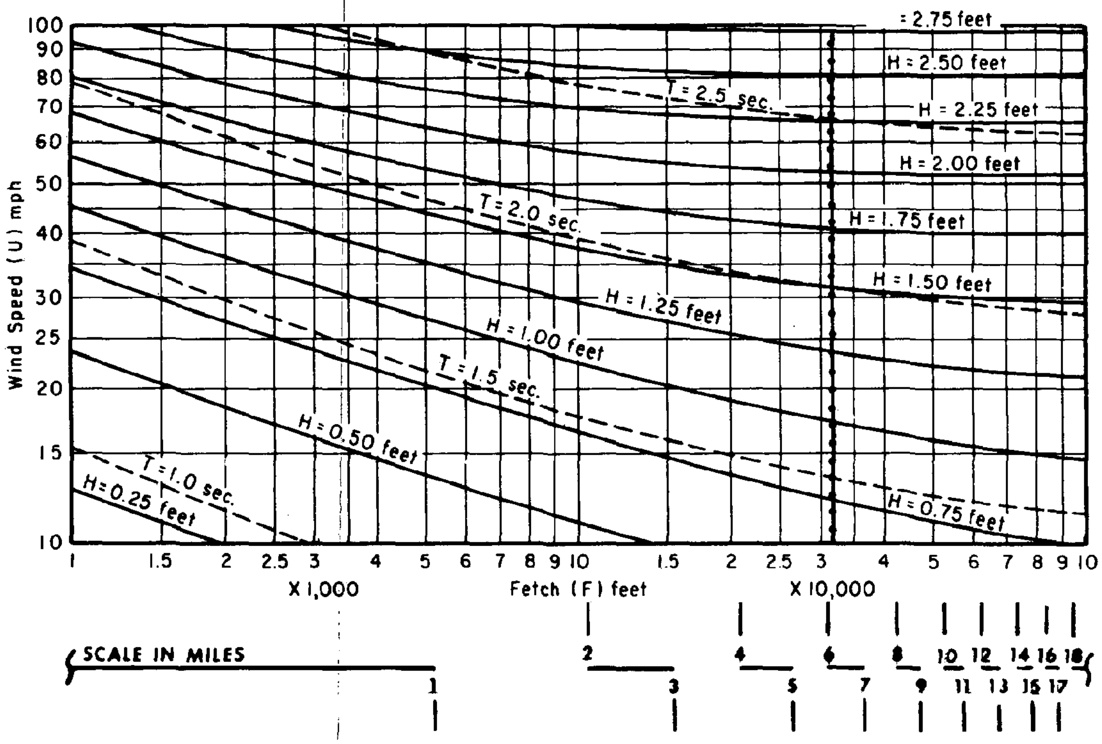
Among the communities covered in this project the Oak Orchard-Riverdale area is unique in several ways. Both communities lie in a relatively protected location on the northern bank of Indian River, approximately six miles west of Indian River Inlet and the Atlantic Ocean. Although storm surges, tides and waves affecting these communities are generated primarily in the Atlantic, they are strongly modified by hydrographic conditions prevailing in the Indian River-Rehoboth Bay complex. The following factors are of importance:

a. Indian River Bay is shallow; generally a maximum of six to eight feet deep; and

b. The fetch across Indian River Bay (distance of open water across which the wave-generating winds blow) is six miles for easterly winds and considerably shorter for all other directions.

The shallowness of the bay and the limited fetch preclude the development of extreme wave heights. Figures 14 and 15 indicate that for water depths of five to ten feet, winds with a fetch of six miles, and sustained speeds of 50 miles per hour, wave heights of 2 to 3.5 feet can be expected. Increasing the wind speed to 80 miles per hour yields waves of 2.5 to 4 feet depending on water depths. Significantly, the magnitude of damage expected in this area from wave attack should be much less than for

FIGURE 15
FORECASTING CURVES FOR SHALLOW-WATER WAVES
CONSTANT DEPTH = 5 FEET



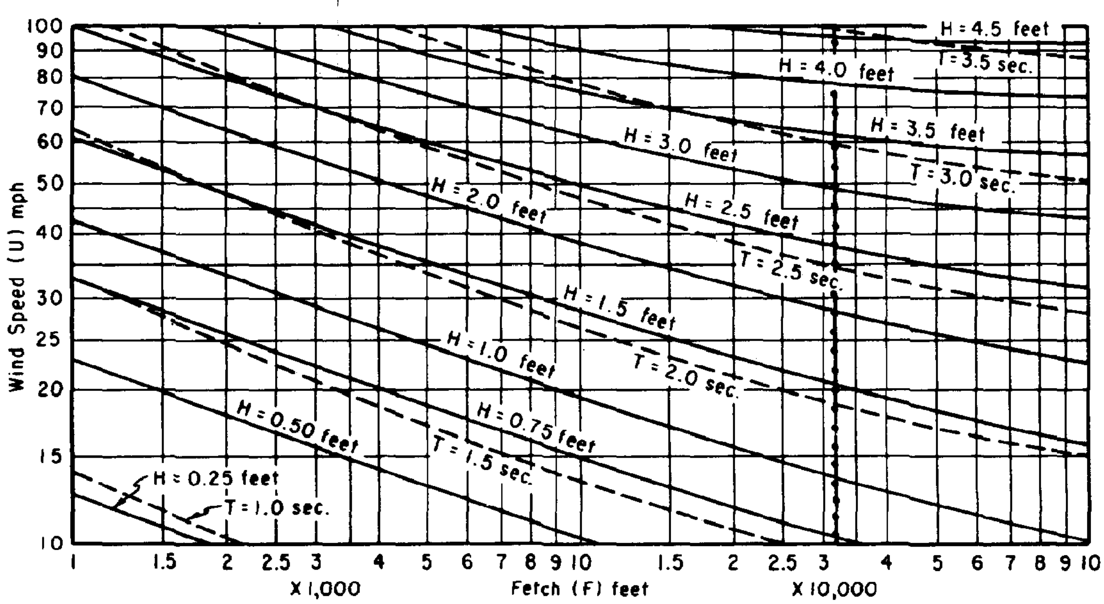


FIGURE 16
FORECASTING CURVES FOR SHALLOW-WATER WAVES
CONSTANT DEPTH = 10 FEET

-•-•-•-•-•-•-•- Maximum Fetch Oak Orchard

Source:
Shore Protection Manual, University of Delaware,
U.S. Army Coastal Engineering Research Center,
Corps of Engineers, 1973

the Delaware Bay and Atlantic Shore communities where deeper waters and virtually an unlimited wind fetch is possible.

Offsetting the shallowness and limited fetch conditions is the fact that the bay is shaped like an irregular funnel with Oak Orchard-Riverdale lying in the constricted portion. The open, broad end of the "funnel" faces the Atlantic. Flood tides and storm surges may enter Indian River Bay through the Indian River Inlet, Assawoman Canal, Lewes-Rehoboth Canal and through storm-caused washovers or breaches in the barrier beach along the Atlantic shore. If these waters are blown inland (westward) by strong sustained easterly winds into the constricted portion of the bay, the water level in the western portions of the bay will rise and cause flooding in adjacent coastal areas. The causes and magnitude of damaging waves, currents and floodwaters affecting these communities situated several miles from the open coast involves a complex set of interacting meteorologic and hydrographic variables.

The most severe flooding in Oak Orchard-Riverdale will develop when a coastal storm with sustained strong northeasterly, easterly or southeasterly winds coincides with abnormally high spring tides that occur approximately twice each month along the Delaware coast.

During the storm of March 1962, Oak Orchard was under two to three feet of water. Many homes on the riverfront were surrounded by as much as five feet of water. The flood caused severe beach erosion in places along the river front. Lots in Riverdale were also covered with a few feet of water. The houses further back from the river were not flooded although there was water in some streets. Some parts of Riverdale are more than ten feet above mean sea level and are thus immune to most flooding. Waves were reported from the river in both Oak Orchard and Riverdale. Flooding in this area was intensified by two high tides.

With the stablilization of the Indian River Inlet in 1939, tidal forces within the Indian River Bay complex have become stronger. One resident believed that because of this fact, tidal flooding could be controlled by regulating flows at the Inlet.

In the absence of a well documented history of storms affecting the area, an alternative source of information on flood tide heights may be obtained from the records of a tide gage located at the Indian River Power Plant, three miles west of Oak Orchard. For example, during the December 1974 coastal sotrm (Figure 16), water levels in Indian River at the power plant reached a maximum of 4.4 feet above mean low water or 3.5 feet above the normally expected high tides for that time. During the December 8 to 10, 1973 (Figure 17) storm, tide levels rose to 2.2 feet above normal on December 9. On September 20 and 12, 1972, water rose 2.6 feet above normal (Figure 18). None of these storms was particularly severe. Only the December 1974 storm created widespread coastal damage. Nevertheless it is likely that tide levels of two to five feet above normal can be expected to occur frequently in this area with subsequent flooding.

The following storms have been identified as causing coastal flooding and damage in Oak Orchard - Riverdale:

September 18, 1924

Reports of high tides and flooding in Rehoboth Bay and Indian River Bay. Probable flooding in low lying areas of Oak Orchard.

No documented damage (published or written reports) was noted between September 1924 and September 1956. It is unlikely, however, that the Oak Orchard-Riverdale area escaped flooding during those years because

FIGURE 17

INDIAN RIVER POWER PLANT

DEC. 1–3, 1974

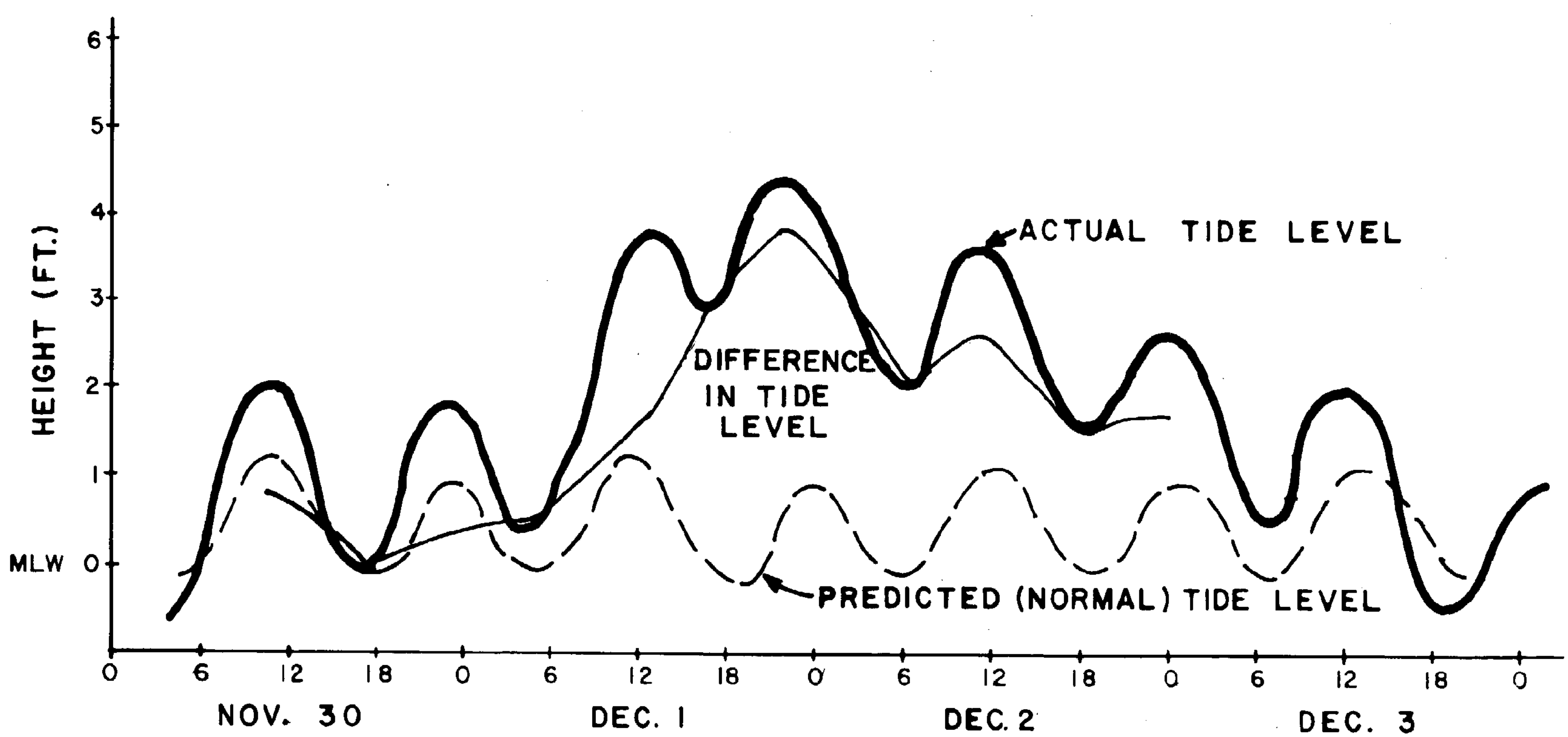


FIGURE 18

INDIAN RIVER POWER PLANT

DEC. 8-10, 1973

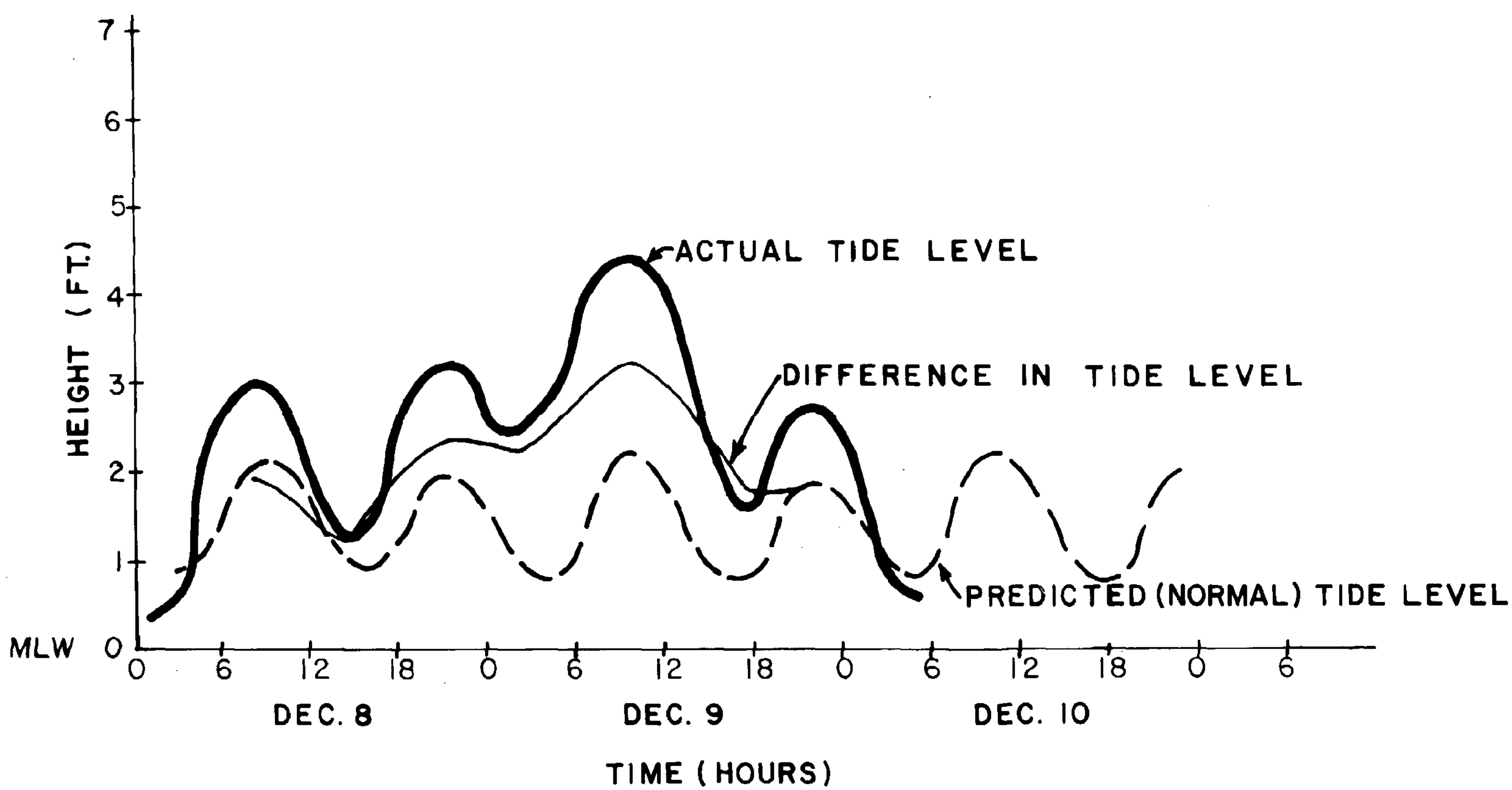
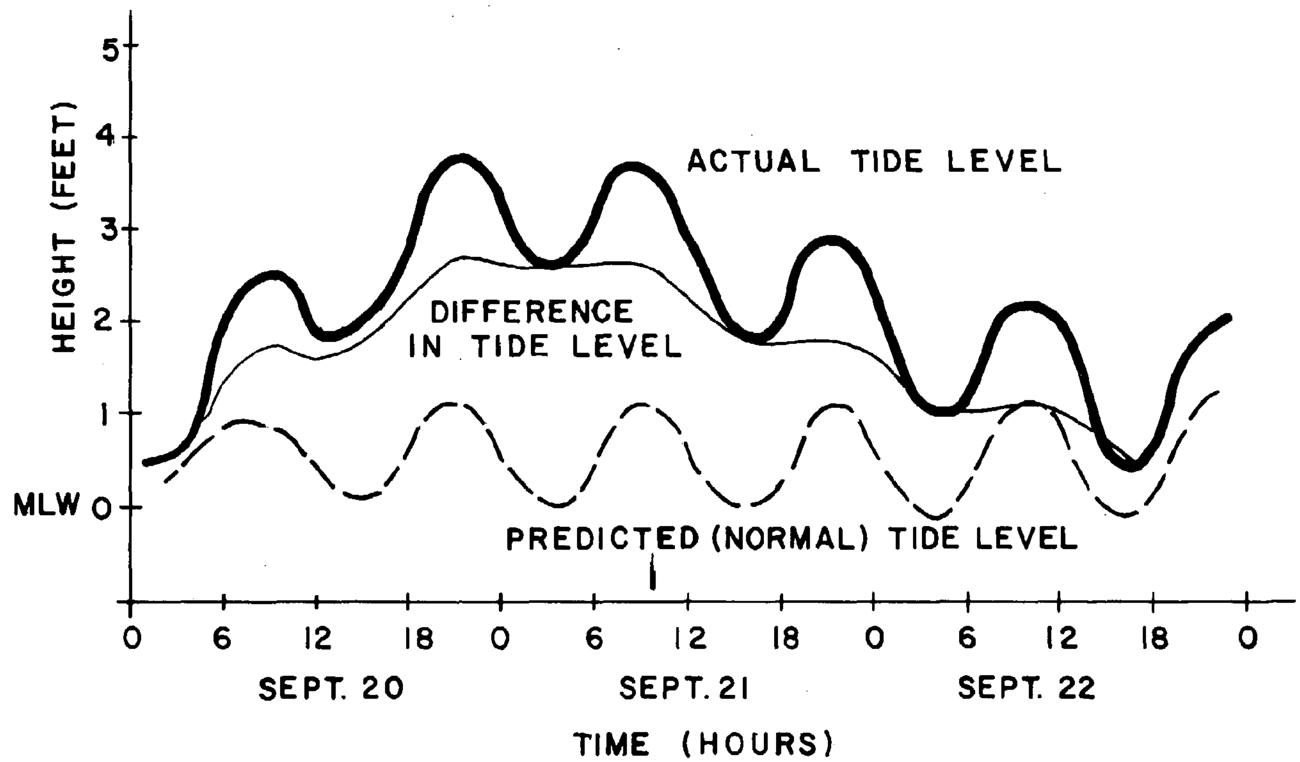


FIGURE 19

INDIAN RIVER POWER PLANT

SEPT. 20-22, 1972



several major coastal storms occurred. The most severe in terms of damage elsewhere were reported on:

January 26, 27, 1933
September 18, 19, 1936
September 15, 16, 1944
August 15, 1953
August 3, 1955

September 27, 28, 1956

Hurricane Flossy; flooding in several communities along Indian River and Rehoboth Bay was reported including Riverdale and Oak Orchard. Tides ranged three to five feet above normal at the Indian River Yacht Club.

March 6-8, 1962

During the height of this devastating storm, waves four feet high rolled into the grove at Oak Orchard. Sands along the shoreline were entirely stripped away. From three to four feet of water covered all the shorefront cottages at Riverdale. Piers along the shoreline were destroyed and some dwellings and shops were lifted off their foundations (see following section for more details).

Flood Damage (See Pocket Map K)

The following is a brief summary of damages experienced in the Oak Orchard area during the storm of March 1962 showing the location, type, and cost of damages. The report is divided into two sections: the first part covers Oak Orchard and the second covers Riverdale.

Eleven interviews were conducted in Oak Orchard. One respondent living on the river front reported that exterior fixtures on the house were torn away and that running water caused interior and grounds damage. The total cost of all damage done to the house and grounds was $2,000. Another respondent, also on the river front, said that some house walls were knocked down due to wave action. Another individual, who owned five homes along the river, experienced $70,000 in damages. This included broken foundations, walls and exterior fixtures as well as interior and grounds damage. Damage was primarily caused by saltwater running through the homes when the waves broke on them. Two other houses on the river front also experienced structural damage.

Some homes which are further back from the Indian River in Oak Orchard also received considerable damage. One respondent said that although his house had not been built in 1962, there had been water on the property. Another person said that his trailer was knocked off its foundation as a result of running water and the interior furnishings were damaged. The total cost came to $600. Another homeowner said that he had experienced $3,000 worth of damage because the walls of his house were fractured and the interior furnishings and grounds received damage due to the saltwater.

Twelve interviews were conducted in Riverdale. Many people alluded to the fact that Riverdale is on higher ground than Oak Orchard, so that fewer people in Riverdale had received severe damage. One respondent along Road 312 received interior and ground damage as a result of running saltwater. Another explained that his house was on high ground and although there was water in the streets and on the property, it did not reach his house. One home near the end of Pocahantas Street received no damage and did not even have water on the property. A house just behind Road 312 on Ok-waw Street had interior and grounds damage, which amounted to $1,000, due to saltwater.

A respondent who lived slightly further back from the river on Ok-waw Street experienced no damage. A respondent even further back on the same street received no damage to his house. A respondent who lived on Clarke Avenue about 200 yards from the river also experienced no damage. However, a homeowner between Nanticoke and Clarke Avenue lost all his interior furnishings. A respondent between Wyankiki Street and Mohowk Avenue and one on Cherokee Street both said that since their homes were on high ground (20 feet above sea level), they had experienced no damage. The last house in this section received structural, interior and grounds damage totalling $8,000 due to running saltwater. This house was on the river front in a low area.

In Oak Orchard there were eleven homes with structural damage. In Riverdale there was one home with structural damage and four with interior damage. All of Oak Orchard is under ten feet (MSL) and this fact seems to be correlated with the amount of damage received. The eastern section of Riverdale is under ten feet (MSL) and tended to receive interior and grounds damage. A section in west-central Riverdale is about ten feet (MSL) and did not experience any water on the grounds. Further to the west is a section which is under ten feet (MSL) and again structural, interior and grounds damage was experienced.

Of particular interest is the apparent effect of coastal orientation on flooding. Most of Oak Orchard lies on a portion of the Indian River Bay running northeast-southwest. The western portion of Riverdale (from about Nanticoke Avenue westward) also lies on a northeast-southwest oriented coast. East of Nanticoke Avenue to the border of Oak Orchard the coast runs more east-west. Southeast storms especially would strike the two low lying coastal segments oriented in the northeast-southwest direction more perpendicularly and hence could result in more flood damage. The east-west coast, however, would be somewhat more protected from the direct force of either a southeast or a northeast storm. Thus the zones of damage seem to reflect, in part, both coastal orientation and elevation differences.

Two respondents on the Oak Orchard river front said that they had experienced some flooding of their properties in December 1974. A home-owner further inland from the river in Oak Orchard had interior and grounds damage due to the storm of 1974. In general, however, the 1974 storm did not bring a great deal of flood damage to the Oak Orchard area.

Bethany Beach and South Bethany

Both Bethany Beach and South Bethany are situated on a section of a dynamic and rapidly changing baymouth barrier complex that extends from Cape Henlopen southward to Fenwick Island (Kraft, 1976). Specifically, Bethany Beach is situated on the seaward end of an "upland" comprised of Pleistocene age sands and gravels. These deposits, when eroded and transported along the shore provide a critical source of sediment to naturally "nourish" Delaware beaches.

South Bethany occupies an adjacent portion of the long baymouth barrier that extends from Fenwick Island northward to Bethany Beach. Unlike Bethany Beach, the community of South Bethany is backed by coastal marshes, dredged and natural channels and shallow bays and as a result, is more vulnerable to flooding than Bethany Beach. Little natural protection is provided by the existing dunes since they have been essentially destroyed or modified as a consequence of development within the dune-field along this shore line.

Coastal erosion rates in the Bethany area are high with an annual loss of 69,000 cubic yards of sand coupled with a shoreline retreat rate of one to three feet per year (Delaware State Planning Office, 1976).

Bethany Beach

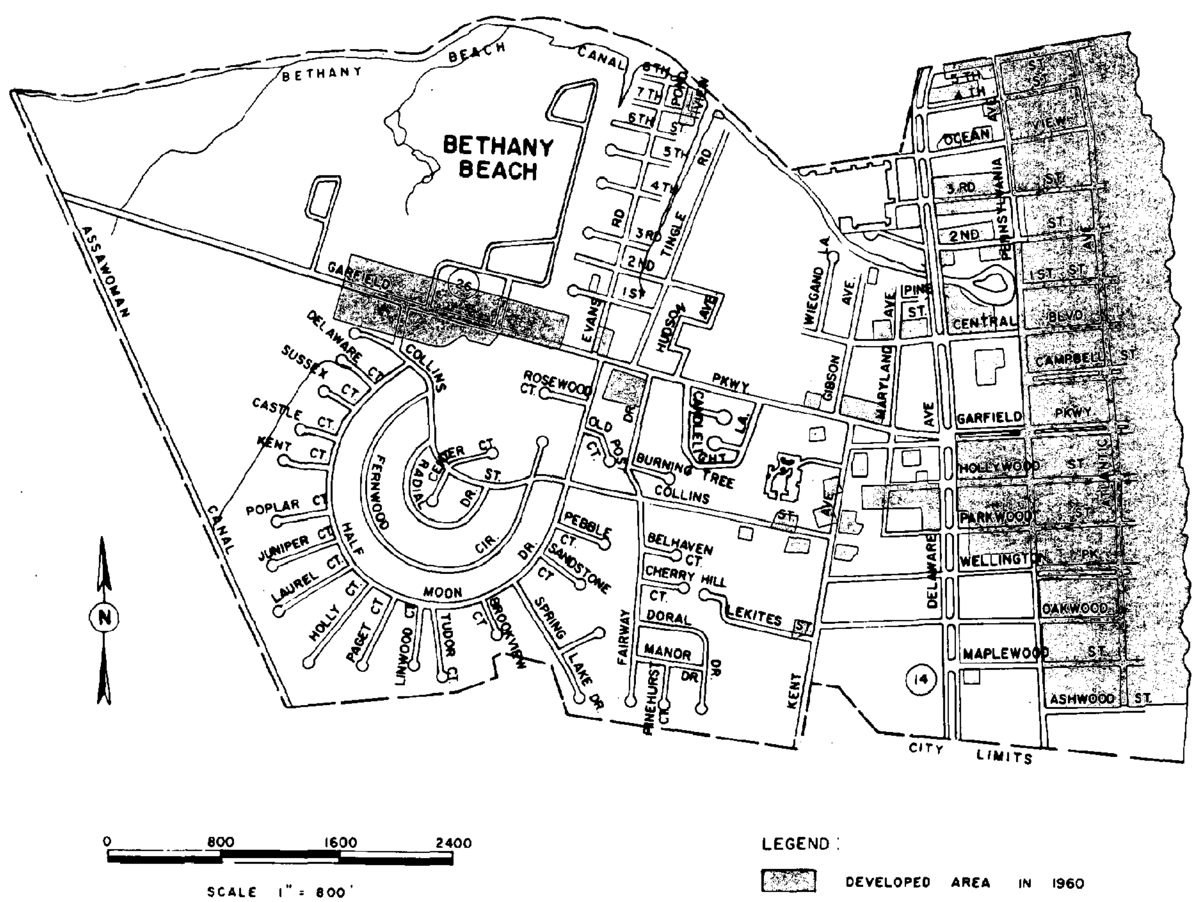
Bethany Beach is an incorporated town which extends 7/8 of a mile along the long sandy beach/barrier island complex which extends from Cape Henlopen to Chincoteague, Virginia. It is located six miles north of the Maryland State line and four miles south of Indian River. The town has grown considerably in recent years; half of the single family residences now located there have been built in the last decade. The 1962 population was estimated to be 200 permanent residents and 4,600 summer residents (U.S. Army Corps of Engineers, 1962).

According to a Corps of Engineers study published in 1966, the estimated property value for the entire town of Bethany Beach was $5,500,000. The estimated value of the beach front area was $1,870,000.

Bethany Beach has a timber boardwalk which extends about 2,000 feet along the beach. Behind it are discontinuous low coastal dunes ranging from ten to thirty feet in height. Where the beachfront has been developed, many of these dunes have been removed. Thus, the natural coastal defenses against storms have diminished and Bethany Beach is very likely to experience inundation and flood damage in the future. The shoreline has also continued to recede

Figure 20

DEVELOPED AREA OF BETHANY BEACH 1960



despite a system of nine groins that have been installed to combat beach erosion. Even artificial beach and dune fill have not solved the problem. In 1966 the beach was losing an average of 69,000 cubic yards of sand per year (U.S. Army Corps of Engineers, 1972).

One hundred and thirty-six interviews were conducted at Bethany Beach. Forty-seven percent of the respondents owned their own residences, but only 14 percent of them considered themselves permanent residents. Of those who owned property in Bethany, 57 percent had some type of flood insurance policy. The dwellings in which they resided were almost entirely single family residences (90 percent). Sixty percent of those who answered the questionnaire had been spending time in Bethany Beach for over ten years.

a. Sources of Flooding

1. 1962 Storm (See Pocket Map L)

Residents who were familiar with the 1962 storm claimed that flooding occurred due to massive waves which broke along the town's entire coast. There was no gradual breaking of the dune line. Instead, respondents recalled that the ocean had risen in two huge waves (estimated at thirty feet) which crashed onto the beachfront properties. When the waters cleared, the entire dune line had been wiped out, with the exception of one small area, and approximately thirty-five homes had been destroyed. It was estimated that water extended as much as four miles inland in the area north of Route 26, as well as in the area directly south of it. Residents of the more southwestern sections had no water on their properties. This can be more easily understood by reference to the map of the area. To the north of Route 26 the Bethany Beach Canal connects with the Assawoman Canal, which originates at Indian River Bay. A large body of water referred to as the Salt Pond lies directly north of the Bethany Canal. Considerable flooding occurred in this area because these canals and marsh areas filled with water and flooded. One resident explained that the ocean waters pass through Indian River Inlet and fill the bay which, in turn, backs up the canals and results in flooding. Flooding of this type was severe enough in the 1962 storm that the ocean and bay waters actually met. The extent to which these two sources were responsible for damage is indicated on the flood damage map. It has been estimated that water coming directly from the ocean affected the area extending inland from the beach front to within a half-block of Pennsylvania Avenue. Markings on the map indicate the extent of this overwash fan. The overflowing canal was responsible for the damage done in other areas. The process by which the canal fills also explains why both salt and brackish water reached these properties.

Strong winds blowing from the northeast for several days also contributed significantly to the large extent of the area covered by floodwaters. Even as far inland as Route 14, wave action was strong enough to break the bridges which cross the Bethany Beach Canal. Water as deep as three to four feet covered Route 14 as far as Indian River Inlet.

As would be expected, water depths were generally higher in the oceanfront area and in the area surrounding the Bethany Beach Canal, averaging about five feet. Further inland and away from the Canal, the water depths dropped to an average of about two to three feet, except for the intersection of Garfield Parkway and Pennsylvania Avenue, where an exceptional depth of water, twelve feet, was reported.

2. 1974 Storm

The flooding which occurred in December 1974 was of much smaller magnitude than that which occurred during the March 1962 storm. Floodwaters were confined primarily to the beach front properties situated between the ocean and Atlantic Avenue. The dune line broke in two specific areas according to information supplied in interviews; these were at Ocean View Parkway and at Third Street. Openings in the dunes under the boardwalks were also cited as a reason that water was able to reach inland properties. While ocean water did come as far inland as Pennsylvania Avenue, it was confined primarily to the paved streets.

The flooding which occurred in December 1974 could have been far more serious if the wind had not diminished when it did. As a result, floodwaters went down quickly as the receding tide carried the water back out to sea.

b. Flood Damage

The purpose of this section is to outline the damage which residents of Bethany Beach have experienced as a result of storm flooding. Damage to residences located along the ocean front will first be described. This will be followed by an analysis of damage in the blocks immediately behind the ocean front strip. Finally, damage to places located on the western side of Route 14 will be considered (See Pocket Map L).

According to information obtained from six interviews conducted between Ashwood Street at the southern end of Bethany Beach and Parkwood Street on the ocean front, three homes were damaged and two others were destroyed as a result of the March 1962 storm. One respondent stated that he suffered $25,000 in damages as a result of the undermining of the foundation of his house. Steel pilings were the only thing that prevented the house from washing away. In another case, the pilings broke and the house shifted forward.

A hotel-apartment complex was situated along the ocean front between Parkwood Street and Garfield Parkway to the north. The owner said he suffered $300,000 in damages to his property as a result of the March 1962 storm. Two of his cottages and their boardwalks were completely washed out. The strong waves and currents brought in five to six feet of sand and mud which were deposited on the roads. The water above these sand deposits was as deep as six feet (the ceiling in the respondent's office was wet). The damage he suffered was a result of sand, mud, and saltwater. Some of his cottages had been secured before the storm and they survived without extensive damage. The respondent also noted that the beach itself was eroded as a result of the storm and many of the dunes were lost.

Five interviews were conducted along the beach from Garfield Parkway northward to Central Boulevard. One respondent said that although he experienced some water seepage into the house in March 1962, no interior damage was done because the water did not accumulate inside. The exterior damage which resulted; repainting of the house, the removal of two feet of sand from the property and the replacement of shingles. Another house located in this area survived the 1962 storm, but since the respondents did not own the house at that time, they could not provide any additional information regarding damage that the house might have experienced. In the section between Central Boulevard and Second Street, there was a house that survived the storm, but had fifteen feet of sand washed out from under it.

Five respondents were interviewed in the beach front area from Second Street north to Fifth Street. They reported structural damage to three houses, one house that was completely destroyed and one house that experienced only interior damage as a result of the March 1962 storm. One respondent said that total damage done to his property cost $5,000 to repair. Damage to another house totalled $6,000 as a result of a flooded basement and structural damage to the front proch.

The extent of damage that occurred along the beach front based on the interviews in that area do not give a totally accurate picture. Information gained from interviews in other parts of Bethany Beach indicate that some thirty-five homes were washed out between Ashwood Street and Fifth Street. This disparity is undoubtedly explained by the fact that some of the residents interviewed had moved to Bethany Beach after the March 1962 storm, while others who were interviewed spent only a few weeks in the community every summer.

A large number of interviews were undertaken in the strip of houses located one block west of the beach between Atlantic and Pennsylvania Avenues. While these houses were not as severely damaged as the oceanfront houses, damage was still extensive throughout the whole strip.

Between Ashwood Street at the southern end of the town and Oakwood Street to the north, three of seven houses at which interviews were conducted experienced property damage due to large deposits of sand. One respondent reported structural damage which involved the destruction of a garage wall by floating debris and cost $500 to replace. His lawn was also ruined by the deposit of three to four feet of sand.

None of the individuals between Oakwood Street and Parkwood Street who were interviewed reported that they had experienced any actual damage to their houses, although two mentioned slight damage done to grounds. They have had water on their property as deep as two to three feet.

There were eleven interviews conducted in the two block area between Parkwood Street and Garfield Parkway, but there was very little damage reported. There was one incident of grounds damage, and one of structural damage. The latter involved an outside post that was knocked down, while sand on the property was as deep as five feet.

The damage reported by four of the eight respondents between Garfield Parkway and Central Boulevard was somewhat more extensive. A total of four houses were destroyed, one additional house had structural damage, one experienced damage to interior furnishings, and one had only its grounds damaged. One man operated a garage. During the 1962 storm, he lost an ice machine which, in turn, knocked over his gas pumps and he lost all of the gas in his tanks. The supplies kept in the garage were ruined by saltwater. Another respondent lost three cottages and he had a large amount of sand in his own house. In another case a house had its stairs ripped off and a wall under the house was damaged by an ice chest which was thrown up against it. There was also a considerable amount of debris deposited on the property including stoves, washing machines and refrigerators.

Fifteen respondents were interviewed between Central Boulevard and Second Street. Two houses were completely destroyed, while four houses received structural damage. One woman reported the loss of interior furnishings as well as the front steps to her home. She also owned four other cottages in the general vicinity, all of which lost their first floor furnishings. She estimated the total damage to be approximately $10,000. The same respondent also pointed out other nearby houses that were damaged. Across the street from her a house was washed off its foundation and deposited on an adjoining lot. Down the street a house was completely destroyed. Another man reported that he experienced structural and interior damage to his house. The front end of the house shifted approximately three to four feet off its foundation, although the back end remained stable. He also lost a stove, a refrigerator and most of his furniture. Total damage was estimated at $3,000-$4,000. A third individual lost interior furnishings and his porch steps. His major complaint, however, was that too much sand was bulldozed off his property after the March 1962 storm so that his property is now lower than the surrounding area.

A total of twenty individuals were interviewed between Second Street and Ocean View Parkway. They reported three incidences of structural damage, four of interior damage and one of ground damage. One house was being built at the time of the storm and it was damaged considerably. All of the building materials were washed away and the floor had to be replaced. Another house lost its floor as well as stairs that were washed away and the floor had to be replaced. Another house lost its floor as well as stairs. A third individual reported $4,000-$5,000 in damages.

The damage described in the nine interviews conducted between Ocean View Parkway and Fifth Street was not as extensive. One respondent reported some structural damage to his house while two reported interior damage. One estimated his damage at $500, but the other placed his damage at $6,000.

The following section deals with properties located farther inland between Pennsylvania Avenue and Delaware Avenue (Route 14). The eight interviews conducted between Parkwood Street and Garfield Parkway showed that four homes experienced interior damage. One respondent estimated that it cost her $4,000 to replace furniture, an air conditioner and a refrigerator. She also had damage done to the grounds. Another respondent was preparing to move into a new house prior to the 1962 storm, and although the structure itself remained secure, she lost $4,000 in furnishings. A cottage situated on Delaware Avenue had $6,000 in damages done to grounds and furnishings.

Between Central Boulevard and Ocean View Parkway respondents reported interior damage to six homes. One respondent claimed damage of $5,000 due to loss of furnishings and appliances in two of his cottages. Only three of the eight respondents had no damage of any kind.

The thirteen interviews conducted between Ocean View Parkway and Fifth Street provided little information regarding flood damage. Only one respondent reported damage from the 1962 storm. This involved severe losses due to saltwater damage to antiques and other furnishings. He was unable to move back into his house for four and one-half months.

On the western side of Route 14 six interviews were conducted in the vicinity of Pine Street, Maryland Avenue and Gibson Street. Although water reportedly reached depths of six feet, the only damage reported was to interior furnishings according to one respondent. Several of the homes which are now located there had not yet been built in 1962, which may explain the apparent lack of damage in spite of the considerable water depths.

Two interviews were conducted farther west in the vicinity of Tingle Road and First Street. One of these respondents reported damage to interior furnishings. In addition six interviews scattered throughout the southwestern section of Bethany Beach indicated that there was no real damage done in the March 1962 storm despite water depths of two to three feet.

In summary the patterns of damage resulting from the 1962 storm seem to be quite consistent. By far the most extensive damage occurred in the beach front areas with an especially large area of heavy damage in the vicinity of the Bethany Canal (Zone A on the damage map). In light of the patterns of flooding previously described, this is not particularly surprising. In general the extent of damage decreased as distance from the ocean increased.

After the March 1962 storm Operation Five High was put into effect by the Corps of Engineers to repair the eroded beach area. Approximately 69,649 cubic yards of sandfill were replaced along a 4,800 foot stretch of beach (U.S. Army Corps of Engineers, 1966).

Damage caused by the storm of December 1974 was extremely limited. Of the 136 respondents interviewed only two mentioned any damage and both of them were situated on beach front properties. At the southern end of the beach, between Ashwood and Parkwood, the steps of one house were ripped away and the sand dune was pushed back approximately twenty feet. In the other incident an apartment complex located between Parkwood Street and Garfield Parkway had its wooden walkways washed out, as well as the existing dune line. No damage was done to the building itself.

Thus, there was considerable difference between the effect of the March 1962 and December 1974 storms in Bethany Beach. The reason for this difference has already been discussed in the section dealing with flood patterns in the community.

c. Interpretation of Aerial Photographs - 1962 Storm

The aerial photographs that were taken of the Bethany Beach area provide less information than do the photographs of the other coastal areas, because the photographic flight line shifted somewhat inland. This alteration in flight line pattern, probably due to the pilot drifting off course, resulted in the elimination of the beach and first 1.5-2.5 blocks from the photographs covering Bethany Beach. A dotted blue line is used to mark the extent of water inundation covered by the photographs. It is assumed from the pattern of this water inundation that the area between the dotted line and the beach has also been inundated and that the ocean as well as the Salt Pond have contributed to this flooding. This assumption is confirmed by our survey data as illustrated on the damage map.

Inland, the extent of water inundation seems to encompass the major sections of the community. Water has flooded sections of the community as far inland as five thousand feet from the beach along Route 26. The northern section of the community from the entrance to Route 26 has been totally inundated, except for a section from Evans Road to the back marsh of Salt Pond. This area seems to have been protected by the trees that line the pond, however this vegetation cover also makes it difficult to note the exact extent of the water in this area. To the south of Route 26 the extent of the flooding is most evident in the streets that parallel the beach. There is a section extending west of Pennsylvania Avenue between Wellington and Ashwood that was not inundated. However, this protected area does not include the entire back section, as there is floodwater on the streets west of Route 14 as far back as Collins and Lekites Streets. The overall coverage of flooding in the inland areas is difficult to determine from standing water because vegetation and farm crops mask the exact surface conditions.

Sand inundation within the parts of the community that are covered in the photographs appears to be limited to small patches spread throughout the community. These patches seem to concentrate around buildings or vegetated areas. Most of these sand deposits are located between Parkwood and the canal adjacent to the pond. The texture and the contrasting tones within the deposits are indications that these patches are most likely a combination of sand and debris washed in with the floodwaters.

Although there are deposits of debris indicating that structural damage occurred from flooding, there is no visible structural damage in the sections of the community viewed by the aerial photographs. Those areas that were inundated by water correspond to the survey information showing interior damage. The areas that did not show inundation on the aerial photographs were areas in which no damage was reported by the survey.

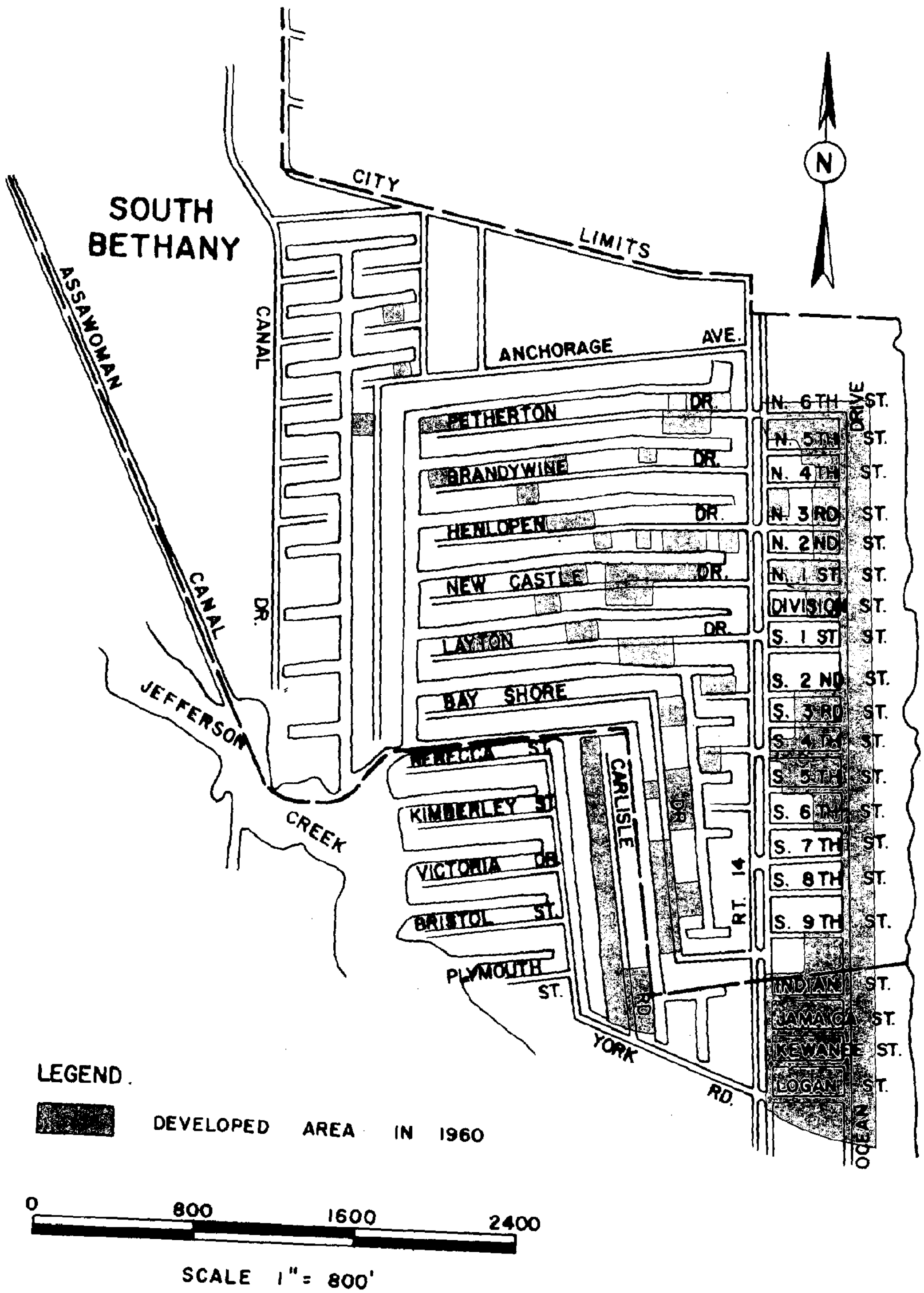
Thus, there is a high degree of correlation between the survey data and the aerial photographs for the areas that were covered by both.

South Bethany Beach

South Bethany Beach is located south of Bethany Beach and Middlesex Beach approximately five miles north of Fenwick Island. Often South Bethany and York Beach are considered as one unit, having a total ocean frontage of 1 2/3 miles. In fact, however, South Bethany Beach is a town in its own right, having been incorporated in 1969. It later annexed York Beach. As of 1966 there were approximately 170 houses located in South Bethany Beach, with 70 situated on the ocean side and 100 on the west side of Route 14 (U.S. Army Corps of Engineers, 1966). This western section contains several hundred acres of marsh land which were reclaimed and developed into a residential area. Canals were constructed to provide water front access to the properties located there. This has, in turn, created new channels for storm flooding to enter the community. The current population for South Bethany Beach is estimated to be 100 permanent residents and 3,000 summer residents (The Sun Bulletin; July 27, 1975).

South Bethany Beach is a community of beach homes and cottages. There are very few commercial establishments within the town. The 1966 value of the beach front property was estimated at $560,000, while the value of the entire town was estimated at $1,440,000. Accurate damage estimates for South Bethany Beach due to the March 1962 storm are not available although $3,110,000 has been given an estimate of damage incurred in the area between, but not including, Bethany Beach and Fenwick. Since South Bethany Beach is the only established community located between these two points, it is reasonable to assume that the damage to South Bethany Beach constituted a major portion of the total damage estimate. The figure seems somewhat

FIGURE 21
DEVELOPED AREA OF SOUTH BETHANY 1960



high in view of the present estimated value for property there (U.S. Army Corps of Engineers, 1966).

The beach area of South Bethany was described in a 1966 Corps of Engineers study as being backed by well-developed dunes. Today, however, these dunes have been completely leveled in the process of home construction which has occurred literally on top of them. There is no longer a significant dune line in there.

A total of sixty-four interviews were conducted in South Bethany Beach. Of those interviewed 56 percent owned their own homes. However, only 6 percent considered themselves permanent residents. Only one-third of the respondents had been residing in or coming to South Bethany Beach for over ten years. On the whole, the residents were relatively newcombers. Eight percent of the respondents were living in single story dwellings, while the remainder were living in single family, multiple story dwellings. Some form of flood insurance policies are held by 64 percent of the property owners interviewed in South Bethany Beach.

a. Sources of Flooding

1. 1962 Storm (See Pocket Map M)

Unfortunately, very little was learned from the interviews regarding the flooding patterns that developed during the 1962 storm. This was to be expected, since many of the residents have only owned homes there for the past five to ten years. They were unaware of what had happened there previously. Also, since only 6 percent of those interviewed live permanently in the community, even though they may have had damage done to their property, they would not be particularly familiar with the specifics of the 1962 storm.

The following information was developed through the interviews.

In March 1962 the primary source of floodwater was the ocean. One respondent reported waves as high as thirty feet breaking on Route 14. The thirty-two houses that were destroyed on the beachfront are evidence of the intensity of these floodwaters. The entire dune area that fronted the ocean was flattened. A respondent living in the canal section of South Bethany Beach stated that sand from the beach front was carried inland into this section. Average water depths in the area east of Route 14 ranged from two to three feet. In the canal section itself floodwaters were thought to be one to two feet deep.

2. 1974 Storm

Somewhat more detailed information was available concerning the December 1974 storm because more of the respondents owned property at that time.

In 1974 South Bethany Beach was flooded when the dunes were breached, particularly in the area between North Fifth Street and South Second Street. This is supported by the fact that damage was most severe in that area. The dunes in the vicinity of North Sixth Street were also washed away, probably explaining why ocean water moved at least 300 feet inland along Petherton Drive. However at the south end of town ocean water advanced only halfway up Jamaica Street.

In most instances the floodwaters were confined to the road sections and left deposits of sand after the waters subsided. What little water did reach the canal section seems to have come from the ocean. Respondents living there said that the canals did not flood, although the water came within inches of the top of the bulkheads which line the canals. It is possible that, if the storm had lasted longer, more significant flooding problems would have developed.

b. Flood Damage

Damage experienced by residents of South Bethany Beach during the two most recent major storms, March 1962 and December 1974, will be discussed separately. For the purpose of organization the discussion will be presented within a locational framework, beginning first with the strip of land directly abutting the ocean (Part I), then proceeding to the blocks found between Ocean Drive and Route 14 (Part II) and finally dealing with those areas on the western side of Route 14 (Part III).

1. 1962 Storm

I. The five ocean front property owners interviewed were not living in South Bethany Beach at the time of the March 1962 storm, and they knew nothing about flood damage that might have occurred prior to their coming to the community. However, information provided by other permanent residents of the community indicated that as a result of the March 1962 storm, a total of thirty-two houses were destroyed along this ocean front strip. Sand dunes as high as fourteen feet were completely leveled.

II. More extensive interviewing was done throughout the blocks which lie between Ocean Drive and Route 14. While thirty respondents were questioned, little information was obtained regarding the March 1962 storm since most of the residents in this area are either renting for a few weeks, or they had only been living in South Bethany Beach for a few years. One individual on Jamaica Street knew that it had been necessary to have the well on his property replaced after the storm. A respondent on South Ninth Street experienced damage to rugs and furniture but was unable to give a dollar estimate of the damage. Another respondent located on South Second Street stated that part of his fence was washed away during the storm, as well as the dune which had stood in front of his property. There was debris for two blocks in either direction. This included telephone poles, wires, rooftops, and household furnishings. Clearing the area cost him approximately $700.

III. On the western side of Route 14 there are a large number of houses situated along man-made canals. Interviews were conducted throughout this area. In the southwest section (Bristol Road, Victoria Drive, Kimberley Street) none of the six respondents had ever experienced any damage from flooding, although some of them had had water on their property. Six interviews were conducted on Bayshore Drive. One individual reported that he had suffered several thousand dollars in damage done to furniture and a boat motor. There was also considerable debris left behind by the moving water. Another house located on Bayshore Drive had also suffered interior damage. The other respondents had not experienced any damage in 1962, although in some cases they had had water on their property as well as deposits of sand. Between Layton Drive and Petherton Drive twelve interviews were conducted. A respondent on Layton Drive stated that he had spent $300 after the 1962 storm to replace beds and do some repainting. On Brandywine Drive there was one case of ground damage.

One further interview was conducted outside the town limits of South Bethany Beach on Hassell Road. Floodwaters in that area cracked a house foundation causing the southwest corner of the house to settle.

The pattern of damage which resulted from the March 1962 storm indicates that the ocean front properties bore the brunt of the damage. Essentially all of the structural damage occurred in this area. Elsewhere throughout South Bethany Beach, damage was rather scattered and not as serious, involving primarily damage to furnishings and grounds.

In light of the population density of South Bethany Beach today, damage on the whole may not seem very great. It is important to note, however, that many of the houses now standing have been constructed since March 1962.

After the storm Operation Five-High was put into effect to repair the eroded beach. Approximately 65,067 cubic yards of sand were replaced along a 3,700 foot stretch of beach (U.S. Army Corps of Engineers, 1963).

2. 1974 Storm

I. Despite the fact that South Bethany Beach has been described as having suffered greater damage than most Delaware beach communities during the December 1974 storm, information supplied in interviews failed to reveal any extensive damage. Along the beach front the only section reporting damage was located between Division Street and North

Sixth Street. This is one area where the dunes were breached. There, two respondents experienced damage. In one case, a bulkhead in front of the house was lost and had to be replaced. The other resident reported damage not only to his bulkhead but also to his garage and septic system. Several pilings were also destroyed. There was an estimated three feet of water on the property. The other three respondents interviewed in this area did not report any damage.

II. In the entire area of South Bethany Beach between Route 14 and Ocean Drive, there were two reported instances of ground damage (thirty interviews were conducted). The most serious damage reported was to a house which lost some of the fill dirt from around the pilings. In general, many of the people living in this area had water on their property, but it seemed to do no real damage.

III. On the western side of Route 14 a total of twenty-four interviews were conducted, but there was just one reported case of damage from the December 1974 storm. A residence on Henlopen Drive experienced interior damage.

For South Bethany Beach as a whole, the roadways themselves probably experienced the most serious damage. Several buckled in a number of places on the ocean side of Route 14 and required expensive repairs. Many of the roads were also covered with sand deposited by floodwaters. Pieces of piling were also strewn about.

c. Interpretation of Aerial Photographs - 1962 Storm

Several streets in South Bethany Beach had clearly breached dunes. These included Kewanee, Indian, South Seventh, South Sixth, South Fourth, South Third, Division, North Second, North Third, North Fifth and North Sixth Streets. Sand covered most of Route 14, but stopped about 100 feet west of it.

All of South Bethany Beach was flooded. At the time the photographs were taken there was water on all the streets along the canals west of Route 14, but the land itself was not under water any longer. The ocean still covered the beach up to and including Ocean Drive.

There are ten areas of structural damage that can be seen in South Bethany Beach. Five of these are between Ocean Drive and the ocean at the ends of South Ninth, South Eighth, Division and North First Streets and between South Seventh and South Sixth Streets. Three damage areas occur along the west side of Ocean Drive between Kewanee Street and Jamaica Street, between Indian Street and South Ninth Street and between South Seventh Street and South Sixth Street. Two damage areas are just east of Route 14 on Logan Street and between Kewanee Street and Jamaica Street. Of the five ocean front damage areas, all of them, except the South Seventh Street area, include homes which were washed away, with only the foundation remaining.

The southern end of South Bethany Beach, in particular from Logan Street to Indian Street, experienced extensive washover. This area experienced damage which extended further inland than anywhere else. All of the breached dunes carried debris from damaged homes.

The damage area shown on the serial photographs corresponds well with the structural damage zone derived from the survey. The interior damage zone derived from the survey also seems to be in agreement with the storm photographs. It covers all of South Bethany Beach not included in the structural damage zone. From the storm photographs, it can be seen that all of South Bethany Beach was flooded in March 1962.

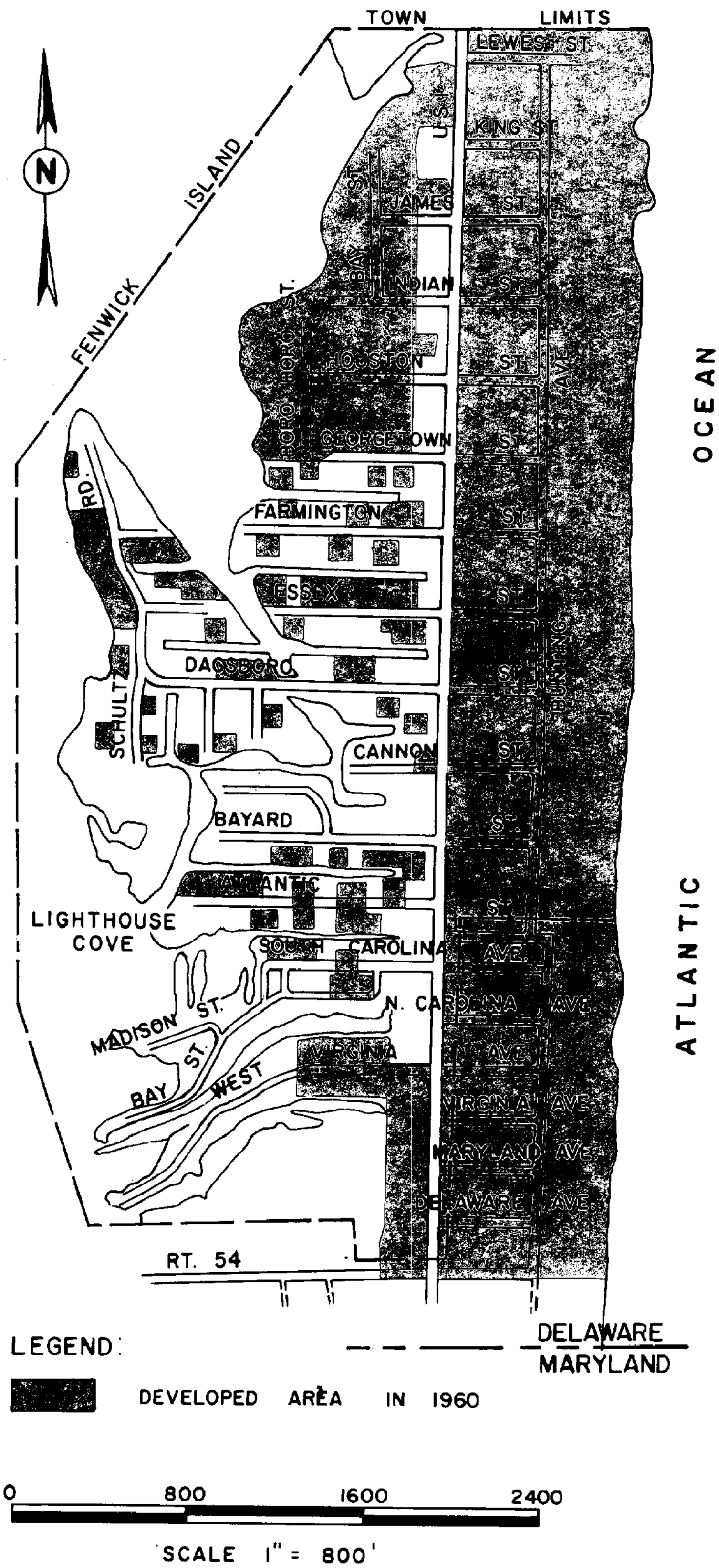
Fenwick Island

Fenwick Island is located on a long baymouth barrier beach extending southward from South Bethany Beach to the Maryland-Delaware State boundary. The community is bordered by the Atlantic Ocean on one side and by the Little Assawoman Bay on the other. On the bay side there are a series of small man-made canals that separate the streets in the northern and central areas. These canals provide direct access to the bay for the residents in Fenwick Island. Where the canal banks are not stabilized with bulkheads, the properties can be inundated during abnormally high tides.

The town of Fenwick Island is incorporated and extends for about a mile northward along Route 14 from the Maryland-Delaware border to the southern end of the State Park. It has a permanent population of fifty-six people. Fenwick Island is a well developed summer resort and during the summer months the population swells to 7,000. Many commerical establishments are located along Route 14 to service this resort community. In 1966 Fenwick Island contained approximately 250 homes (U.S. Corps of Engineers, 1966) and more than half of these were located on the beach front. Many of the houses on the west side of Route 14 are situated along the canals that connect to the bay. The total property value in 1966 was estimated at $2,550,000. The beach front alone was valued at $506,000 (U.S. Army Corps of Engineers, 1966). Zoning laws for the town of Fenwick Island restrict the residential section to only one house per lot. A portion of the community south of Atlantic Avenue is unincorporated and zoning laws are not as restrictive there. This section contains several trailer parks on the bay side of Route 14.

Figure 22

DEVELOPED AREA OF FENWICK ISLAND 1960



There were 161 interviews conducted in Fenwick Island. Sixty-three percent of those surveyed owned property in the community. Thirty-seven percent of the property owners are covered by flood insurance of some type. A sizeable number of the respondents (42 percent) spend three months or more in Fenwick, while of those who spend less time there, a significant number have been coming to Fenwick for over ten years. Those people interviewed lived primarily in single story dwellings (49 percent), but there was also a significant number living in multiple story dwellings (35 percent) and a few in trailers (7 percent).

Sources of Flooding

a. 1962 Storm

Fenwick Island was flooded in March 1962 by water both from the ocean and the Little Assawoman Bay. The dunes on the ocean front were first breached by ocean waves described as high as 40 feet. The breaching of the dunes had been facilitated by earlier ocean encroachment onto the dunes through erosion and by the leveling of some dunes to provide residents with a better view of the ocean.

The first break in the dunes occurred at the north end of Fenwick Island around Indian Street. Ocean water driven across the island into the bay caused the gradual rising of bay water which, in turn, filled the canals on the bay shore of the island. The rising bay water then flooded into town from the west to meet the ocean water coming through various breaks in the coastal dunes. Route 14 was covered with about five feet of water and sand. The town itself was covered fairly uniformly with from two to four feet of water both from the ocean and from the bay.

b. 1974 Storm

Along the ocean front, waves washed over the dunes in a few places but there were few significant breaks in the dune line. The high water was not accompanied by winds high enough or waves or currents strong enough to result in severe damage. Some properties west of Route 14 along the canals experienced minor flood damage.

Flood Damage (See Pocket Map N)

This section will outline the damage which occurred in Fenwick Island during the March 1962 storm. The December 1974 storm flattened the coastal dunes somewhat and resulted in some erosion on the ocean side, but otherwise little real damage was reported.

In describing the 1962 damage the area will be divided into three sections. The first section includes those dwellings within one block of the ocean. The second section includes all of Fenwick Island between Bunting Avenue and Route 14, and the final section includes all areas west of Route 14.

Twenty-five houses were surveyed between Bunting Avenue and the ocean. Four permanent residents were interviewed between King Street and Farmington Street and additional information about this area was obtained from other Fenwick residents. Four houses in this area were completely destroyed and two suffered structural damage. One of the respondents whose home suffered structural damage estimated his loss at $9,000. Three permanent residents were interviewed between Farmington and Bayard Streets. The homes of each experienced structural damage. An estimated $7,500 in damages was reported for one. This respondent reported that forty foot waves actually broke upon his house. Six permanent residents were interviewed between Bayard Avenue and the southern end of Fenwick Island. Additional information about this area was given by other Fenwick residents. There were four homes totally destroyed, one suffered structural damage and one suffered interior damages. One of these homes was reportedly split in half due to thirty-five foot waves breaking upon it. One respondent had experienced damages of $20,000 when his home was totally destroyed. Ocean water carried this house inland towards the bay. The respondent with interior damage had experienced a $10,000 to $12,000 loss. The original dune between South Carolina and Atlantic Streets had been very high, but it had been leveled to give residents a better view of the ocean. The earlier removal of this dune resulted in great damage during the 1962 storm to houses nearby.

Thirty-nine houses were surveyed in the area between Bunting Avenue and Route 14. In the area south of Maryland Avenue, four permanent residents were interviewed. In each case, their homes received structural damage. One respondent had less than $100 damage due to broken water pipes. The foundation of another house had shifted. All four houses were located on Bunting Avenue.

Between Maryland Avenue and South Carolina Avenue four permanent residents were interviewed. Four homes in this area experienced structural damage and one suffered interior damage. One respondent said that the front steps were broken off her home. Another received $300 damage to a patio. A third person had a total loss of $43,000 which resulted form structural damage to his own home and to six cottages. Another owner experiencing structural damage said that his windows and porch had been broken and required $3,500 to repair. Between South Carolina Avenue and Farmington Streets there were eight permanent residents interviewed. Two respondents reported structural damage, another had interior damage, and five respondents experienced damage to their grounds. A respondent on Cannon Street experienced structural damage to a storm door, while one on Dagsboro Street had damage done to outside stairs. North of Farmington Street two permanent residents were interviewed. One respondent reported no damage in 1962 while the other reported structural damage. The home with structural damage washed inland and caused damage to the wing of a hotel behind it.

West of Route 14 ninety-six interviews were conducted. In the trailer park along Route 54 there were only two permanent residents out of thirteen interviewed. No one reported any personal damage, but some were aware of what had happened in this area during the 1962 storm.

Along West Virginia Avenue two permanent residents were interviewed, and each had experienced interior damage to his home. This damage was caused by standing water, sand and mud. Along South Carolina Avenue and Madison Avenue there were four permanent residents interviewed. One home suffered structural damage due to broken exterior appointments, and one house experienced interior damage. Two respondents had experienced 1/2 foot of water on their property from the bay. Although one resident had not lived there at the time, he knew that there had been three to four feet of water covering some areas with resultant structural damage. In the area along Atlantic Avenue only one permanent resident was interviewed. His home experienced interior damage. Another respondent said that in 1962 this area was covered with three feet of water. No permanent residents along Bayard Avenue had been there in 1962, so no damage was reported.

In the area of Dagsboro, Essex, and Farmington Streets west of Route 14 eighteen permanent residents were interviewed. Three homes had structural damage, six had interior damage and one resident experienced grounds damage. Eight respondents reported no damage. One respondent on Schultz Street attributed structural damage to the force of the wind. Another near Dagsboro Street had $1,000 in damages to a boat and boat pump. The other respondent reporting structural damage had a broken water pump and a damaged wall. A respondent on Dagsboro Street reported interior damage of $3,000 to a washer, water pump and car. On Essex Street a respondent had $300 in interior damages to a freezer and a water pump. Another person on Essex Street had $700-$800 in interior damages, also to a freezer and a water pump. Two respondents on Farmington Street each noted $150 of interior damage to their water pumps. North of Georgetown Street there were ten permanent residents interviewed. Four houses had suffered structural damage, three had interior damage and three had no damage. One respondent had $200 in structural and ground damages. Another respondent reported $12,000 in wind damage to the roof of his house.

In the ocean front section there were a total of fourteen homes with structural damage and one with interior damage. In the section between Bunting Avenue and Route 14 there were eleven homes with structural damage, two with interior damage, and four with ground damage. In the section west of Route 14 there were seven homes with structural damage, eleven with interior damage, and two with ground damage.

There is a clear pattern of severe damage along the ocean front, which took the brunt of the storm waves. The area of structural damage extends, in general, quite far inland. In some areas this is due to the lack of protection from the dunes, some of which had been removed before the time of the storm. In some areas it is due to the fact that Fenwick Island's ten foot high dune line extends far inland, so that when the dunes were breached sand and water would be carried further inland. Houses in the northern section of Fenwick Island, where the dunes broke first, experienced structural damage extending inland to the bay areas. The homes on the west side of Route 14 showed a marked contrast in damage. The majority of these homes suffered interior damage, since the flood waters had insufficient velocity and depth to cause damage to structures.

The total cost of damage in Fenwick Island during the 1962 storm has been estimated at $2,060,000 (1962 prices, U.S. Army Corps of Engineers, 1966).

After the 1962 storm Operation Five High was established to repair damaged dunes. Fenwick Island received approximately 67,549 cubic yards of sand fill along a 6,000 foot stretch of beach (U.S. Army Corps of Engineers, 1963).

Interpretation of Aerial Photographs - 1962 Storm

Each street perpendicular to the ocean front in Fenwick Island had a breached sand dune. The pattern was very discontinuous with almost all the sand deposits being along the street and not covering the areas in between. The exception to this pattern occurred at the northern end of Fenwick Island from Georgetown Street to Indian Street. The sand extended inland as far as 200-400 feet west of Route 14.

All of Fenwick Island was flooded, except for the southern portion west of Route 14, between Route 54 and Virginia Avenue. Many homes along the canals were still flooded by bay water at the time of the photograph. The ocean still covered a portion of the beach up to fifty feet east of Bunting Avenue which parallels the ocean.

There are sixteen visible damage areas in Fenwick Island, eleven of which are between Bunting Avenue and the ocean. The other damage areas are west of Bunting Avenue, along Virginia Street, Farmington Street, Houston Street, Indian Street, and between Indian and James Streets.

Most of the damage areas are between Virginia and Bayard Avenues and between Essex and King Streets. Debris carried by the ocean water is visible on the breached sand dunes, mainly between Essex and James Streets. Damage areas which are located west of Bunting Avenue are found in the northern section of Fenwick Island where washover sand extended fartherest inland.

The damage areas from the storm photographs correspond to the general outline of the structural damage zone derived from the survey; they both indicate structural damage in the area from halfway between Route 14 and Bunting Avenue to the ocean. In the northern section of Fenwick Island the structural damage zone extends from west of Route 14 to the ocean according to the survey. The damage areas shown in the photographs also extend farther inaldn there, although not as far as the damage zone derived from the survey. Many of the structures reported by residents to have suffered structural damage did not appear to have structural damage on the storm photographs. The structural damage to these homes may not be of a type which is easily visible on an aerial photograph.

All of Fenwick Island not included in the structural damage zone was classified as a zone of interior damage from the survey information. Since the storm photographs showed that all of Fenwick Island was covered by floodwaters in March 1962, the zone designated as interior damage seems reasonable.

IV. PERCEPTUAL AND BEHAVIORAL REACTIONS TO THE FLOODING HAZARD

INTRODUCTION

The coastal flooding hazard involves not only the flooding event itself but also the collective reaction of the affected residents. Therefore, planning measures designed to respond to future flood hazards should consider not only the likely degree of actual flooding, based on estimates of previous floods, but also the perceptual and behavioral reactions of the population to an anticipated flood. In particular, knowledge of the degree to which concerned individuals perceive the potential flood hazard can be an important element in evaluating human behavior during a flood, or the likelihood that individuals will initiate prior preventive measures. Such factors obviously need to be considered in any planning procedure which is designed to integrate government and private measures to minimize future flood damage.

In this part of the report concerning perceptual and behavioral reactions to flooding, three basic issues may be posed concerning the attitudes of Delaware's coastal residents:

1. To what extent is the flood hazard perceived?
2. What sort of preventive measures should be taken?
3. Who is responsible for flood prevention?

Clearly there is a relationship between each of these issues. The strength of flood hazard perception influences the extent and nature of preventive measures which individuals believe to be necessary. Moreover, the extent and nature of preventive measures may influence the degree to which different agencies (individual, local, state, federal) are felt to bear responsibility.

One of the frustrations frequently encountered by planning agencies is the difficulty of identifying which segment of a population holds a particular attitude. In attempting to delineate the responses to the three basic issues noted above, it is here hypothesized that the attitudes of the population will differ according to certain variables, and that different variables will be significant at several geographical scales. Thus, at the scale level of comparisons between communities, those variables most likely to be responsible for different attitudinal responses on the part of the population would include location factors (whether the community was on the bay shore or on the ocean, whether it was protected or unprotected), and residence factors (whether a majority of respondents were owners or renters). At the scale of the individual community, the most important variable would be residence history (long-term or short-term, summer season or other, permanent or temporary, owner or non-owner) and flood history (recently exposed to flooding or not). Finally, at the most detailed scale within the community, the most significant variable is the discontinuity of the local hazard environment (degree of past flooding in one part of the community but not in others).

This section of the report, therefore, deals with the responses of the population to the three basic issues (i.e., flood hazard perception, preventive measures, and responsibility) in terms of the variable listed above, at three different geographical scales, as indicated in the following graphical summary:

TABLE 6

BETWEEN COMMUNITIES	INDIVIDUAL COMMUNITY	WITHIN COMMUNITY			
Variables	Variables	Variables	Issues		
			Flood Hazard Percep.	Preven. Meas.	Res-ponsi-bility
Bay shore or Ocean	Perm. resident or nonpermanent resident	Local dif. in the hazard environment			
Protected or unprotected	Summer or other				
Owner or renter	Long-term or short-term				
	Owner or renter				
	Flood history				

METHODOLOGY

The analysis and conclusions of this section of the report were based on a survey questionnaire. The questions were first analyzed to determine which were most logically related regarding perception of the respondents. Selection of those questions ultimately used in the analysis was also determined using standard statistical tests of significance, which indicate how well the responses to each question are correlated.

At the "individual community" scale, five questions were selected to be correlated with all other questions. These five variables were: question 6, distinguishing residents (those living in the community year-round) from nonpermanent residents (those visiting or living in the community for only a portion of the year); question 7, which separated those respondents who were present in the community _only_ in the _summer months_, from those others present during _other seasons_; question 8, which identified _long-term residents_ (those present in the community for five years or more) and _short-term residents_ (those present in the community for only one or two years); question 3, which divided _property owners_ from _non-owners_; and question 10, which distinguished _those who had experienced a flood_ from _those without such experience_.

Not all questions from the questionnaire were compared in terms of the five variables noted above. Some were deleted because they were inappropriate to the topic of this section of the report, while others were not used because the sample size of the responses was insufficient to draw reasonable conclusions.

The comparisons selected for emphasis at the scale of the "individual community" then formed the base for additional analyses made at the two other scales. Thus, the conclusions resulting from the examination of each community became the data upon which comparisons were made at the scale "between communities". And selected questions used at the scale of the "individual community" were plotted by individual respondent to provide the data base for analysis at the scale "within community". In this latter analysis, maps of the responses to certain questions were created with the SYMAP computer mapping program, and the resultant distributions were compared with flood damage maps.

ANALYSIS AND CONCLUSIONS

Scale: Between Communities

a. Sample Population Profile

Table 7 summarizes the distribution of interviews completed during the project and contrasts these with estimated population statistics for the communities studied.

Respondents interviewed for the project totalled 875. The largest number of interviews were made in Fenwick Island, Bethany Beach, and Rehoboth Beach. Of the total number of respondents, 165 (about 19 percent) were permanent residents while the rest were generally either short-term beach users or part-time (summer) residents. The SYMAP sample size differs from the total number of interviews because beach users, short-term renters, and those who did not own property were eliminated.

b. Discussion of Answers to Questionnaire

A large percentage of the respondents in Rehoboth Beach #1, Bethany Beach, South Bethany, and Fenwick Island were nonpermanent residents, who only visit during the summer months and do not own property in the communities (3, 6, 7).* Bowers Beach and Oak Orchard/Riverdale areas are distinguished by having a predominantly permanent resident population in the survey sample. In all of the communities at least 60 percent of the respondents were "long-term" (five years or more) residents or visitors, with the exception of Rehoboth Beach #1 which had only 52 percent "long-term" visitors (8).

With the exceptions noted above, the "typical" respondent was a property

*Number in parentheses refer to question numbers in Table 8 or on the questionnaire in Appendix I. Graphical comparisons of the responses of each community to selected questions are found in Appendix II.

owner; a "long-term", nonpermanent resident; or a visitor who inhabited the coastal community during one or more seasons of the year.

Flood experience of the respondents was the greatest in Bowers Beach (90 percent), Slaughter Beach (70 percent), and Oak Orchard (62 percent). In the other communities, flood experiences ranged between 45-50 percent (10). A large percentage of people in Bowers Beach, Slaughter Beach, and to a lesser degree Bethany Beach, believed that flooding was a problem in their community (11). Bowers Beach and Slaughter Beach had many respondents with flood experience and many who believed flooding to be a problem, but Bethany Beach had a slight majority with no flood experience yet nearly two-thirds of the respondents believed flooding to be a problem. Rehoboth Beach #1 and South Bethany had the highest percentages of individuals who had no opinion on whether flooding was a problem or not. Respondents in Rehoboth Beach #1, Bethany Beach, and South Bethany defined less threatening environmental conditions (such as water in the streets) as a flood (12). This may explain why so many in Bethany Beach believe flooding to be a problem. Individuals in Bowers Beach, Dewey Beach and Henlopen Acres, at the other extreme, are most likely to define a flood as a more serious event such as the occurence of structural damage. Bowers Beach and Slaughter Beach had the highest percentage of people who thought flooding had increased over the years, which may also help explain why those two communities think that flooding is a problem (37).

Bowers Beach and Slaughter Beach were flooded the most (once a year or more), according to respondents (24), and also received the most damage of any type due to flooding (29). Those two communities also have the highest percentage of individuals who think that there will be floodwaters on their

TABLE 7

Population Profile

Communities	1973 Estimated* Permanent Residents	Interviewed Permanent Residents	"SYMAP" Sample Size	Total Number Interviewed	Column B Divided By Column A
Bowers Beach	290	21	27	33	7%
Bethany Beach	196	19	63	136	9%
Fenwick Island	57	19	104	158	33%
Henlopen Acres	124	13**	29**	39**	--
Rehoboth Sample 1	--	--	--	250	--
Rehoboth Sample 2	1,489	33	55	67	2%
Slaughter Beach	85	15	31	35	18%
South Bethany	24	4	33	64	17%
Oak Orchard/ Riverdale	N/A	13	19	24	Unincorporated Communities
Dewey Beach Area	N/A	15	32	39	Unincor. Comm.
Broadkill Beach	N/A	13	27	30	Unincor. Comm.
North Shores	N/A	Combined/W Henlopen Acr.	Combined/W Henlopen Acr.	Combined/W Henlopen Acr.	
Total		165	420	875	

* "Population Estimates and Projections", U. S. Department of Commerce, May 1975.

** Includes residents of North Shores.

Rehoboth Sample #1 - Interviews with people on the beach, Summer 1975.
Rehoboth Sample #2 - Interviews with people at their homes, rental units, etc., Summer 1976.

TABLE 8

Selected Questions
(Percent)

Selected Questions	Bowers Beach	Slaughter Beach	Broadkill Beach	Henlopen Acres North Shores	Rehoboth #1	Rehoboth #2	Dewey Beach	Bethany Beach	South Bethany Beach	Oak Orchard	Fenwick Island
3. Property Owner	76	83	87	77	9	85	82	47	56	83	63
6. Nonpermanent Resident	28	57	57	67	97	50	62	86	94	46	88
Permanent Resident	72	43	43	33	3	50	38	14	6	54	12
7. Resident or visitor: summer only	16	36	20	26	89	26	34	71	56	21	55
Resident or visitor: other season(s)	84	64	80	74	11	74	66	29	44	79	45
8. Long-term residents or visitors (+ 5 years)	73	77	60	64	52	85	82	70	62	87	81
Short-term residents or visitors (1-2 years)	10	6	26	15	26	4	5	18	28	8	9
10. Respondents with previous flood experience	90	73	57	43	47	56	56	50	48	62	51
Respondents with no flood experience	10	27	43	57	53	44	44	50	52	38	49
11. Flooding problems do exist	82	77	47	42	27	26	36	60	42	48	37
No flooding problems exist	7	23	43	45	33	70	59	24	38	43	52
12. <u>Definition of a flood:</u>											
Water above normal; not in inhabited areas	27	27	24	10	26	20	19	21	17	27	22
Water in the streets	21	24	31	33	39	32	24	42	47	27	28
Water on your property	3	33	24	23	12	21	19	16	8	23	21
Minor structural damage caused by floodwaters	34	6	17	23	18	18	32	16	25	18	24
Major structural damage caused by floodwaters	10	6	3	8	3	5	3	3	3	4	5
16. <u>Damage can be reduced by:</u>											
Protective devices (bulkheads, dunes, etc.)	48	73	51	58	22	35	44	32	35	30	37

TABLE 8 (continued)

Selected Questions	Bowers Beach	Slaughter Beach	Broadkill Beach	Henlopen Acres North Shores	Rehoboth #1	Rehoboth #2	Dewey Beach	Bethany Beach	South Bethany Beach	Oak Orchard	Fenwick Island
18. Responsibility for re building funds:											
Individual	14	15	23	10	4	8	11	4	8	13	9
Government	54	54	53	60	47	55	75	41	45	26	43
19. Would a coastal flood alter your plans to visit or live here:											
Yes	14	14	14	8	13	9	3	10	5	4	5
No	83	83	86	82	79	88	79	77	87	91	87
24. Perceived frequency of flooding:											
Once a year or more	49	44	23	17		2	6	11	16	9	30
Once every ten years	29	28	23	21		9	47	40	23	33	29
27. Highest level of coastal floodwater on your prop.:											
At least one foot or greater (no upper limit)	63	50	26	30		33	59	84	45	87	66
29. Damage incurred during coastal storm:											
Structural damage	20	26	8	10		2	13	36	12	36	30
No damage	7	23	42	65		19	48	24	54	37	43
34. Preventive measures taken:											
Raising dwellings on pilings or blocks	14	10	47	43		15	37	20	26	61	40
Storing belongings in safe place	17	47	0	0		0	0	0	0	0	2
Nothing done	59	0	37	43		83	60	57	35	17	29
35. Preventive measures were taken:											
Before damage occurred	61	50	88	93		87	73	71	78	67	71
36. Action to take if storms and flooding is predicted:											
Evacuate	25	41	48	31		27	30	36	45	23	52
Do nothing	25	14	15	31		28	17	5	12	12	4

TABLE 8 (continued)

Selected Questions	Bowers Beach	Slaughter Beach	Broadkill Beach	Henlopen Acres North Shores	Rehoboth #1	Rehoboth #2	Dewey Beach	Bethany Beach	South Bethany Beach	Oak Orchard	Fenwick Island
37. Perceived frequency of flooding:											
No change in recent yrs.	41	42	65	67		85	76	68	64	84	72
39. Perceived chance of flooding next year:											
Not likely	30	37	68	83		95	64	54	51	50	54
Highly probable	41	30	18	0		0	16	11	18	0	19
40. Financial aid sought after storm damage/flooding:											
None	73	80	96	91		100	87	83	100	94	91
43. Know someone who left community due to experience with flooding:											
Yes	32	41	4	15		9	19	32	18	6	28
No	68	59	96	85		91	81	68	82	94	72
45. Did you know of potential for flooding in community before moving in:											
Yes	62	63	67	75		63	50	74	72	56	61
No	38	37	33	25		37	50	26	28	44	39
46. If no, would it have changed your decision to move here?											
Yes	44	36	33	23		0	19	14	22	25	13
No	44	64	56	62		90	75	86	56	50	78
Don't know	11	0	11	12		10	6	0	22	25	8
47. Respondents with Federal Flood Insurance:											
Yes	50	46	33	50		13	33	57	64	20	37

property within the next year (39). Respondents in Oak Orchard and Bethany Beach rank high: a) among those thinking that flooding occurs only once every ten years (24); b) among those who have never received more than one foot of water on their property (27); and c) among those who have received structural damage (29). Individuals in Rehoboth Beach #2, South Bethany, Broadkill Beach and Henlopen Acres all tended to report that they: a) did not experience flood damage; or b) seldom experienced flooding, or if they do, the floodwaters reach only up to the property (29, 24, 27). The same four communities rank high among those who believe that flooding on their property within the next year is unlikely.

When asked to suggest the most effective measure to reduce storm and flood damage, individuals in all communities except Oak Orchard overwhelmingly selected protective devices as their first choice (16). Slaughter Beach residents had the highest percentage of respondents (seventy-three percent) suggesting protective devices. Thirty-seven percent of the respondents in Oak Orchard, on the other hand, (the largest percentage in any community) suggested that no measures could be effective in reducing damage from flooding. It is interesting to note that Oak Orchard respondents, a very large percentage of whom had experienced some structural damage and water one foot or more deep during the March 1962 storm have taken the attitude that nothing can be done to prevent this type of damage from storm flooding. When other measures were suggested by the interviewer, the most frequently accepted choice was the flood proofing of homes (17). However, many times this response was given in combination with one or more other measures, so that no community had more than a 33 percent response to flood proofing alone.

Rehoboth Beach #2, followed by Dewey Beach, Bowers Beach, and Bethany Beach are the communities where respondents have done the least to take preventive measures (34). It is notable that of these communities, Rehoboth Beach #2 and Dewey Beach do not think flooding is a problem, while Bowers Beach and Bethany Beach do think it is a problem but still have not taken preventive measures. Oak Orchard, Slaughter Beach, and Broadkill Beach are the communities that have taken the most preventive measures, and a high percentage of individuals in these communities think that flooding is a problem. The most popular preventive measure selected by all the communities, except Bowers Beach and Slaughter Beach, was the use of pilings and the raising of structures above ground level. Oak Orchard had the highest response (61 percent) of those opting for pilings and raising structures to prevent damage. Interestingly, 47 percent of the respondents in Slaughter Beach and 17 percent of the respondents in Bowers Beach opt for the storing of belongings in a safe place as a measure to reduce damage. One half to two-thirds of all the communities took preventive measures prior to damage occurring (35).

If a flood were forecast for their community, a fairly high proportion of individuals in Rehoboth Beach #2, Henlopen Acres, and Bowers Beach would do nothing (36). The residents of Fenwick Island and Bethany Beach would be least likely to react by doing nothing. The highest proportion of individuals who would want to evacuate is found in Fenwick Island (52 percent) followed closely by Broadkill Beach (48 percent). Respondents in Oak Orchard and Bowers Beach expressed the least interest in evacuation, 23 and 25 percent, respectively.

Federal, State, and local governments were consistently chosen by all the communities as the proper bodies to be responsible for providing money to rebuild a flood damaged community (18). In Broadkill, 23 percent of the respondents did feel that the individual should be responsible. Interestingly, private insurance is rarely mentioned by respondents as a source of aid in time of flooding damage. A very large proportion of individuals in all communities have not sought aid (40). Only in Bowers Beach, which also has the largest proportion of individuals with flood experience, did a significant minority (25 percent) seek aid after a flood. The small sample responding to questions 41 and 42 makes detailed conclusions from these questions uncertain.

Dewey Beach, Oak Orchard and to a lesser degree Bowers Beach and Slaughter Beach had the highest proportion of respondents who were not aware of any flood potential in their community before moving there (45). Bowers Beach and Slaughter Beach respondents rated highest in stating that if they had been aware of the flood potential, it would have affected their decision to move to the community (46). Approximately one-third of the respondents in Bowers Beach, Slaughter Beach, and Bethany Beach had known people who had left the community due to their flood experience (43). Only a minority in all communities knew of anyone who had left their community for this reason. When the respondents were asked if they would change their own plans about living in the community if a flood occurred, the consistent response in all communities was that it would not alter their plans (19).

Scale: Individual Community

a. Bowers Beach

1. Perception of Flood Hazard

The inhabitants of this community were primarily property owners, long-term residents and present throughout the year (3, 6, 7, 8)*. Experience seems to play an important role in the flood perception of these residents. A slightly larger percentage than usual, 38 percent, had been present for the 1962 storm (9), and a very high 90 percent had experienced a flood (10). Half had encountered water reaching the property at least once a year, although a 25 percent minority believed this occurred only once every ten years (24). The impact of severe floods was strong in the respondents' feelings. Nearly 60 percent stated that in the worst flooding water had reached a depth of at least one foot over their property (27), and one-half experienced structural and interior damage (29). It is not surprising, therefore, that with this greater background of severe flood experience, the respondents tended to define flooding in terms of a threatening environmental condition. Only one-half of the sample would regard water reaching the property, but not the residence, as a flood since this is apparently a frequent occurrence. On the other hand, fully one-third do not consider conditions as a flood unless some minor structural damage occurs (12) (Table 8). For this reason the view of the community, which overwhelmingly stated that flooding was a problem in the area (11), should be accepted with some seriousness. It also explains why only 30 percent stated that it was unlikely that water would reach their property in the next year (39).

*Numbers in parentheses refer to appropriate questions from the questionnaire, Appendix I and Appendix II.

The small sample size does not allow meaningful comparisons of residential variability in response to the questions. However, it may be possible to discern a somewhat greater flood concern among nonpermanent residents, even though they experienced slightly less severe flood damage than did permanent residents (11). Furthermore, nonpermanent residents perceived a higher frequency of minor flood conditions reaching their property (24). Such distinctions may suggest that it is the frequency with which flood conditions are perceived rather than their severity which determines the degree to which individuals perceive flooding as a problem in the area.

2. Preventive Measures

Protective devices (levees, dunes, jetties, groins, etc.) were volunteered by half the sample as measures that might be taken to prevent storm damage, while fully 40 percent believed no measures would be adequate or had no suggestions (16). When various alternative measures were suggested by the interviewer, 40 percent opted for flood proofing of homes and in some cases early warning was added. Ten percent felt zoning might be a useful measure while 15 percent continued to believe there were no solutions (17). Other than the slightly greater variety of options selected than in some other communities, the generally more-sensitized perception of flooding by Bowers Beach residents did not result in startlingly different opinions regarding preventive measures. Even more surprising, fully 60 percent indicated that they had taken no preventive measures. Of those that had, the measures ranged from storing belongings safely, to the use of pilings and the raising of structures (34). It is interesting to note that among the small minority who took some individual preventive measures, most did so before damage occurred (35). However, when the responses to these two previous questions are disaggregated by type of resident, a clear pattern emerges in which a much larger proportion of non-permanent, summer-only, and short-term residents were among those taking preventive measures. Long-term, other season, and permanent residents, who make up a majority of the total and whose experience of flooding is much greater constitute most of those who had taken no measures. This latter, long-term group saw evacuation or the moving of belongings to a safe place as the most reasonable reaction to a flood warning. Nonpermanent residents, summer-only residents and short-term residents were more likely to be among the 25 percent of the total sample who would do nothing in the face of such a warning (36).

3. Responsibility

A wide variety of responses existed to the questions concerning responsibility for flood damage reconstruction. The largest group, some 40 percent, believed funds should be provided by Federal and State sources, while only 14 percent believed the individual should carry the responsibility. There was little or no suggestion that responsibility should be shared between the individual and the government (18). Only one-quarter had applied for such aid (40). Of these, a mere 14 percent had obtained federal aid. A large majority, some 70 percent, had relied on family and friends, while only 14 percent had used a combination of State government aid and help from family and friends (41). This suggests that, while individuals believe government aid should be forthcoming in such circumstances, their expectation is not borne out by prior experience.

b. Slaughter Beach

1. Perception of Flood Hazard

The Slaughter Beach community is well established. Over three-quarters of the sample responding to the questionnaire had been residents for five years or more (8)* and more than 80 percent were property owners (3). Moreover, although permanent residents were slightly outnumbered by nonresidents (defined as those spending less than the whole year in the community) (6), a substantial part were in the community for more than just the summer months (7).

Because of this background, the sample's flood experience is substantial. Over one-third were present for the March 1962 storm (9) while two-thirds claimed they had experienced a flood (10) and one-half indicated that they recalled at least one time when floodwaters reached a depth of at least one foot on the property (27). However, there is some discrepency in the responses concerning flood history. For instance, in the question concerning damage, a little more than half the respondents indicated either no damage had been encountered or damage to the grounds only (29). Yet, at the same time, two-thirds of the respondents felt that flooding

*Numbers in parentheses refer to appropriate questions from the questionnaire. Appendix I and Appendix II.

was a problem in Slaughter Beach (11). Resolution of these apparently conflicting opinions may be possible by focusing on the definition of flooding. Response to question 12 (see Table 8) indicates that over 80 percent perceive a flood condition as existing once water has reached the edge of the property but before any structural damage has occurred (12). This tendency to consider environmental conditions as a flood when those conditions fall considerably short of producing significant damage, is an important context in which to evaluate the sample's flood prognostications and behavior. Thus, the fact that over half believe it probable or highly probable that floodwater will reach their property in the next year (39) (a view which correlates closely with the 44 percent who experienced this condition at least once a year in the past) (24), does not necessarily imply a population ready to undertake preventive measures.

Distinctions between different categories of residents do not appear to cause great differences in response to the questions. There is some indication that those present for the summer-only, and therefore less familiar with the first hand experience of flood conditions, are slightly <u>more</u> likely to perceive higher frequency of flooding and to believe flooding is a problem in the area (10, 11, 24).

2. Preventive Measures

Reactions to questions 16 and 17 reveal that most residents do not envisage prevention in terms of measures directly pertinent to the individual property, but rather to the community at large. This is consistent with the view of a flood as not being immediately and personally threatening. Thus, when asked to suggest preventive measures, a striking two-thirds volunteered protective devices: levees, dunes, breakwaters, jetties, groins, etc. (16). Only when other measures were suggested by the interviewer was flood proofing of homes most frequently mentioned and then by only one-third (17). Reflecting this lack of individual preparation, nearly half the respondents stated that they had taken no preventive measures; of those who had there was an even division between work undertaken before and after the damage occurred (34, 35).

Reaction of the sample to a flood forecast, on the other hand, may reflect the more extreme perceptual range of flood definition. Since half indicated that evacuation and movement of belongings would be their response to a flood warning (36), such a warning is perhaps seen in the definitional context of a flood as a severe threat to person and property. While differences between nonpermanent, summer, permanent and other season residents were generally slight, it is interesting to note that the former were slightly less likely to evacuate in the face of a flood warning, even though they tended to perceive the nature of a flood as somewhat more threatening.

3. Responsibility

Consistent with the tendency of the sample to choose community preventive measures over individual measures, 50 percent of the respondents felt that Federal and State government (but significantly not county or city government) should provide the funds for rebuilding following flood damage; only 15 percent suggested that the individual should be responsible (18). On the other hand, this reaction was somewhat hypothetical since only 20 percent of respondents had ever sought such aid.

c. Broadkill Beach

1. Perception of Flood Hazard

Distinctive features characterize the Broadkill Beach community. Most of the sample are owners (3)*, only a few restrict their residency to the summer season alone (7) and more than half are long-term residents (five years or more) (8). However, there is an almost even division between those who are permanent residents and those present for less than twelve months (6).

In terms of flood perception, more than half the respondents defined a flood as those environmental conditions which would produce standing water in the streets; conditions which are substantially less than those likely to produce structural damage (12) (see Table 8). The reason for this generous definition of flood may be explained by the general residential flood history of the community. When asked about the effects of the most severe flood experienced, over half the respondents stated that the water had reached the property or grounds but not the residence (27). Furthermore, 80 percent stated that there was either no damage or damage to the grounds only (29). This view of flooding as a less significant and threatening event may explain why only a minority considered flooding a problem (11). Other reasons for this view include an overall lack of flood experience by the sample as a whole:

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I.

three-quarters of the respondents were not present for the 1962 flood (9) and only a little more than half had experienced any flooding at all (10). It is not surprising, therefore, that as many as 68 percent believe that there is little likelihood of floodwaters reaching their property in the next year (39).

Evaluation of questionnaire responses in terms of certain residence history variables reveal differences of perception which are obscured in the overall Broadkill Beach totals. Thus, more long-term and other season residents than short-term and summer-only residents had experienced flooding and believed flooding was a problem in the area. Similarly, while the amount of flooding experienced by permanent and nonpermanent residents was about the same, far fewer permanent residents thought flooding was a problem than did non-permanent residents (10, 11). The latter distinction was compounded by the fact that while nonpermanent residents had experienced a higher frequency of flooding in the past (24), permanent residents had experienced more damage from the most severe storms (29). Yet, when the expectation of future flooding is examined, many more permanent residents believe waters are unlikely to reach their property in the next year than nonresidents (39). However, more summer and short-term residents felt that waters were unlikely to reach their properties next year than long-term or other season residents (39). The confusion in responses among the different residential variables may be simplified by considering flood perception as a continuum. First there are nonpermanent and summer residents whose experience with floods is generally limited. They express some concern for the possible effects of flooding and its frequency of occurrence. Next, there are the short-term, and permanent residents whose experience with more severe floods is greater. As a consequence, they perceive the more frequent minor water expansion as unimportant by comparison. It may be that exposure to considerable damage from floods results in a fatalistic view of flooding in which the inability of human actions to effect much protection predominates. Finally, there are long-term residents whose more substantial experience of severe flooding may lead them to a more realistic concern for flooding and a greater perception of flood-producing environmental phenomena. For this reason, this latter group of residents may react similarly to the nonpermanent and summer residents, but for different reasons (12).

2. Preventive Measures

The residential distinctions made above become useful in explaining the differences in response to questions concerning preventive measures. When asked what measures might reduce storm damage, one-half responded that protective devices (levees, dunes, jetties, groins, etc.) should be used, while one-third either said nothing would be of use or had no idea (16). Furthermore, when other methods were suggested by the interviewers, 10 percent still answered "none", while one-fifth endorsed flood proofing of homes (17). However, when these questions are disaggregated by residence variables, it can be seen that permanent residents and short-term residents are much less likely to volunteer protective devices and more likely to believe that no specific measures will be of value (16). Again, the fatalistic approach of these residents may explain the contrast with the view of long-term and nonpermanent residents. When questioned concerning individual measures taken, pilings and the raising of structures were preferred by a majority and most had undertaken such measures prior to the occurrence of damage. But once more, many nonpermanent residents had taken such measures while many more permanent residents had done nothing (34, 35). Finally, in reaction to a flood forecast, approximately one-half would evacuate. However, in terms of residential variables, many more nonpermanent, summer only, and long-term residents would be in the evacuation category, while more permanent, other season, and short-term residents would be in the category to do nothing (36).

3. Responsibility

The State and Federal governments should bear the cost of flood damage repair according to about one-half of the total residents, while only one-fifth believe the individual had responsibility. Slightly more permanent, other season, and short-term residents felt the individual had responsibility than did nonpermanent residents, summer only and long-term residents (18). However this distinction was hypothetical since an extremely small proportion of the sample had ever sought such aid (40).

d. Henlopen Acres Area

1. Perception of Flood Hazard

The people interviewed in Henlopen Acres were primarily owners, nonpermanent residents or long-term residents, who lived in the community for longer than just the summer (3, 6, 8, 7)*.

The flood experience of the inhabitants of Henlopen Acres will be discussed first, so that their perceptions of the flood hazard in the area can be better understood. Most of the people had not experienced any flooding and only 40 percent had been in Henlopen Acres in March 1962 (9, 10). Sixty percent had never received sea or canal water on their property, while 20 percent received it about once every ten years and 20 percent received water once a year or more (24). About 30 percent had some type of flood damage, equally divided between structural, interior, and ground damage while 65 percent have had no damage (29). In 40 percent of the cases, some floodwaters had reached the property but not up to the residence. Almost 25 percent of the sample had water depths of over two feet (27).

Most people in Henlopen Acres have not been affected by flooding at all. A minority of about 40 percent have experienced some floodwaters and damage. These figures correlate fairly well with the perception of flood hazard. About 40 percent said that flooding is a problem and 10 percent had no opinion (11). Eight percent agreed that it was not likely that floodwaters would reach their property next year (39). Respondents in Henlopen Acres had a fairly rigorous definition of flooding, in that 33 percent said that only when the water caused structural damage could it be considered a flood (12) (see Table 8).

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

The sample in Henlopen Acres can be disaggregated into different types of residents in order to show how certain factors affect perception of flood hazard. The nonpermanent residents in this case responded quite differently from permanent residents. More frequent flooding, higher water levels and more damage was experienced by nonpermanent residents than by permanent residents. Yet, permanent residents are more likely to be aware of a flooding problem, while more nonpermanent residents had no opinion about flooding as a problem.

2. Preventive Measures

Almost 60 percent agreed that protective devices (levees and dunes) would be effective in reducing flood damage and 20 percent had no idea of any effective measures (16). When preventive measures were suggested to the respondents, 20 percent decided that a combination of flood proofing homes, protective devices, zoning and an early warning system would be effective (17). Forty percent had personally taken preventive measures by putting their homes on pilings or raised structures and 40 percent had done nothing (34). Almost every one who took preventive measures did so before damage occurred (35). One-third would evacuate if a flood were forecast while one-third would do nothing (36).

Here again, prominent differences between nonpermanent residents and permanent residents can be seen. Nonpermanent residents were more likely to have taken the preventive measure of putting their homes on pilings and to evacuate. Permanent residents were more likely to have taken no preventive measures and to do nothing if a flood were forecast. Therefore, the flood experience on the part of nonpermanent residents shows up clearly in the area of preventive measures.

3. Responsibility

Sixty percent felt that financial responsibility to rebuild a flood damaged community should be taken care of by the Federal government, the State government or a combination of the two (18). The response was the same when flood damaged public areas (boardwalk, beach, etc.) were specified. However, flood damaged private homes were a different matter. Almost one half thought that the individual home owner ought to be responsible. Less than 10 percent of those in Henlopen Acres had ever sought financial aid after flooding (40). Half said they did have Federal Flood Insurance and half did not (47), which correlates well with the fact that there was also an equal split between those who did think flooding was a problem and those who didn't. Finally, nonpermanent residents, who had more flood experience, were more likely to have flood insurance than permanent residents, who had less flood experience.

e. Rehoboth Beach #1

1. Perception of Flood Hazard

Rehoboth Beach will be analyzed in two sections. The people in Rehoboth Beach #1 were interviewed on the boardwalk and the beach, while those in Rehoboth Beach #2 were interviewed in their homes.

Rehoboth #1 consisted almost entirely of nonpermanent residents, non-owners and people who are there only during the summer (3, 6, 7).

However, one-half had been coming to Rehoboth Beach for five years or longer (8).

Only 10 percent had been in Rehoboth Beach in March 1962, but almost 50 percent had experienced a flood (although not necessarily in Rehoboth Beach) (9, 10).

Most of the people in this sample had no flood experience in Rehoboth Beach upon which they could base their perceptions of flooding there. It is not surprising that 40 percent had no opinion about whether flooding was a problem in the area. Thirty percent thought that flooding might be a problem (11). When asked to define a flood, more than half cited standing water in the streets. Twenty percent mentioned a stricter definition, by saying that only when water caused structural damage could it be called a flood (12).

The responses to the preceding questions can be disaggregated by type of resident to show how flooding experience may affect flooding perception. Those people who had been coming to the community for five years or longer were more likely to have flood experience and thus to have some opinion on whether flooding is a problem or not (10, 11). The people who had only been coming to Rehoboth Beach one or two years and those with no flood experience were more likely not to venture an opinion on the flooding problem of Rehoboth Beach (11).

2. Preventive Measures

Twenty percent thought that protective devices (levees, dunes) might be effective in reducing flood damage, but 40 percent thought that nothing would be effective or had no idea (16). When certain possible preventive measures were suggested to respondents almost 20 percent agreed that a combination of flood proofing homes, protective devices, zoning and an early warning system would be an effective way to reduce flood damage (17). The people with no flood experience were the ones most likely to say that nothing could be done or had no idea of what could be done to prevent flood damage (16).

3. Responsibility

A total of 40 percent of those interviewed felt that the Federal government, the State government or a combination of the two should be financially responsible for rebuilding flood damaged communities. The rest of the people were divided between different governmental agencies, the individual, and insurance (18).

f. Rehoboth Beach #2

1. Perception of Flood Hazard

Most of the people in Rehoboth #2 were property owners, long-term residents and were in the community for longer than just the summer (3, 7, 8). There was an equal number of permanent residents and nonpermanent residents (6).

The flood history of Rehoboth #2 will be examined to determine how it affects the community's awareness and concern with flooding. Slightly more than half the people had experienced a flood (though not necessarily in Rehoboth Beach) (10). Although almost 60 percent had been in Rehoboth Beach in March 1962, fully 90 percent had never experienced seawater on their property nor damage due to sea flooding (9, 24, 29). Of those who had received water on their property, most reported that the water at its maximum depth had not reached to the level of the residence. Only 33 percent had maximum water depths of one to three feet and none had over three feet of water on their property (27).

Since flooding in Rehoboth's residential sections had not been severe at all, it would be expected that few people would consider flooding as a threatening environmental condition. In fact, only 30 percent thought that flooding was a problem (11). It is not surprising that nearly everyone in Rehoboth Beach felt it unlikely that seawater would reach their property next year (39). When asked how they would define a flood, half of the sample said either a water level above normal or water in the streets. Eighteen percent thought that a flood occurred only when there was structural damage due to water level (12) (see Table 8).

Flooding perceptions in Rehoboth Beach can be further analyzed by comparing differences in perception as a result of different residence experience. The permanent residents, long-term residents, property owners and people with flood experience were more likely to report that flooding does occur in Rehoboth Beach (although only once every ten years), to have experienced water depths of one to three feet and to think that flooding was a problem (24, 27, 11).

2. Preventive Measures

One-third of the people mentioned protective devices such as levees and dunes as measures which might be effective in reducing flood damage, while another third thought that nothing could be done or had no idea of any effective preventive measures (16). The low concern for flooding, shown by the people of Rehoboth Beach, is reflected in the fact that 80 percent had taken no preventive measures. Only 15 percent had put their homes on pilings or raised structures (34). However, most people who took preventive measures did so before damage occurred (35). When asked what they would do if a flood were forecast, one-third would evacuate and one-third would do nothing (36).

A pattern of consistency again emerges among permanent residents, long-term residents, property owners and those with flood experience. More of these people believed that a combination of flood proofing homes, zoning and an early warning system would be an effective way to reduce flood damage (17). Although this group was more concerned that flooding is a problem, more of them said that they would do nothing if a flood were forecast (36).

3. Responsibility

Almost one-half felt that the financial responsibility for flood damage reconstruction should fall to either the Federal government, the State government, or a combination of the two (18). When asked to differentiate between who should pay for the public areas (boardwalk, beach, schools, etc.) of a flood damaged community, most people again mentioned the Federal and State governments. Opinion was much more divided on who should pay for a private home damaged in a flood. Almost 25 percent cited the individual, 33 percent said insurance and 30 percent said that the Federal and State governments should be financially responsible. Since so few in Rehoboth had received any damage, there were no instances where people had ever sought financial aid after flooding occurred (40). Only a small minority had Federal Flood Insurance (47). The long-term residents, owners and those with flood experience were more likely to have flood insurance, again reflecting a higher degree of concern for flooding.

g. Dewey Beach Area

1. Perception of Flood Hazard

The community of Dewey Beach is overwhelmingly composed of owners with 82 percent of those interviewed being in this category (3). Another distinctive feature of the Dewey Beach sample is that 82 percent are long-term (five or more years) residents (8). Although 62 percent are nonpermanent residents (6), the majority are present in the community for longer than just the summer (7).

Flood experience within the Dewey Beach community is almost evenly split--56 percent said they had experienced a flood and 44 percent had not (10). Yet, 61 percent of the residents said they were there for the 1962 storm (9). This can either be due to the fact that some of those who were there in 1962 came down after the storm was over to survey the damage or they were referring to their house being present and not to themselves personally. In either case the experience and contact with environmental conditions associated with severe flooding are familiar to most of the residents in the community. This statement is reinforced by the respondents rather severe definition of a flood (12). The majority of the community did not consider environmental conditions to be a flood until water had reached their property. Even more surprising was the 32 percent of the residents who considered the occurrence of minor structural damage as their definition of a flood (see Table 8).

Though the community has a rigorous definition of a flood, the threat of such a condition is offset by the fact that 60 percent of the population does not consider flooding to be a problem (11). To understand the reasons behind the community's low concern for the serious flood conditions they define, it is necessary to examine the flood history of Dewey Beach. Almost 60 percent of the residents have experienced water on their property over one foot high, 48 percent of the entire community has never received damage, and only 13 percent has received structural damage (27, 29). So, with a definition of flooding conditions that includes structural damage, this may explain why the majority do not show concern for the flooding problem. The frequency of flooding in the community was seen as low by the residents--47 percent said it occurred every ten years and 31 percent had never experienced it (24). Thus, the majority, 64 percent, of the population did not think it likely that water would reach their property next year (39). This could also be a factor in the response that flooding is not a problem.

Divisions by residency status show different aspects of the community for evaluation. It was found that permanent residents, other season residents, and those who had not experienced a flood thought flooding was more of a problem (11). There appears to be a correlation between permanent and other season residents, the amount of interior and/or structural damage received from flooding, and concern for the flood problem (11, 29). The relationship between those with no flood experience and their concern for the flood problem may be attributed to their lack of knowledge about the environmental conditions of a flood, and the threat of the unknown.

2. Preventive Measures

When asked to suggest measures that could be effective in reducing damage from storms or flooding, 44 percent of the community said protective devices (dunes, jetties) (16). The next largest group (17 percent) thought no measure could be effective. Though nonpermanent residents and permanent residents had almost an equal percentage who said protective devices would be an effective solution, permanent residents were more likely to chose "none", as their response. In addition to the responses above, residents were asked what measures they thought could reduce damage. From these responses 55 percent of the community agreed that flood proofing, either alone or in combination with other responses, would be effective in reducing damage. Even with this list, 10 percent of the permanent residents still thought that nothing could be done to prevent damage (17).

The residents of the community were also asked what measures they had taken to reduce damage (34). Thirty-seven percent had their house on pilings or raised structures, and 60 percent had done nothing. People who had experienced a flood were more likely to have their houses raised on pilings. However, when asked if the preventive action was taken before or after damage, a higher percentage of the flood experienced residents and the nonpermanent residents had taken action before damage (35). The information also indicates that nonpermanent residents are more likely to try to prevent damage, than permanent residents who feel nothing can be done. If a flood were forecast for this community, 30 percent said they would evacuate, 20 percent would keep informed of warnings and 17 percent would do nothing (36). Only 15 percent of the permanent residents said they would evacuate and 31 percent of them would do nothing. Permanent residents are less likely to take preventive measures, and they also seem unwilling to leave the community even if a threatening storm does occur.

3. Responsibility

The community thought that government should bear the most responsibilty for rebuilding a flood damaged community--36 percent said Federal government, 17 percent said State government and 19 percent said both Federal and State government. Only 11 percent of the community said that the individual himself should be responsible (18). However, when asked specifically about who should be responsible for private property, 39 percent thought the individual should pay for the damage. Only 33 percent of the community have Federal Flood Insurance to cover damage (47). The nonpermanent residents and flood experience groups have a higher percentage of insurance holders than the permanent and no flood experience residents. It is interesting to note that while permanent residents are aware that flooding is a problem, and received more damage than nonpermanent residents, they are less likely to have Federal Flood Insurance. It is difficult to determine the quality of aid that has been offered to this community in the past, since only 12 percent have sought aid after flooding (40). This aid was sought from the Federal government. While 66 percent were somewhat satisfied with aid received, 33 percent were not at all satisfied (41, 42).

h. Oak Orchard

1. Perception of Flood Hazard

Oak Orchard is an old and stable community. A majority of the respondents were permanent dwellers who had been present in the community for more than just the summer months (6, 7)*. Almost all owned their own homes and lived there for more than five years (3, 8). Consequently, as might be expected, the population possessed considerable flood experience. More than two-thirds had been exposed to flooding and a similarly high proportion had been present for the 1962 storm (9, 10).

Oak Orchard, however, appears to be a community which demonstrates that flood perception by a population with considerable flood experience results in a wide variety of observations and opinions that are frequently inconsistent. For instance, with regard to flood frequency, although approximately one-half the respondents believed floodwaters and reached their property at least once in the previous ten years (24), only half of these respondents believed this would not occur in the coming year and one-third believed it was

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

probable (39). With regard to flood severity, 87 percent stated that the highest water had reached at least one foot in depth over their property and half of these stated the depth as over three feet (27). Damage to property or belongings resulting from such floods affected 63 percent of the respondents (29). Yet, when attention was directed from flood experience to opinion only 48 percent of the respondents believed that flooding was a problem in the community (11). Resolution of considerable flood experience with this relatively limited view of flooding as a problem is not achieved by examining the definition of a flood. Over half the population believe water standing in the streets constitutes a flood, while a little more than three-quarters would define a flood as water on the property (Table 8) (12). Many of the environmental conditions included within the community's flood definition would not be expected to produce the level of damage which the community has experienced. Perhaps one explanation for the dichotomy between flood experience and flood perception may lie in the tendency of long-term residents, who have encountered and perhaps survived severe flooding in the past, to minimize flooding as a specific threat to their existence in the community.

Unfortunately, no resolution of this issue is achieved by investigating the responses to questions in terms of the residential variables. Rather, such an exercise merely compounds the impression of inconsistency. Thus, for instance, fully 67 percent of those who claim not to have experienced a flood, report water on their property at a depth of over three feet, and 20 percent indicated damage to interior furnishings (10, 24, 27). In part this may be explained by the small sample size and in part by the possibility that some respondents interpreted flood experience in question 10 to refer to their person alone and not their property. But such inconsistency may also be reflective of the general tendency for highly divergent opinions to result from a population with substantial flood experience.

2. Preventive Measures

The conclusions regarding the Oak Orchard community already hypothesized are further reflected in their responses to questions dealing with preventive measures. When asked to volunteer ideas, only 30 percent suggested protective devices (jetties, groins, levees, dunes, etc.) while 35 percent said no measures would be effective and 22 percent had no idea (16). After the interviewer offered suggestions, there was a wide scattering of responses with 46 percent including flood proofing of homes (17). Interestingly, a much higher proportion of those who had previously experienced a flood, than those who had not, included early warning among the suggested measures.

Less than one-fifth of the population had taken no preventive measures themselves, while a large number (61 percent) had opted for pilings and raised structures. Examining the responses among residential variables, a slightly larger number of those who had not experienced flooding had erected pilings and raised structures, while a slightly higher proportion of owners than non-owners had done nothing (34). About two-thirds of those who had taken measures did so prior to incurring damage (35).

It may be that the tendency of many people to rely on substantial protective devices encourages a sense of security which could explain their view of flooding as being somewhat less of a problem than in other communities. It may also explain why there is a diverse reaction to a potential flood warning. With such an occurrence only 23 percent indicated that they would evacuate and all in this group had experienced flooding. Conversely, 50 percent of those who had not experienced flooding would do nothing in the face of a flood warning (36).

3. Responsibility

Responses to the question concerning financial responsibility for the repair of flood damage were quite diffuse. Twenty-six percent suggested Federal and State entities should bear the burden (18). However, almost no one had sought such aid (40). Federal Flood Insurance was carried by 20 percent of the residents and most of those had previously experienced flooding. A surprisingly high proportion, also 20 percent, did not know whether or not they carried such insurance. The bulk of those who did not carry insurance were also those who claimed not to have previously experienced flooding (47).

i. Bethany Beach

1. Perception of Flood Hazard

A majority of respondents spend only the summer months in the community and are, therefore, nonpermanent residents. Most, however, have also been returning to the town for over five years and in this sense are categorized as long-term visitors (6, 7, 8)*. There is an even division between those who own and those who rent their properties, as well as a similar division regarding those who have and have not experienced a flood (3, 10).

As might be expected with such a background of temporary visitation, the experience of flood frequency by the respondents seems to be limited. Only 21 percent were present for the 1962 flood (9). Forty percent stated that water reached their property only once every ten years and another 40 percent indicated that either this condition never occurred or they simply did not know (24). Consequently, it is not surprising that over one-half predicted that it would be unlikely for floodwaters to reach their property in the coming year (39). In contrast, the experience of flood severity appears to be considerable. Eighty-four percent stated that at least one time the water level reached over one foot in depth on their property and a large minority (46 percent) indicated a depth of over three feet (27). Under these circumstances damage was

*Numbers in parentheses refer to appropriate questions from the questionnaire, Appendix I and Appendix II.

considerable. Over half indicated that they had received structural damage or destruction of interior furnishings (29).

The high flood severity factor appears to outweigh the factor of low flood frequency in influencing the population's opinion regarding flooding in general. Although the respondents had a rather limited definition of flooding (over half viewed less than damaging environmental conditions as a flood (12) (Table 8), 60 percent believed flooding to be a problem in the area (11). Interestingly, among the variables only the distinction between owner and nonowner produced a variation of more than 12 percent between the categories in response to this last question.

2. Preventive Measures

Opinions concerning appropriate preventive measures were quite varied with no strong, consistent trend. Protective devices (levees, dunes, jetties, groins, etc.) were volunteered by 32 percent of the population as the most likely method to reduce damage. This was the largest proportion of respondents to favor any one measure (16). When other alternatives were suggested the response was even more variable, with the largest proportion (20 percent) deciding that a combination of flood proofing of homes, zoning and early warning broadcast by radio or TV would be the most effective (17).

The undecided nature of the respondents' opinions regarding prevention was mirrored in their personal actions to reduce damage, where 57 percent said they had done nothing (34). Of the minority who had taken some action, the largest proportion (20 percent) mentioned pilings and raising structures (34). Most had taken such measures prior to damage occurring (35).

The general lack of action concerning prevention is perhaps due to the nature of the flood experience of the community, which involves infrequent but severe flooding. This might explain why a majority of those responding would agree to evacuate and move belongings to a safe place if a flood warning was forecast (36).

3. Responsibility

There was considerable division of opinion regarding responsibility for repairing flood damage. Forty percent believed the Federal and State governments should be responsible and only 6 percent felt the individual should bear the cost (18). A rather high proportion, nearly 60 percent, had taken out Federal Flood Insurance; a factor which might explain why 60 percent stated that they had taken no personal preventive measures (47, 34).

j. South Bethany Beach

1. Perceptions of Flood Hazard

Almost all the South Bethany Beach respondents were nonpermanent residents, yet nearly two-thirds had been visiting the community for more than five years (6, 8)*. In the other variable categories, there was an even division between owners and renters, summer only and other season residents and among those who had experienced flooding and those who had not (3, 7, 10).

The 1962 flood contributed little to the community's flood experience, since a mere 13 percent had been present at the time (9).

*Numbers in parentheses refer to appropriate questions from the questionnaire, Appendix I and Appendix II.

Furthermore, 69 percent stated that they had experienced no damage, or damage to the grounds only, from the most severe flood (29). Nearly half stated that water had never even reached the edge of their property (24) and only a minority of the population indicated that water had stood at a depth of more than one foot on their property from any storm (27). It is this background of limited experiences with flooding which explains why more than half of the population do not expect floodwater to reach their property in the next year and why only 42 percent believe flooding to be a problem in the community, compared with 38 percent who believe it is not a problem and as many as 20 percent who are uncertain (11). Moreover, this minority opinion of flooding as a problem is held in spite of the fact that the respondents have a modest definition of flooding. Sixty-four percent believe a flood to be represented by environmental conditions which would not result in any significant damage (12) (Table 8).

It might be anticipated that these conclusions based on the total responses hide variations in flood perception among the various categories of resident, and particularly it would be expected that more owners would perceive flooding as a problem. However, this is not the case. Only a minority of owners believe flooding to be an issue in South Bethany Beach (11).

2. Preventive Measures

Perhaps because flooding is not thought of as the threat it is in some communities, no clear trends emerged from replies to the questions concerning preventive measures. Protective devices (levees, dunes, jetties, groins, etc.) were the most frequently volunteered suggestions, but only by 35 percent of the respondents; only one-quarter stated "none" or "no idea" (16). When the interviewer suggested other measures, flood proofing of homes was most frequently mentioned, but again only by one-fifth of the respondents (17). With regard to the measures individuals themselves had already taken, only a very small proportion of the population (less than one-quarter) had done anything, and of those, bulkheads and seawalls were chosen by more of the respondents who had experienced flooding, while pilings and raised structures were preferred by those who had not previously experienced flooding (34). About three-quarters of those who had taken preventive measures had done so prior to the occurrence of any damage (35).

Only one-half of those interviewed answered the question on their reaction to a flood warning. However, among these respondents, close to half indicated that they would evacuate, while a mere 12 percent suggested that they would do nothing (36). The overall impression gained from the response to this last question suggests that, while the population, in general, does not perceive flooding as a particular problem, the fact that their prior flood experience is limited results in their more immediate and radical response to a flood warning.

3. Responsibility

Forty-five percent of the respondents believed that the Federal and State governments should be responsible for providing funds to rebuild following flood damage and only 8 percent believed the individual was responsible (18). Of course, the question was entirely hypothetical as none of the respondents had ever sought aid (40).

The profile of the South Bethany Beach community, which emerges from the responses to the questionnaire, is of a population with limited flood experience, a majority view that flooding is not a problem and a consequent set of mild opinions and lack of specificity concerning preventive measures and responsibility. Nevertheless, it appears to be a cautious community, for 64 percent of the owners state that they carry Federal Flood Insurance (47).

k. Fenwick Island

1. Perception of Flood Hazard

A very large proportion of the population of Fenwick Island does not reside there permanently. These people, however, have been visiting the area for five years or longer (6, 8)*. In the other residential categories is a fairly even division between those visiting only for the summer and those in residence during other seasons, a slight preponderance of owners over non-owners and an even split between those who have and have not experienced a flood (3, 7, 10).

The flood experience of the respondents was moderate relative to some other communities. A little less than one-third (29 percent) were present for the 1962 flood and their definition of a flood was somewhat more realistic; only 50 percent would view standing water in the streets as a flood, while the other 50 percent defined a flood in

*Numbers in parentheses refer to appropriate questions from the questionnaire, Appendix I and Appendix II.

terms of more severe environmental conditions (12) (Table 8). The experience of respondents to flood frequency was highly varied. Approximately one-third experienced water on their property at least once a year, while at the other extreme, an additional one-third experienced this condition only once every ten years. An additional one-third had never experienced this phenomenon (24). This preponderance of opinion implying a rather low flood frequency is reflected by a majority (54 percent) who believe it is highly unlikely that floodwaters will reach their property in the coming year (39). With regard to flood severity two-thirds had experienced water to a depth of at least one foot over their property and a little more than half had suffered some form of damage to structures, interior furnishings, or grounds (27, 29).

Relative to other communities, Fenwick Island's flood experience would appear to be modest as reflected in the responses of the community as a whole. Consequently, it is hardly surprising that only a minority (37 percent) believe flooding to be a problem in the area (11). However, masked by this majority view of relative unconcern, a number of trends become apparent upon examination of residential variables. For instance, more individuals with flood experience see flooding as more of a problem than those without experience (11, 39). In contrast, a higher proportion of long-term residents believed flooding was not a problem and floodwaters would not reach their property in the coming year (11, 39). Since slightly more short-term residents than long-term residents also had experienced flooding (3, 10), it would appear that there is a minority of the population who perceive the threat of flooding and its effects more clearly, but whose views are obscured by the majority opinion.

2. Preventive Measures

Few strongly held views were expressed regarding measures which might prevent flood damage. Thirty-seven percent volunteered protective devices (jetties, groins, levees, dunes, etc.) while an additional 30 percent had no idea or said nothing could be done (16). When considering suggestions offered by the interviewer, a wide variety of measures were chosen by the respondents, most frequently as combinations (17). More than two-thirds of the respondents had taken some individual measures, with a similar proportion of these individuals taking action prior to experiencing flood damage. Here, clearer preferences emerged with fully 40 percent utilizing pilings and/or raised structures (34, 35). In spite of taking such protective measures, over 60 percent of the population would evacuate and move belongings to a safe place if a flood were forecast (36).

3. Responsibility

The Federal and State governments were thought by over 40 percent of the respondents to be financially responsible for rebuilding a flood damaged community (18). Only 9 percent felt the responsibility belonged with the individual. Almost none of the respondents, however, had ever sought such aid (40). Federal Flood Insurance was carried by only 37 percent and only relatively low 9 percent were uncertain regarding their participation in the insurance program (47). There is an interesting, if understandable, relationship between insurance coverage and flood perception in Fenwick Island. Approximately 50 percent of the residents do not carry insurance and the same approximate percentage do not believe flooding to be a problem (11, 47).

Generally, Fenwick Island is a community with moderate flood experience and a modest concern for flooding. This overall view, however, hides a smaller percentage of residents for whom flooding is more of an issue, as expressed by preventive measures taken and insurance carried. For the most part this small minority seems to be composed of those who have experienced flooding but, at the same time, have a relatively shorter history of residence in the community.

Scale: Within Community

The purpose of the SYMAP computer-drawn maps presented in Appendix V and discussed in this section is to determine whether the distribution or pattern of responses to selected questions on the questionnaire offers further insight into a community's perception of coastal flooding and their reaction to this natural hazard. While each mapped response does not always display or produce an obvious and explainable pattern, it is hypothesized that the geographical location of replies might be in general accord with the localized patterns of the flood hazard. The storm damage maps can be compared with the SYMAP computer maps and perceptual attitudes and opinions of the population can be contrasted with the reality of flooding. The computer maps of questionnaire responses can also be compred with each other. In the analysis of the maps for each community which follows, the major objective will be to evaluate the extent to which the pattern of responses is consistent with the area(s) of significant or extraordinary storm damage. This hypothesis is based on the assumption that within each community there should be a "zone of concern" in which perception of flooding is more developed and opinions on future flooding and techniques for prevention clearly held. Such a zone might be thought to correspond with the area(s) of significant previous damage. Beyond this zone, perceptions by individuals within the community might be expected to be less clearly developed and less accurate. Conversely, the extent to which this hypothesis may not be borne out by the mapped distributions would indicate the degree to which perceptions of flooding and suggestions for prevention are inconsistent.

An understanding of the method by which the maps were constructed is most important in order to avoid any misunderstanding in their interpretation. Each map was produced by identifying the location of each respondent within the community and assigning specific values to those data points depending upon the particular response to a question. The SYMAP computer program then interpolates the hypothetical values of all other areas of the community between the data points and shades areas of the same value with an identifying pattern. The interpolation of perceptions and opinions held by residents who were not interviewed is similar to any other form of statistical sampling in which conclusions drawn from a certain proportion of the population are projected to represent the whole community. In the case of a geographical sample the selected opinions are projected over the adjacent area to include those zones within the community where no interviews were obtained. This is an important assumption, but one which must be made unless every individual in the community is interviewed. Such an assumption, furthermore, is reasonable when dealing with an individual's perceptions, since opinions concerning behavior in the face of natural hazards are frequently influenced by communication and interaction between neighbors. Nevertheless, the assumption leads to a number of significant qualifications which must constantly be borne in mind when interpreting the maps which have been produced for this project.

Since the maps are based on only a sample of the community, they cannot be viewed as completely accurate and precise in the sense of, for example, property survey maps. Rather, the patterns are designed to convey a generalized impression based upon the assumption that people located close to a respondent may tend to hold similar views.

The sample size obviously influences the validity of the patterns produced and it is important to be aware, therefore, that some communities had a lower density of respondents than others. The sample size also varied with the question. Thus, in some cases it is possible for only one respondent to substantially influence the interpolated pattern around that data point. Consequently the interpretation and comparison is aided by noting that each map prints the actual location of each respondent by means of a numeral. The particular numeral used a a location indicates the category into which the respondent falls, as indicated by the map key.

Not all questions in the questionnaire are amenable to this type of analysis. Thus, only those questions which could be scaled, or reduced to an "either-or/yes-no" response, were mapped. Of the ten questions chosen for SYMAP analysis, four have been isolated in each community to exemplify the type of consideration that all maps received. These four questions (11, 24, 35, 47)* were selected for their value in highlighting the three basic issues of study: the extent of flood hazard perception; the sort of preventive measures that should be taken; and the matter of who holds the responsibility for flood protection in each community.

a. Bowers Beach

The distribution of interviews conducted in Bowers Beach did not lend itself well to SYMAP analysis. Interviews tended to be clustered spatially and large areas were devoid of data. Thus, distortion in the appearance of these maps is greater than that in other communities surveyed. Due to the small number of interviews in South Bowers Beach, this area was not included in the community analysis.

Almost all property owners interviewed in Bowers Beach were aware of a local flooding problem (9)*. Only two residents of those sampled said they had never experienced bay water on their property (24). The most

*Number in parentheses refers to appropriate questions from the questionnaire, Appendix I and Appendix II. SYMAPs are included in this report for only these four questions. Others are on file at the Office of Management, Budget and Planning.

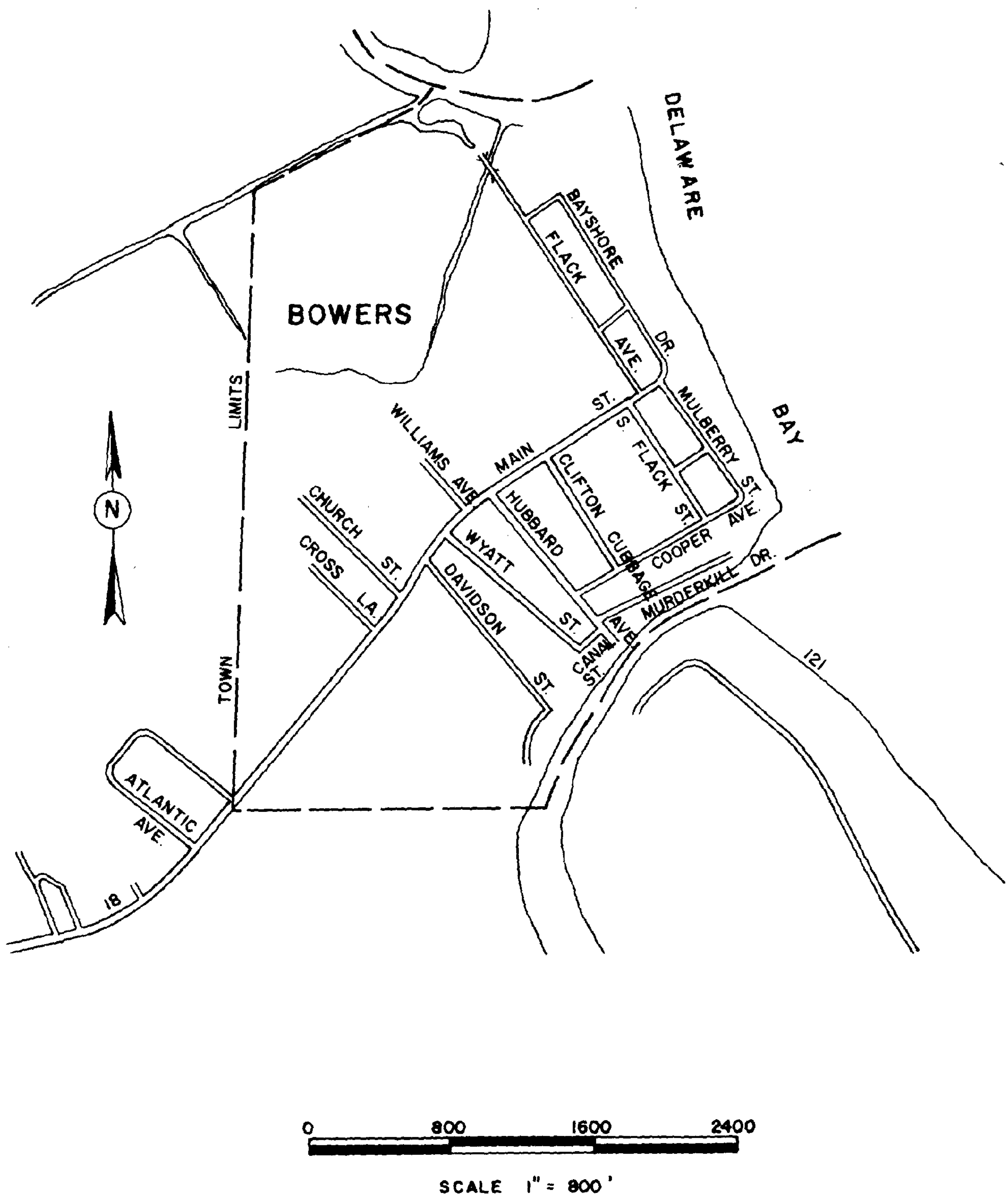
frequent inundation was reported by property owners on Hubbard Avenue and North Flack Avenue. However, the majority of respondents in this area have taken no preventive measures against flood damage (35). Where such measures had been implemented, action was taken prior to experiencing any storm damage. Since only 11 percent of those questioned gave a response regarding their holding of Federal Flood Insurance (47), the corresponding SYMAP was not produced.

If only the flood damage maps are considered, it would be expected that most of the community would pose a "zone of concern" as defined earlier. However, the preliminary analysis of SYMAP indicates a different trend. As a whole, Bowers Beach appears more uniform in opinion than other bay communities studied. Upon closer inspection of the computer maps three attitudinal areas become evident.

1. Atlantic Avenue area. This area although outside the corporate limits of Bowers Beach, shares the town's moderate level of flood experience. Flooding has occurred since 1962 (9, 10) and is perceived as a local problem by the residents sampled (11). Inundation by bay water is perceived to be less frequent than in the remainder of the community (24), but higher maximum water levels have been experienced (27). Damages were incurred primarily on grounds and interior furnishings (29). In spite of their admission of flood hazard, most inhabitants did not appear to feel threatened, and thus had taken no protective measures (35).

2. Hubbard Avenue and William Avenue vicinity. This area contains most of those residents present for the 1962 flood (9). Significant flooding has occurred since that time

FIGURE 23



DELAWARE
BAY
BAYSHORE
DR.
FLACK
AVE.
BOWERS
LIMITS
TOWN
N
MULBERRY
ST.
MAIN
ST.
S. FLACK
ST.
WILLIAMS
AVE.
CLIFTON
HUBBARD
CHURCH
ST.
CROSS
LA.
WYATT
ST.
CUBBAGE
AVE.
COOPER
AVE.
DAVIDSON
ST.
CANAL
ST.
MURDERKILL
DR.
121
ATLANTIC
AVE.
18
0
800
1600
2400
SCALE 1" = 800'

respondents report flood experience (10). Both high water and extensive damages have been suffered in the area (27, 29). When combined with frequent flooding (24), such conditions would appear to be sufficient reason for the property owners to be concerned about the flood hazard (11). In spite of their perception of a flooding problem, however very few of those interviewed had taken action to protect their property (35).

3. Northeast area. East of Flack Avenue and north of Cooper Street. The majority of the population here has had flood experience in the years since 1962 (9, 10). Water from the St. Jones River reaches their property quite frequently, although at low depths (24, 27). Property owners interviewed have experienced a variety of damage levels (29) and feel that such conditions could recur in the near future (39). Their perception of the flooding problem (11) and construction of preventive measures (35), indicate a greater degree of concern for flood hazard than is shown by the remainder of the community.

4. Conclusion. From the SYMAP analysis it is evident that the residents interviewed in the northeastern portion of Bowers Beach have a greater awareness of flooding and the need for protection. The remainder of the community expressed concern, yet had taken little or no protective or preventive actions. It appears that, in spite of a history of extensive flood damage, those sampled did not feel threat from coastal storms to be significant enough to instigate preventive measures.

b. Slaughter Beach

Slaughter Beach has suffered severe damage from two major coastal floods in the past twenty years. The beach has receded some forty feet;

several homes have been washed away or damaged beyond repair, and nearly every property has received some form of flooding. The greatest destruction occurred during the March storm in 1962 when seventeen homes were destroyed and many others were damaged. The U.S. Army Corps of Engineers' report (1962) cites the northern section of Slaughter Beach (see SYMAP for divisions), as receiving the greatest damage. A less severe storm, in December 1974, caused considerable property damage to residences in the central section of Slaughter Beach. The southern beach lost thirty to forty feet of sand during this storm, but little property damage occurred.

With such extensive destruction in the Northern part of Slaughter Beach, it would be expected to emerge as a "zone of concern". The Central section might also show a high degree of sensitivity, while the Southern section, with milder damages to properties in both 1962 and 1974, would understandably be less concerned. The residents interviewed, however, showed the opposite trend in their responses.

Two of the major questions of perception and reaction to flooding as a hazard (35 and 47)* show "zones of concern" corresponding more closely to areas containing residents who had experienced the March 1962 storm than to the areas known to have suffered most. Every resident interviewed in the southern section of the community has taken precautions against flood damage while only half of those interviewed in the central zone and even fewer in the north have taken such measures (35). Of the people asked about Federal Flood Insurance, two-thirds of southern Slaughter Beach, none of the central residents and half of the northern

*Numbers in parentheses refer to the appropriate questions from the questionnaire, Appendix I and Appendix II.

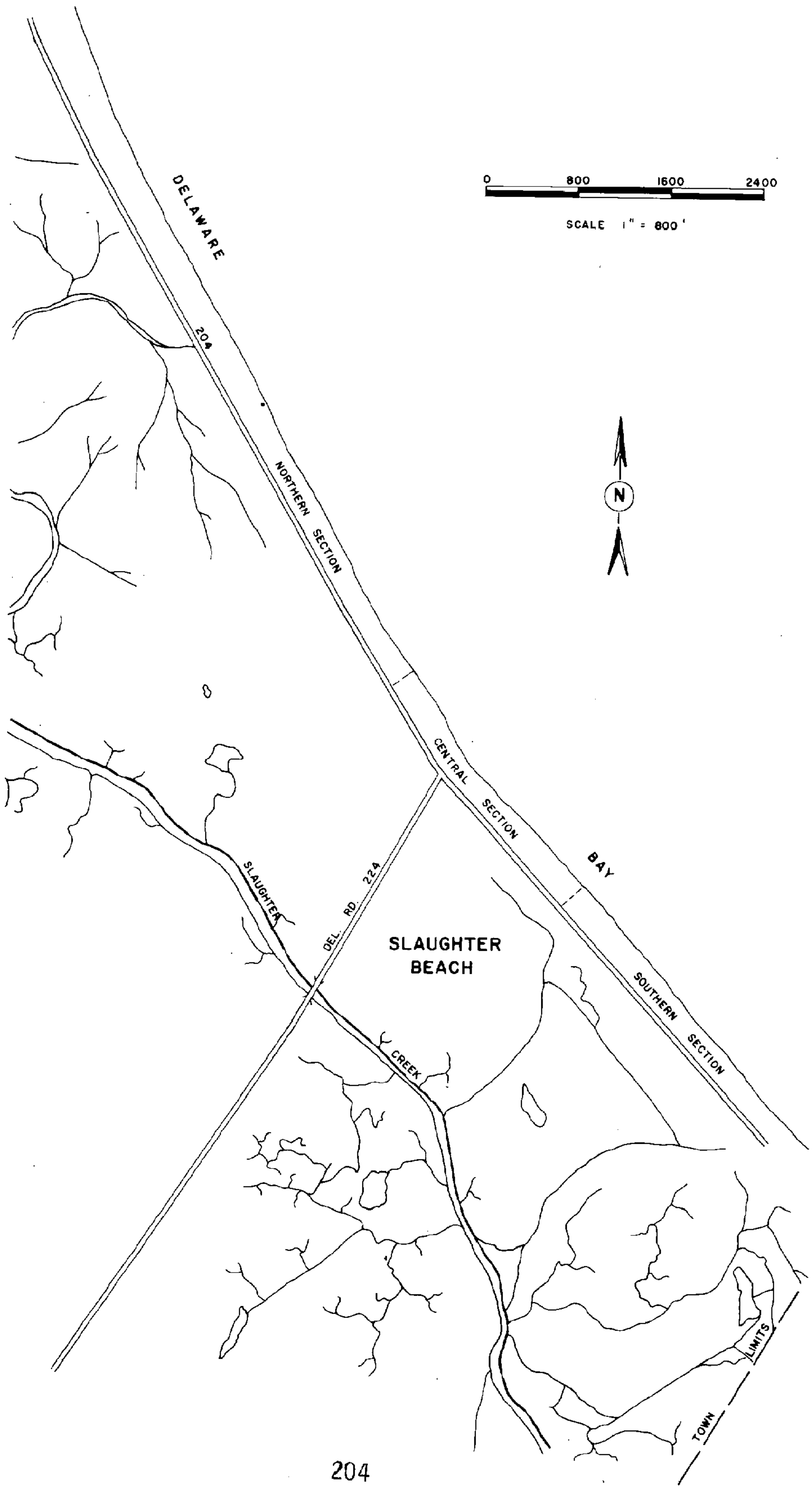
area residents hold flood insurance policies (47).

The questions concerning perception of flooding as a problem (11) and the frequency of bay water flooding (24) do not seem to show the same distinction between 1962 and later residents. Nearly everyone in the northern and southern portions of Slaughter Beach said they perceive flooding to be a problem in their area. Half of the central respondents agreed while the rest said they perceived no problem (11). Yet, the central residents reported the most frequent water on their properties, at least once every two to five years. Only a few in the north and south reported water that often, most of them saying that water reaches their properties only once in ten years (24).

Looking at the sections of Slaughter Beach individually, it becomes more apparent that those actually present for the storm in 1962 show greatest concern for flooding regardless of geographic location or whether they suffered damage in the 1974 northeaster.

1. Northern Section: north of the sixth groin. This section, while known to have suffered severe damages in 1962, shows only minor damage or none at all on the SYMAP of damages (29). This is due to the small portion (35 percent) of the present-day residents sampled who experienced that storm (9). The heavy damages indicated in Question 29 were reported by those few people present in March 1962. The remainder of the northern residents have had minor grounds damage or no damage at all. Most of those in the northern section said they had experienced a flood (10) and consider flooding to be a problem in the Slaughter Beach community (11). The majority also consider it probable

FIGURE 24


0
800
1600
2400
SCALE 1" = 800'
N
DELAWARE
BAY
204
NORTHERN SECTION
CENTRAL SECTION
SOUTHERN SECTION
SLAUGHTER BEACH
SLAUGHTER
CREEK
DEL. RD. 224
TOWN LIMITS

that bay waters will reach their properties "next year" (39). However, only the residents from 1962 have taken preventive measures (35) and only half of the residents have Federal Flood Insurance (47).

2. Central Section: sixth to the thirteenth groin. Slightly more 1962 residents (45 percent of the sample) are still living in the central area of Slaughter Beach (9). Their damages in 1962 were less severe, though substantial, and the greatest damages in the 1974 flood occurred here. Most of these respondents said they have experienced a flood (10), though their definitions of a flood are fairly mixed - ranging from "water level above normal" to "major structural damage" (12). Most central residents expect water on their property at least every two to five years (24); two-thirds of them considering it probable that it will happen next year (39). All have had at least six inches of water, most considerably more, on their property (27). Everyone interviewed had experienced at least grounds damaged by bay waters (29). Yet, only half of those interviewed have taken preventive measures (35).

3. Southern Section: south of the thirteenth groin. In contrast to the north and central sections, residents of the southern part of Slaughter Beach seem to represent a "zone of concern". A majority of those interviewed have been residents since 1962 (9) and have experienced flooding (10). Their definition of a flood is consistently more conservative than the other sections; half defining it as "water level above normal" (12). The frequency of bay waters reaching their properties varies from once a year to once in ten years (24) and their damage experiences range from severe structural disturbances, with

water over three feet, to no damage at all (27 and 29). Their expectations of flooding next year vary from "highly probable" to "not likely" (39). In spite of these extremes of experience, all but one resident feels that flooding is a problem for the area (11). They have all taken some flood preventive measures (35), and two-thirds of those questioned about Federal Flood Insurance hold such insurance policies (47).

4. Conclusion. The southern Slaughter Beach residents interviewed stand out as those with the greatest concern about flooding, though they have been, geographically the least endangered by past floods. The sample of central residents shows less concern in terms of flood precautions, yet this section has experienced greater damages and more frequent flooding than southern Slaughter Beach. The present northern residents sampled express even less concern, although their part of town is known to have been devastated in 1962.

The departure of older residents who felt the brunt of the March 1962 storm is probably the cause of this inverse relationship. Newer residents, experiencing the northeaster in December 1974, may feel they have seen the flooding and damage brought by coastal storms and found it less threatening than older residents know it to be.

c. Broadkill Beach

The community of Broadkill Beach has suffered relatively minor damage from flooding in the years since 1960 with the significant exceptions of the coastal storms occurring in March 1962 and December 1974. The most severe destruction from coastal storms has been concentrated between West Virginia

Street and Florida Street and to a lesser extent in the area south of Route 16 along Bayshore Drive. The remainder of the community has been affected by floodwaters to a much lesser degree. If a "zone of concern" exists in Broadkill Beach, it would seem likely that the area most heavily damaged would exhibit the greatest awareness of hazard and subsequent protective reactions. On closer examination this simple hypothesis does not appear to hold true.

The majority of residents in the southern portion of the community and a small group in the northern portion on the bay side (east of Bayshore Drive) believe there is a coastal flood problem. In contrast, most respondents in the north and a few in the south indicate no perception of a flood hazard (11)*. It is apparent that the southern portion of the community receives water more frequently than the north. Residents interviewed north of Louisiana Street had never experienced water from Delaware Bay on their property. Residents in the blocks between West Virginia and Florida Streets consistently responded that they had experienced coastal flooding at least once every ten years (24).

Flood prevention measures have been taken by occupants of the extreme northern and southern portions of the community. A distinct contrast is presented by people in the West Virginia to Florida Street area and several others on the marsh side of Bayshore Drive who have taken no measures at all (35). Patterns of Federal Flood Insurance holdings are indistinct because only twelve residents were asked this question. "Bay side" residents (located east of Bayshore Drive) are the primary carriers of this flood insurance. Most respondents in the West Virginia to Florida Street locale indicated they did not have coverage (47).

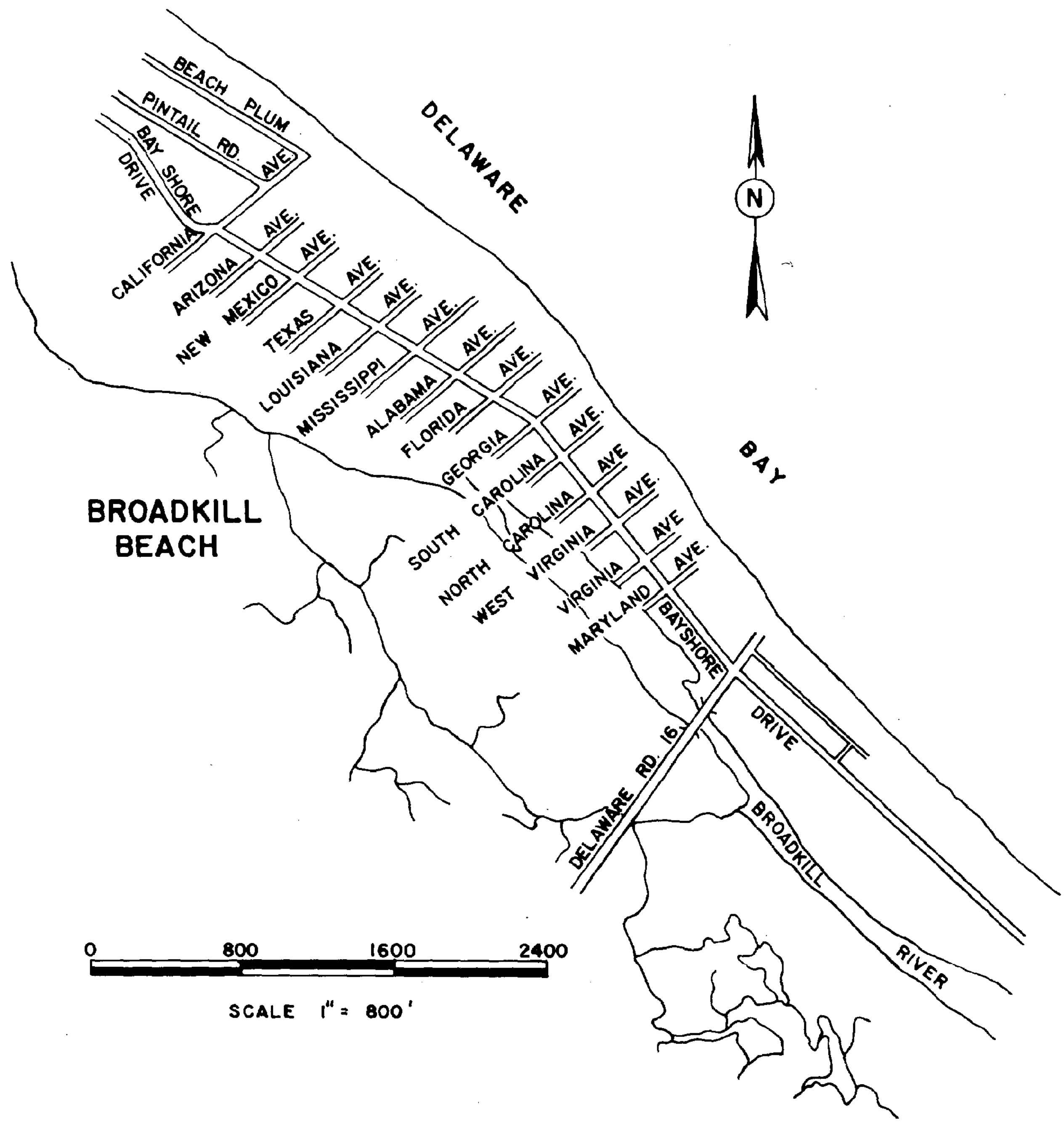
*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

From these and other questions for which SYMAP was produced, distinct patterns of attitudes emerge. It is important to note that no residents were sampled in the central portion of Broadkill Beach immediately south of the intersection of Delaware Road 16 and Bayshore Drive. Thus, this area of the community must be ignored in the following analysis, although it was a developed area prior to 1962 and is reported to have sustained flood damage.

1. West Virginia Street to Florida Street vicinity. This area corresponds very closely with the most severe damage zone represented on the 1962 flood damage map. The residents interviewed had experienced the storm conditions in 1962 (9, 10) but did not perceive flooding as an important community problem (11). This attitude is reflected by an absence of flood prevention measures and Federal Flood Insurance (35, 47). Although storm tides occur infrequently (24), this area did experience the greatest depth of floodwaters when they occurred (27) and flooding had caused the most damage (29) here. In this area, a flood is viewed as a serious event causing much damage (12), but nevertheless, it is not frequent enough to merit protective action or excessive concern.

2. Southern area. This area is located at the extreme southern end of Broadkill Beach and is bounded on the north by the older section developed prior to 1962 near the junction of Delaware Route 16 and Bayshore Drive. Although not a developed area until after the March 1962 storm (9), the southern section has since experienced significant coastal flooding (10) and damage. Floodwaters are believed to be fairly frequent (24), although the depth of flooding has been very low (27).

FIGURE 25


DELAWARE
BAY
BEACH PLUM
PINTAIL RD.
AVE.
BAY SHORE
DRIVE
CALIFORNIA
ARIZONA
NEW MEXICO
TEXAS
LOUISIANA
MISSISSIPPI
ALABAMA
FLORIDA
GEORGIA
SOUTH CAROLINA
NORTH CAROLINA
WEST VIRGINIA
VIRGINIA
MARYLAND
AVE.
BAYSHORE
DRIVE
DELAWARE RD. 16
BROADKILL RIVER
BROADKILL BEACH
N
0
800
1600
2400
SCALE 1" = 800'

Even though flood damage has been slight (29), the majority of residents believe flooding is a significant problem and have undertaken preventive measures prior to flood damage (35). Awareness of the flood hazard is more prevalent in this area than in any other portion of the community and has been demonstrated by the preventive measures taken.

3. Northern area-north of Florida Street. Reactions here are the most variable in the community. There appears to be a slight difference in flood experience between residents on the bay side and those on the marsh side (west of Bayshore Drive). Although most inhabitants had never experienced bay water on their property (27) the inhabitants on the marsh side of this area indicated previous experience with flooding (10). In spite of the fact that flooding is considered a problem primarily by bay side people (11), protective measures have been taken throughout the area (35). A lack of flood damage (29) and limited experience with flooding appears to prevent these people from being accutely aware of flood hazard without impairing their sensitivity to the possibility of flooding in the future.

4. Conclusion. Among residents of Broadkill Beach, the greatest awareness of flooding and need for protection is evident in the southern portion of the community. In this case, awareness is coupled with the frequent low floods and minor damages sustained in the area. Conversely, the residents of the area receiving the most severe damages and infrequent, deep floodwaters do not perceive a flooding problem or a need for protection. Frequency of flooding appears to be a more important variable to flood hazard awareness than the potential severity of subsequent flooding.

d. Henlopen Acres - North Shores

Most of North Shores exists on filled marsh land and is, therefore, less than ten feet above mean sea level. When dunes were breached in March 1962, the southern section of North Shores became a basin in which the ocean and rising canal waters met. The depth of floodwater reached at least five feet in some places. The northern part of North Shores was undeveloped in 1962, so that there were no reports of water depths in that section. Some of the area was covered in December 1974 when the dunes were breached at the end of Fairview Road, and enough ocean water came through to cover Duneway with a few feet of water.

Henlopen Acres has some higher elevations. Parts of this community are over ten feet above mean sea level. This includes most properties west of Zwaanendael Avenue, where the majority of residents were above the 1962 flood waters. East of Zwaanendael Avenue, however, between Tidewaters and Henlopen Avenue and further north on Tidewaters to the Yacht Basin, some residents reported from one to five feet of water in March 1962.

On the basis of this past experience, southern North Shores and the northeastern section of Henlopen Acres might be expected to be "zones of concern". With very little flooding in 1962, residents in southwestern Henlopen Acres are likely to show less concern about a flood hazard. Mixed reactions would be expected in northern North Shores where no one has experienced personal property damage, but some may realize a potential for future flooding.

Most residents interviewed in both communities said they felt that flooding is a problem for their area (11)*. The only notable exceptions

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

were in northern North Shores and along Zwaanendael Avenue in Henlopen Acres. The property owners interviewed in these areas replied that they do not consider flooding to be a problem.

Respondents along the Lewes and Rehoboth Canal in southern North Shores and northeastern Henlopen Acres expect canal waters to reach them at least once a year (24). Most other residents interviewed in these sections said that canal or ocean waters reach them about once every ten years. Everyone interviewed in northern North Shores and southwestern Henlopen Acres said they had never experienced canal or ocean water on their property.

The preventive measures taken do not seem to correlate well with the areas of most frequent flooding. Home-owners in northern North Shores, for example, said they do not consider flooding a problem and have never had seawater on their properties, yet all of these people reported taking preventive measures (35). In contrast to this, only half of the respondents in southern North Shores, where flooding caused considerable damage, said they have taken preventive measures of some kind. Residents of the most frequently flooded area in Henlopen Acres have not, in general, taken flood prevention measures. Instead less frequently flooded residents along Zwaanendael Avenue reported having taken such measures. In the southwestern section of Henlopen Acres, where most homes were above floodwaters, nearly all of the respondents had taken preventive measures.

Possession of Federal Flood Insurance shows still another distribution of responses. Fifty percent of respondents in northern North Shores and 66 percent in southern North Shores said they have Federal Flood Insurance (47).

In northeast Henlopen Acres, the respondents who have these policies are mostly the same people who did not take preventive measures, while those who did take preventive measures do not have flood insurance. Most respondents in southwestern Henlopen Acres do not have Federal Flood Insurance policies.

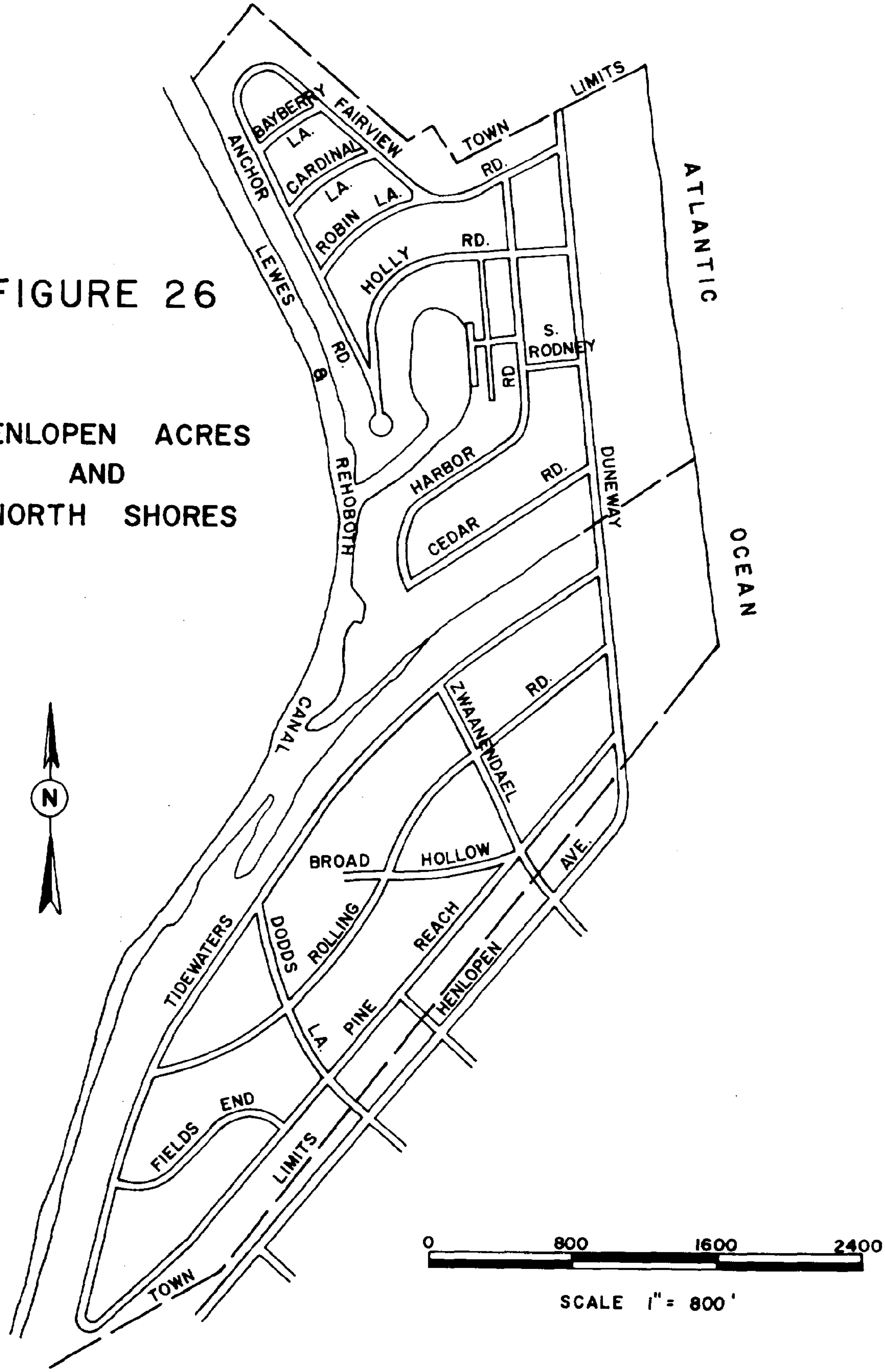
For further discussion of local reactions to the flood hazard in Henlopen Acres and North Shores, the communities will be broken into the sections used in the above discussion. Henlopen Acres will be divided into northeastern and southwestern areas. Two respondents on Tidewaters, in the northeast section will be included in the southwestern discussion because they have had no flood experience. North Shores will be broken into northern and southern sections:

1. Southwestern Henlopen Acres: west of a line drawn from Henlopen Yacht Basin to the intersection of Zwaanendael Avenue and Henlopen Avenue. Due to higher elevations, these respondents have had little flood experience (24, 29). They have taken precautions (35), but do not expect water to reach them next year (39) and have not bothered with Federal Flood Insurance (47).

2. Northeastern Henlopen Acres: east of the line described above. Most of these respondents experienced the March 1962 northeaster (9, 10) and have suffered some combination of grounds, interior, or structural damages (29). The one resident on the Lewes and Rehoboth Canal said he has water on his property at least once a year (24) and expects the same next year (39). The rest of the respondents in this area expect to have floodwaters no more than once every decade. They

FIGURE 26

HENLOPEN ACRES
AND
NORTH SHORES



do not expect this to happen next year. Despite the greater frequency, residents closest to the canal said they have not taken preventive measures (35). The respondents closest to the ocean, however, expecting seawater to reach them much less often, have all employed some kind of protective device(s). Ownership of Federal Flood Insurance, as mentioned above, is the reverse of preventive measures taken. Those who have these policies have not taken preventive measures and those who have taken measures do not have Federal Flood Insurance (47).

3. Southern North Shores: south of South Rodney Street. This area appears to have a smaller portion of long-term residents than the Henlopen Acres sections. Only 50 percent of those interviewed experienced the March 1962 storm (9, 10). Although most of the respondents said they have had water from the ocean or canal on their properties (24), only 40 percent have had as much as one foot of water or damages of any kind (27, 29). Only those with flood experience have taken preventive measures (35) and only 10 percent of the respondents felt there was a fair chance of ocean or canal water reaching them next year (39). Nevertheless, 80 percent said they consider flooding to be a problem (11), and 70 percent have Federal Flood Insurance (47).

4. Northern North Shores: north of South Rodney. This section was not developed in 1962. Most of the people interviewed here did not experience the March storm of 1962 and most have never had water on their property (24, 27). All but one said that flooding is not a problem (11) and everyone said they consider it unlikely that ocean or canal water will reach their property next year (39). In spite of this dearth of flood

experience, every respondent said his property is protected with some kind of preventive measures (35) and 50 percent said they own Federal Flood Insurance (47).

5. Conclusion. Southwestern Henlopen Acres is the only section with a very low threat of future flooding. Respondents from this area have taken preventive measures in spite of this and show more than enough concern for such a mild flood hazard.

The hazard is greater in northeastern Henlopen Acres, yet a smaller percentage of these respondents said they have taken preventive measures. The residents in the canal area were the people without protective measures, even though they said the canal floods far more frequently than the ocean. This kind of flooding may be quite harmless by contrast with ocean flooding, but the situation warrants further attention with the severe fifty and one hundred year floods in mind.

Northern and southern North Shores are also in need of attention based on the property owners' attitudes towards flooding. Only the respondents who experienced the high waters and damages of March 1962 consistently express a high degree of concern. Their community is very low in elevation and certain to receive future washovers, as it did in 1962.

e. Rehoboth Beach

Rehoboth Beach is generally situated on ground more than ten feet above mean sea level; thus destruction from even the most severe storms has been limited to the boardwalk and buildings which front on the ocean. High tides, wind-driven waves and extreme beach erosion during the "northeaster" of

March 1962 caused the destruction of the boardwalk and many commercial establishments. Minor flooding occurred in the southern portion of Rehoboth Beach as Silver Lake overflowed and sent water down King Charles Avenue. Damage from more recent storms, including that of December 1974, has been much less significant.

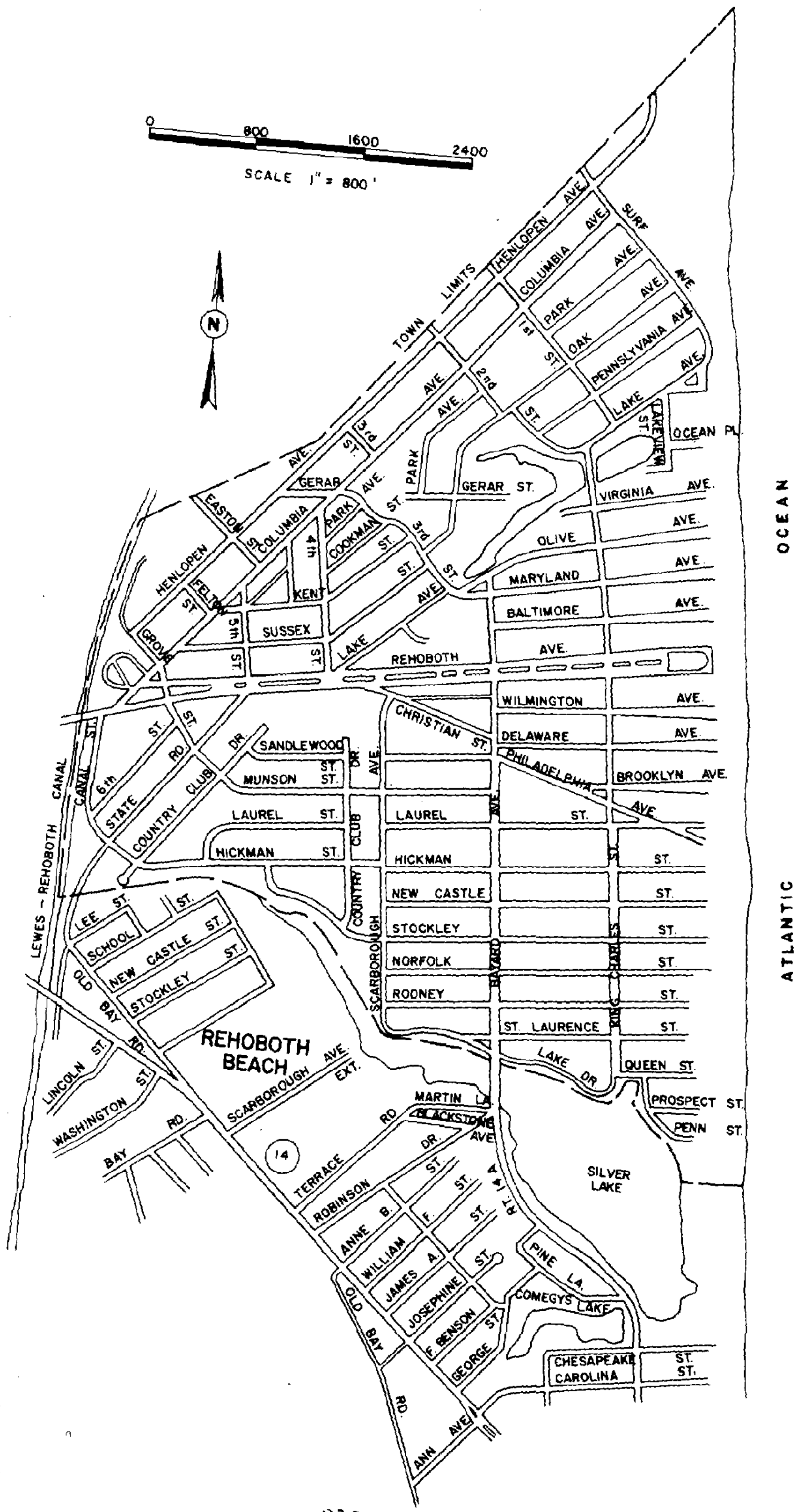
Considering only the damage maps (See Pocket Maps), one would expect the greatest degree of flood concern to be expressed by property owners along the ocean front and those in the Silver Lake-King Charles Avenue area. This hypothesized trend appears only partially true when responses to the questionnaire are examined by SYMAP computer analysis.

Perception of flooding as a concern is most prevalent north of Lake Gerar and in the vicinity of Silver Lake (11)*. Very few residents interviewed had ever experienced sea or lake water on their property. The majority of people who had experienced these conditions perceive them to recur infrequently (24). Property owners who reported sea or lake water on their property live in the vicinity of Silver Lake. Preventive measures, although uncommon in Rehoboth Beach, have been taken primarily by residents sampled on the northern shore of Silver Lake. The majority of people who had taken action did so prior to damaging floods (35). Ownership of Federal Flood Insurance is dispersed throughout the community. The largest concentration of flood insurance carriers is on the northern shore of Silver Lake (47).

Examination of responses given to the questions outlined above reveals an overall trend in Rehoboth Beach. Opinions expressed in the city appear

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

FIGURE 27


0
800
1600
2400
SCALE 1" = 800'
N
TOWN LIMITS
HENLOPEN AVE.
COLUMBIA AVE.
SURF AVE.
PARK AVE.
OAK AVE.
PENNSYLVANIA AVE.
LAKE AVE.
1st ST.
2nd ST.
3rd ST.
LAKE VIEW
OCEAN PL.
GERAR ST.
VIRGINIA AVE.
OLIVE AVE.
MARYLAND AVE.
BALTIMORE AVE.
REHOBOTH AVE.
WILMINGTON AVE.
DELAWARE AVE.
CHRISTIAN ST.
PHILADELPHIA AVE.
BROOKLYN AVE.
EASTON ST.
FELTON ST.
4th
KENT
COOKMAN ST.
SUSSEX
5th ST.
GROVE
6th ST.
STATE RD.
COUNTRY CLUB DR.
SANDLEWOOD
MUNSON ST.
LAUREL ST.
HICKMAN ST.
NEW CASTLE ST.
STOCKLEY ST.
NORFOLK ST.
RODNEY ST.
ST. LAURENCE ST.
SCARBOROUGH
BAYARD AVE.
KING CHARLES
LAKE DR.
QUEEN ST.
PROSPECT ST.
PENN ST.
MARTIN LA.
BLACKSTONE AVE.
SILVER LAKE
LEWES - REHOBOTH CANAL
CANAL ST.
LEE ST.
SCHOOL
OLD BAY RD.
LINCOLN ST.
WASHINGTON ST.
BAY RD.
REHOBOTH BEACH
SCARBOROUGH AVE. EXT.
14
TERRACE RD
ROBINSON DR.
ANNE B. ST.
WILLIAM F. ST.
JAMES A. ST.
JOSEPHINE ST.
E. BENSON
GEORGE ST.
RT. 1A
PINE LA.
COMEGYS LAKE
CHESAPEAKE ST.
CAROLINA ST.
ANN AVE.
OCEAN
ATLANTIC

to be unified with regard to perception of flood hazard. Only one distinctive attitudinal area was identified as separate from the community as a whole:

1. North shore of Silver Lake in King Charles Street vicinity. Property owners interviewed in this area experienced the "northeaster" in March 1962 (9, 10). Minimal flooding and damages were reported by these people (27, 29). They believed such events to be unlikely (24), yet many residents had taken preventive measures (35) and about one half also hold Federal Flood Insurance (47). Although these people did not report very extensive flood experience, their actions indicated a relatively high degree of concern for flood hazards.

2. Remainder of community. The majority of residents interviewed in Rehoboth Beach were present for the March 1962 storm (9), yet only one-half of them claim to have flood experience (10). In the few areas reached by ocean water, depths were reported as shallow (27) and little damage was suffered (29). Accordingly, flooding was not believed to be a problem by most property owners sampled (11). Since flooding was believed to be an unlikely occurrence (39), few people interviewed had taken preventive measures (35) or carried Federal Flood Insurance (47).

3. Conclusion. Due to the fact that ocean front property is primarily commercial in nature, very few interviews were obtained in this portion of Rehoboth Beach. Thus, SYMAP does not accurately portray the zone of severe damage suffered along the boardwalk or the attitudes held by property owners there. The opinions expressed by the rest of the community appear very consistent with their minimal flood experience.

Residents in the Silver Lake - King Charles Street area reported the greatest degree of flood experience and concern for the flood hazard.

f. Dewey Beach

The Dewey Beach area is composed of the residential communities of Sea Breeze and Rehoboth-by-the-Sea as well as Dewey Beach proper. Much of this land is less than ten feet in elevation and thus is vulnerable to coastal storm flooding. Wave action in March 1962 caused beach erosion, dune destruction and subsequent extensive flooding over much of the area. Structural damage was prevalent along the ocean front in Dewey Beach, while farther inland damage was incurred from floodwaters, primarily to the interior and the furnishings of dwellings. Rehoboth-by-the-Sea and Sea Breeze suffered only exterior property and "grounds" damage in the same storm.

If only the damage maps (see "Flood Damage") are considered, it would be expected that residents of those areas which experienced most of the severe and frequent damage would express the greatest concern for future flood hazard. However, this hypothesized trend does not appear consistent when responses to the questionnaire (Appendix I) are examined by SYMAP.

Flooding is considered a problem by the majority of respondents south of Bellevue Street. Several people between Swedes Street and New Orleans Street, west of Route 14, also perceive a flood hazard (11)*. North of Dagsworthy Street, flooding is perceived to be infrequent. Between Dagsworthy Street and Rodney Street, flood conditions recur as often as once a year. Flooding is perceived by those interviewed to be less frequent south of Rodney Street (24). Few respondents had taken flood preventive

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

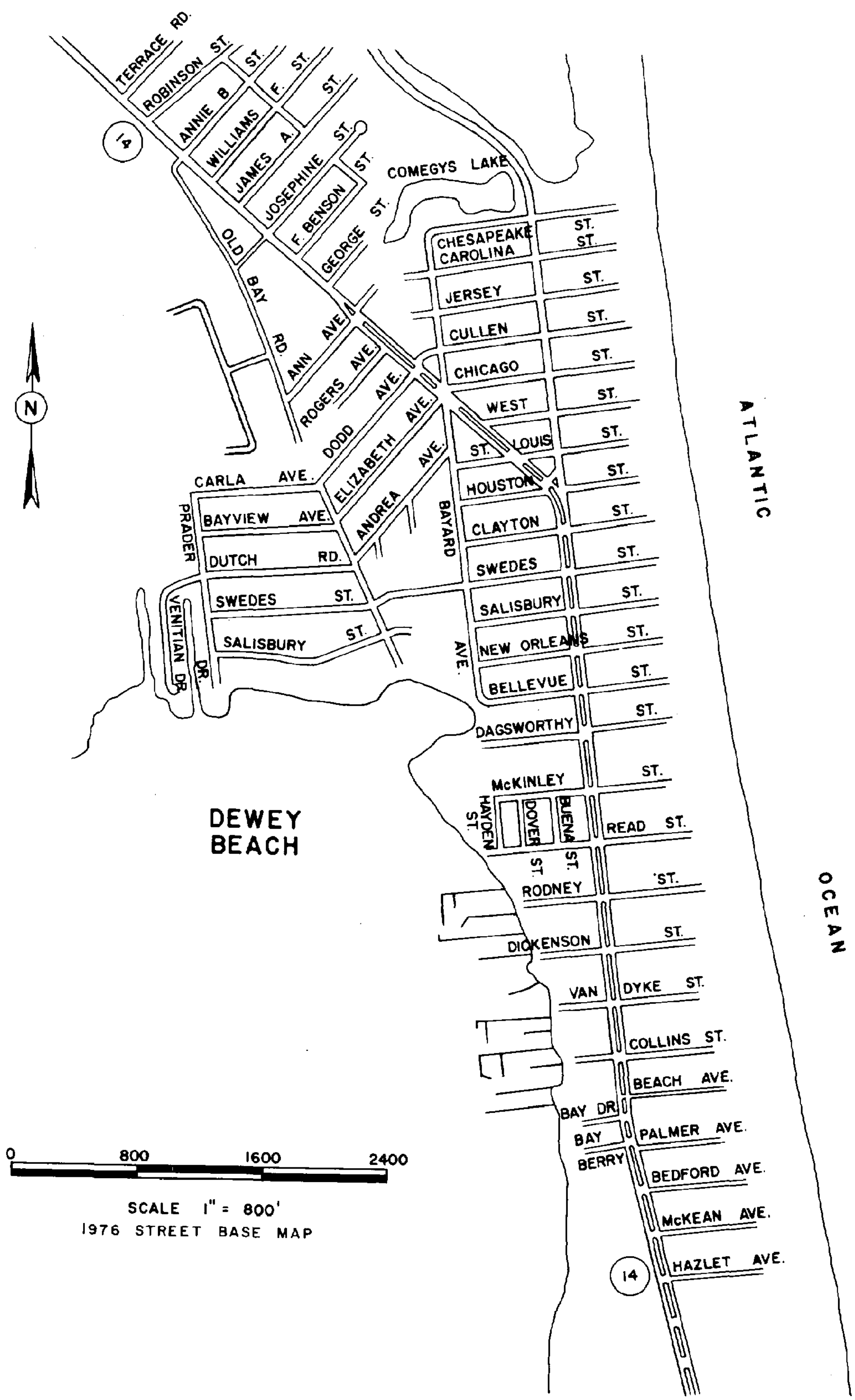
measures in Sea Breeze or south of Bellevue Street. North of Bellevue Street, on the ocean side of the community (east of Route 14), preventive measures had been taken, often before damage occurred (35). Federal Flood Insurance was held primarily by respondents on the ocean side of Dewey Beach (47).

Opinions in Dewey Beach appear varied with regard to perception of flood hazard. Several distinct attitudinal areas emerge on inspection of the SYMAP computer maps:

1. Sea Breeze: west of Dodd Street. The majority of respondents in this area experienced the flood in March 1962 (9, 10). Most property owners interviewed had never experienced sea or bay water on their land (24), or suffered flood-related damage (29). Since they consider the possibility of future flooding unlikely (39), none had taken preventive measures (35) or carried Federal Flood Insurance (47).

2. Southern: south of Bellevue Street. This is the area of most severe damage from the March 1962 storm. Many respondents in this area experienced significant flooding in that storm (9, 10). Residents interviewed perceive flooding to occur quite frequently (24). Maximum water depths reported by property owners average two to three feet and associated property damage has been quite severe (27, 29). The area's extensive flood history provides ample reason for residents' feeling that flooding is a problem (11). Even though future flooding was considered probable (39), few respondents had taken preventive measures (35) and only half of them carry Federal Flood Insurance (47).

FIGURE 28



TERRACE RD.
ROBINSON ST.
ST.
F. ST.
ST.
ANNIE B
WILLIAMS
JAMES A.
JOSEPHINE ST.
F. BENSON ST.
GEORGE ST.
COMEGYS LAKE
14
OLD BAY RD.
ANN AVE.
ROGERS AVE.
DODD AVE.
ELIZABETH AVE.
ANDREA AVE.
CHESAPEAKE ST.
CAROLINA ST.
JERSEY ST.
CULLEN ST.
CHICAGO ST.
WEST ST.
ST. LOUIS ST.
HOUSTON ST.
CLAYTON ST.
SWEDES ST.
SALISBURY ST.
NEW ORLEANS ST.
BELLEVUE ST.
DAGSWORTHY ST.
McKINLEY ST.
BAYARD AVE.
N
CARLA AVE.
BAYVIEW AVE.
PRADER
DUTCH RD.
SWEDES ST.
SALISBURY ST.
VENITIAN DR.
DR.
HAYDEN ST.
DOVER ST.
BUENA ST.
READ ST.
RODNEY ST.
DICKENSON ST.
VAN DYKE ST.
COLLINS ST.
BEACH AVE.
BAY DR.
BAY BERRY
PALMER AVE.
BEDFORD AVE.
McKEAN AVE.
HAZLET AVE.
14
DEWEY BEACH
ATLANTIC
OCEAN
0
800
1600
2400
SCALE 1" = 800'
1976 STREET BASE MAP

3. Central ocean front: east of Route 14 between Bellevue Street and Salisbury Street. These people were present for the storm in March 1962. Although sea or bay water was perceived to inundate local property infrequently (24). When flooding has occurred, moderate damage and water depths of one to two feet have occurred (29, 27). In spite of the fact that the majority of respondents did not consider flooding a local problem (11), many had taken precautionary action before flooding occurred (35). Few residents sampled carried Federal Flood Insurance (47).

4. Northern ocean front: east of Route 14 and north of Salisbury Street. The majority of these people, although present in March 1962, did not claim flood experience (9, 10). Those respondents who reported sea or bay water on their property suffered very little damage and only shallow water depths (29, 27). Water on local property is perceived to be an infrequent occurrence (24), thus flooding is not considered a problem (11). The majority of residents interviewed had taken preventive measures (35) and carried Federal Flood Insurance (47). They appear to be cautious in nature.

5. Northern bay side: west of Route 14 and north of Bellevue Street. Residents interviewed in this section reported very little flood experience. Most of these people did not experience the flood in March 1962 (9, 10). The majority of them had never suffered flood-related damage (29) or received sea or bay water on their property (24). Coastal storm flooding was considered unlikely (39) and thus was not a cause for concern (11). Since this area was perceived to be relatively immune to

flood hazard, most respondents had taken neither preventive measures (35), nor Federal Flood Insurance (47).

6. Conclusion. Attitudes held by respondents in Dewey Beach appear to be closely allied with general hypothesized trends. The outstanding exception is that of the southern area. In this locale, concern for flood hazard was voiced, yet no preventive or protective actions have been taken. This portion of Dewey Beach proved to be flood prone and severe damage will likely occur again.

g. Oak Orchard and Riverdale

Oak Orchard and Riverdale have been mapped together because of their geographic proximity on the Indian River. Their flooding histories are, nevertheless, different from one another and their residents' perceptions reflect these differences.

Average elevations in Riverdale are greater than ten feet above mean sea level while in Oak Orchard they are ten feet or less. This difference has kept most Riverdale properties above floodwaters except for the beach front. The March 1962 storm covered most of Oak Orchard with two to three feet of water while the river front experienced water depths of five feet and four foot waves. Only the beach front in Riverdale had floodwaters three to four feet deep. In both communities, these river front areas were designated as "zones of concern". The inland area of Oak Orchard might also be such a zone although flooding is less severe than along the shoreline.

Most Oak Orchard residents expressed the opinion that flooding is a problem in their area, while most Riverdale residents felt it was not (11)*.

*Numbers in parentheses refer to appropriate questions from the questionnaire, Appendix I and Appendix II.

However, people along the river front in Oak Orchard tended to think that flooding is not a problem, while those along the river in Riverdale tended to think that flooding is a problem.

The residents' perceptions of flooding frequency also follow the Riverdale-Oak Orchard distinction. Few respondents in Riverdale have ever experienced floodwaters on their properties. Everyone interviewed in Oak Orchard has (24). Only in the river area of Riverdale did respondents report high water experience. The perceptions of frequency varied without consistency. The Oak Orchard responses were not divided by river and back areas. Instead, there was a graded change in the frequency reported from "once in ten years" in the southwest to "at least one a year" in the northeast (24).

The Oak Orchard respondents showed the greatest caution with regard to flood damage. Everyone reported the employment of preventive measures (35). Most of these people, including all river front residents, took these measures before damage occurred. In Riverdale nearly all residents interviewed said they have taken preventive measures, but only 30 percent, all inland area residents, took these measures before they incurred damage.

A small number of respondents in both communities reported the possession of Federal Flood Insurance (47). In Oak Orchard, these people were concentrated in the sections reporting the most frequent flooding. Riverdale's two policy-holding respondents are central beach residents.

Although there are a few discrepancies in perception, the river front residents interviewed in Oak Orchard and Riverdale exhibit distinctions and will be discussed separately from their respective communities.

1. Oak Orchard river front.

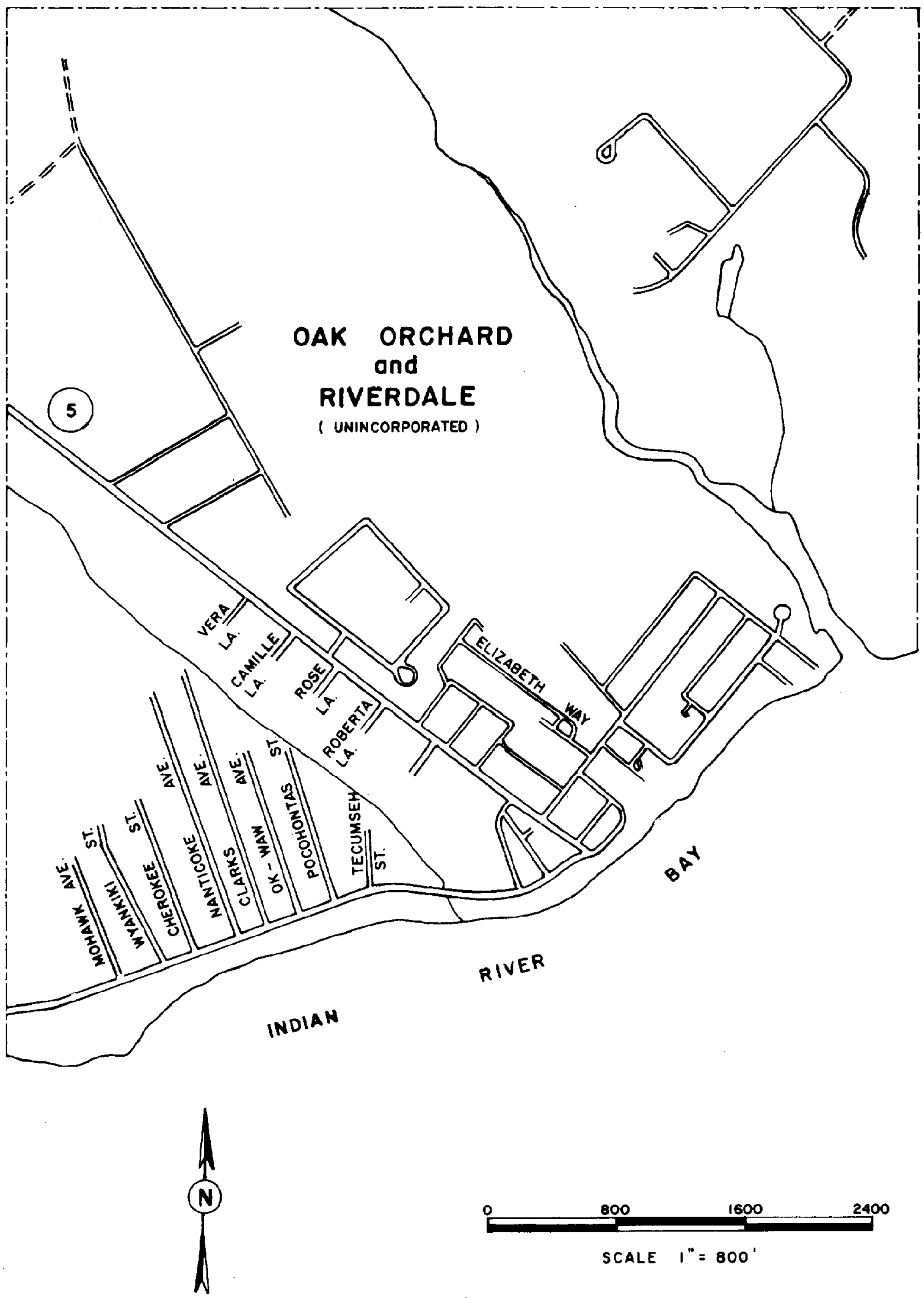
Most of these residents were here for the March 1962 storm (9). Although not all have been personally present for a flood (10), every resident has had over one foot of water on his property (27) and has experienced some flooding damage (29). The extreme eastern and western beach front respondents report the most frequent flooding and most believe they have water on their property at least once every five years (24). They define a flood as "water in the streets" or on private property (12), which all have experienced, but only half say they consider flooding to be a problem (11). All of these people have taken preventive measures before damage (35), but few have purchased Federal Flood Insurance (47) and most would express no opinion on the likelihood of flooding next year (39).

2. Oak Orchard inland area.

the residents interviewed were in Oak Orchard for the March 1962 storm (9). Most, however, say they have experienced a flood (10) and consider flooding a problem (11). Seventy-five percent have had over two feet of water (27) and some form of damage to their properties (29). Those interviewed did not report river waters reaching their properties very frequently (24) or expect this to happen next year (39). They exhibit a fairly high degree of caution in terms of preventive measures (35), and half of the respondents have Federal Flood Insurance (47).

3. Riverdale river front. Half of these respondents moved to Riverdale after the March 1962 storm (9). Just over half

FIGURE 29


OAK ORCHARD
and
RIVERDALE
(UNINCORPORATED)
5
VERA LA.
CAMILLE LA.
ROSE LA.
ROBERTA LA.
ELIZABETH WAY
MOHAWK AVE.
WYANKIKI ST.
CHEROKEE ST.
NANTICOKE AVE.
CLARKS AVE.
OK - WAW AVE.
POCOHONTAS ST.
TECUMSEH ST.
INDIAN RIVER BAY
N
0 800 1600 2400
SCALE 1" = 800'

of them have flood experience (10) and consider flooding a problem in their area (11). Although two-thirds of the respondents said they have had as much as two feet of water on their properties and report water reaching them at least once in two to five years (24, 27), the majority do not expect river waters to reach them next year (39). Damage has been sparse (29), few preventive measures have been taken (35), and only one resident has Federal Flood Insurance (47).

4. Riverdale inland area. All of these respondents were present in March 1962 (9). They reported no flooding or damage to their properties (24, 29). They do not expect river waters to reach them next year (29), but half say they consider flooding a problem (11), and all have taken preventive measures (35). Only one resident has a Federal Flood Insurance policy (47).

5. Conclusion. The river front area of Oak Orchard exhibits elements of a "zone of concern", as defined earlier, but may not actually be such an area. These property owners have clearly experienced the most severe flooding in the area and all said they have taken preventive measures before damage. Yet, only half of those interviewed said they consider flooding a problem and most expressed no opinion on the likelihood of river waters reaching their properties next year. It is possible that the residents questioned were not seriously threatened by the flooding and damage incurred in March 1962. They may have no opinion on the likelihood of flooding next year because they realize the difficulty of predicting when the right conditions will combine to cause another flood in their area. If their lack of opinion is due

to apathy, however, because they do not expect to see another flood, then this area presents a problem that must be remedied by educational programs.

h. Bethany Beach

The community of Bethany Beach has experienced extensive coastal flooding. Since 1960, at least eleven storms have hit its shores and caused severe beeach erosion, flooding, and property damage (see "Coastal Storm History"). The March storm of 1962 destroyed thirty-five homes, damaged many others, and removed 300 feet of sand from the beach.

Although the primary source of coastal flooding is the ocean, the Bethany Beach canal in north central Bethany Beach is an additional source of floodwaters. This canal links the town with Indian River Bay and permitted bay water to extend as far as four miles in-land.

In March 1962, southwestern Bethany Beach was the only major portion of town to escape inundation. In subsequent storms, the beach front blocks, east of Atlantic Avenue, have been flooded most often. Some portions of the second block east of the beach front (Atlantic to Pennsylvania Avenues) have also been flooded. These sections correspond roughly to the "A" zone on the damage map (see Pocket Map L), the region of most severe flooding history. Further inland, residents of the third block (between Pennsylvania and Delaware Avenues) and those northwest of the Delaware Avenue-Route 26 intersection received substantial flooding only in March 1962.

Considering the severity and frequency of flooding along the beach front, one would expect these property owners to express a greater degree of concern about coastal storm damage and the flooding hazard than those in western and southwestern sections of the community. One may hypothesize that the area along the Bethany Canal should also comprise a "zone of concern". The distribution of responses to the questionnaire (Appendix I), displayed by SYMAP analysis, demonstrate partial verification of this hypothesis.

Flooding is considered a problem in Bethany Beach by 75 percent of the residents interviewed (11)*. The remaining 25 percent are scattered through the community in no particular pattern. The only consistency among these respondents is that most of them were <u>not</u> in Bethany Beach for the March storm in 1962.

A distinct gradation is evident when perception of flooding frequency is examined. The percent of residents who have never had water on their property decreases greatly from west to east in the community (24). Eighty percent of those interviewed west of Delaware Avenue said they had never experienced water on their property, 62 percent in the next block east, 33 percent in the next block, and none along the beach front. Of those with high water experience, the beach block residents reported the greatest frequencies. Half of these said water reaches their property at least once a year. Most of the remainder said sea or bay water reaches them once every ten years.

Few preventive measures have been taken by any of the property owners interviewed west of Atlantic Avenue (35). Half of the residents along the canal, a strong potential flood source, have taken steps to avoid flood damage. By way of contrast, all but one beach front respondent <u>have</u> taken preventive measures.

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

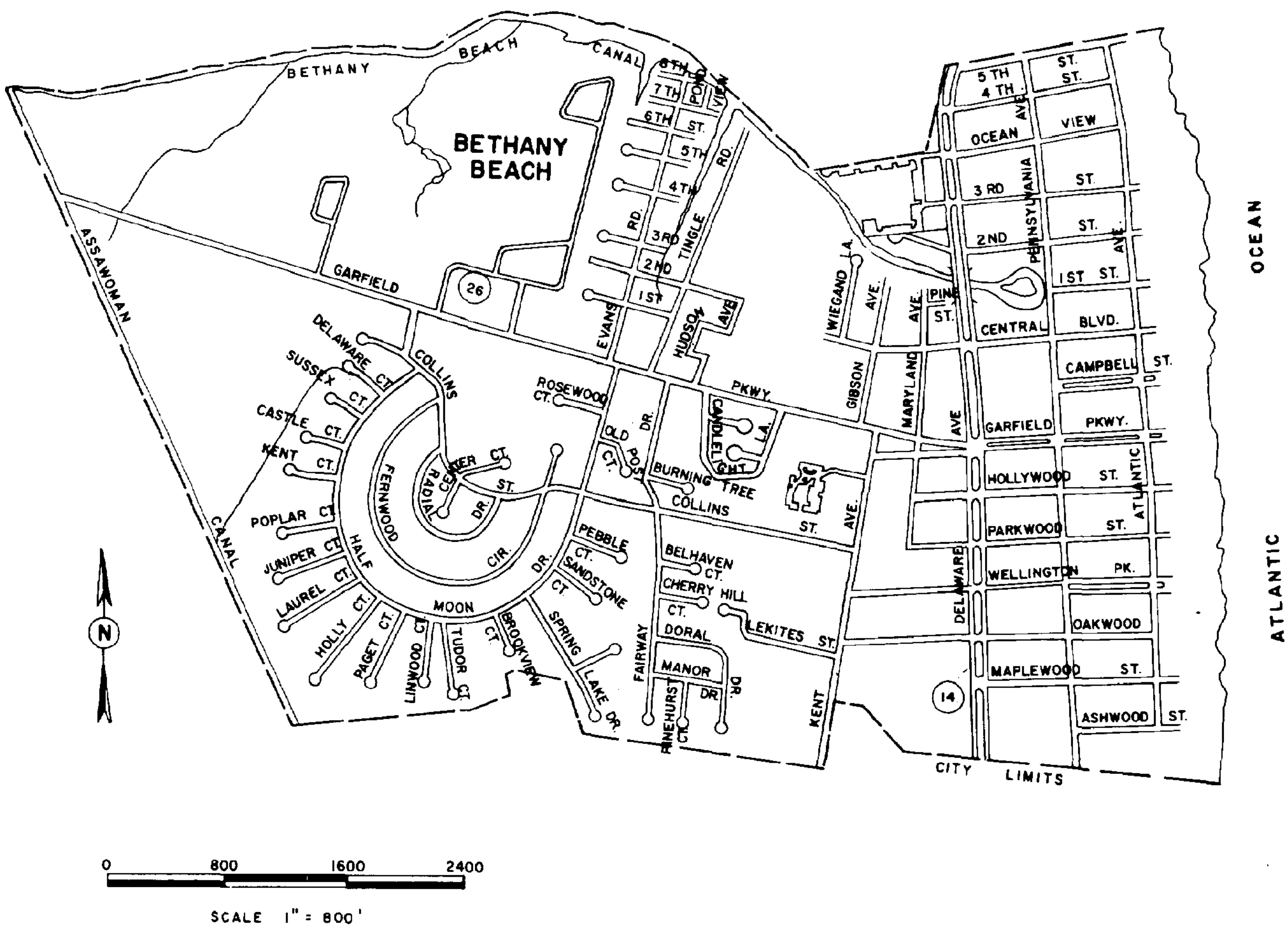
Federal Flood Insurance is owned by a much larger percentage of the residents interviewed (47). Over 50 percent of respondents east of Delaware Avenue said they have flood insurance (47). Most of the much smaller group interviewed to the west of Delaware Avenue said they did not have flood insurance.

Four general areas of similar flood experience and reaction to the flood hazard can be distinguished in the above discussion. These areas include the area west Pennsylvania Avenue, the section next to or near the Bethany Canal, the section between Pennsylvania and Atlantic Avenues; and the area east of Atlantic Avenue along the beach front:

1. West of Pennsylvania Avenue. The only time flooding has reached this section of Bethany Beach was during the March 1962 northeaster. About half of the residents interviewed were here at that time (9). Many of them said they have experienced a flood (10) and most consider flooding a problem for the area (11). Some residents to the north of Route 26 reported water levels of one to three feet or higher (27), with various types of property damage (29). However, the majority felt flooding would not occur more often than once every ten years (24) and it is not likely to happen next year (39). Seventy percent have taken no preventive measures (35) and about half have Federal Flood Insurance (47).

2. Bethany Beach Canal. Residents in this section differ from those interviewed west of Pennsylvania Avenue. Only one of the seven property owners was there in March 1962 (9), and very few said they have experienced a flood (10). Even though all say they have never personally experienced water on their grounds (24), they felt very high water

FIGURE 30


BETHANY BEACH CANAL
BETHANY BEACH
ASSAWOMAN CANAL
GARFIELD PKWY.
COLLINS ST.
HALF MOON CIR.
FERNWOOD DR.
RADIAL DR.
CENTER CT.
DELAWARE CT.
SUSSEX CT.
CASTLE CT.
KENT CT.
POPLAR CT.
JUNIPER CT.
LAUREL CT.
HOLLY CT.
PAGET CT.
LINWOOD CT.
TUDOR CT.
BROOKVIEW CT.
SPRING LAKE DR.
SANDSTONE CT.
PEBBLE CT.
ROSEWOOD CT.
OLD POST DR.
BURNING TREE
BELHAVEN CT.
CHERRY HILL CT.
DORAL
MANOR DR.
FAIRWAY
PINEHURST CT.
LEKITES ST.
KENT AVE.
EVANS RD.
TINGLE RD.
HUDSON AVE.
POND VIEW
CANDLELIGHT LA.
WIEGAND LA.
GIBSON AVE.
MARYLAND AVE.
DELAWARE AVE.
PENNSYLVANIA AVE.
ATLANTIC AVE.
PINE ST.
CENTRAL BLVD.
CAMPBELL ST.
HOLLYWOOD ST.
PARKWOOD ST.
WELLINGTON PK.
OAKWOOD
MAPLEWOOD ST.
ASHWOOD ST.
OCEAN VIEW
5TH ST.
4 TH ST.
3 RD ST.
2ND ST.
1ST ST.
6TH
7TH
8TH
26
14
N
CITY LIMITS
ATLANTIC OCEAN
0
800
1600
2400
SCALE 1" = 800'

levels are possible on their properties (one foot to over three feet (27)) and could result in various types of damage. Half consider it unlikely that sea or bay water will reach their property next year (39). The same half own Federal Flood Insurance (47) and have taken no preventive measures (35). Those that consider floodwaters probable <u>have</u> taken preventive measures.

3. <u>Between Pennsylvania and Atlantic Avenues.</u> Less than half of these respondents claimed to have been in Bethany Beach in March 1962 (9), yet 75 percent said they have had over one foot of water on their property (27) and some type of damage (29). Eighty percent do not expect floodwaters to reach their properties next year (39). Only 24 percent have taken preventive measures (35), and slightly more than 50 percent have Federal Flood Insurance (47).

4. <u>Beach front block: east of Atlantic Avenue.</u> A majority of the residents interviewed here were in Bethany Beach during the March 1962 storm (9). Nearly everyone said he considers flooding a problem (11). Most have had over three feet of water on their properties (27) and some type of property damage (29). All but one have taken preventive measures before damage (35) and over half have Federal Flood Insurance (47).

5. <u>Conclusion.</u> The beach front respondents clearly express the greatest concern about the flood hazard. Their flooding experience has been the most severe, most of them consider flooding a problem, and almost all have taken measures to prevent future damage.

Contrasted with this section of property owners are the canal area residents. While most of them did not experience the March 1962 storm, they seem to be aware of the water levels and damage that their area received. Half of them do not expect floodwaters to reach them next year and have not bothered to take preventive measures. The seven residents interviewed may have had less flood experience than their neighbors by chance of random sampling. Assuming that they are typical, however, this represents a potential problem area and should be examined further for need of preventive measures and further awareness of the possible flood hazard.

i. South Bethany Beach

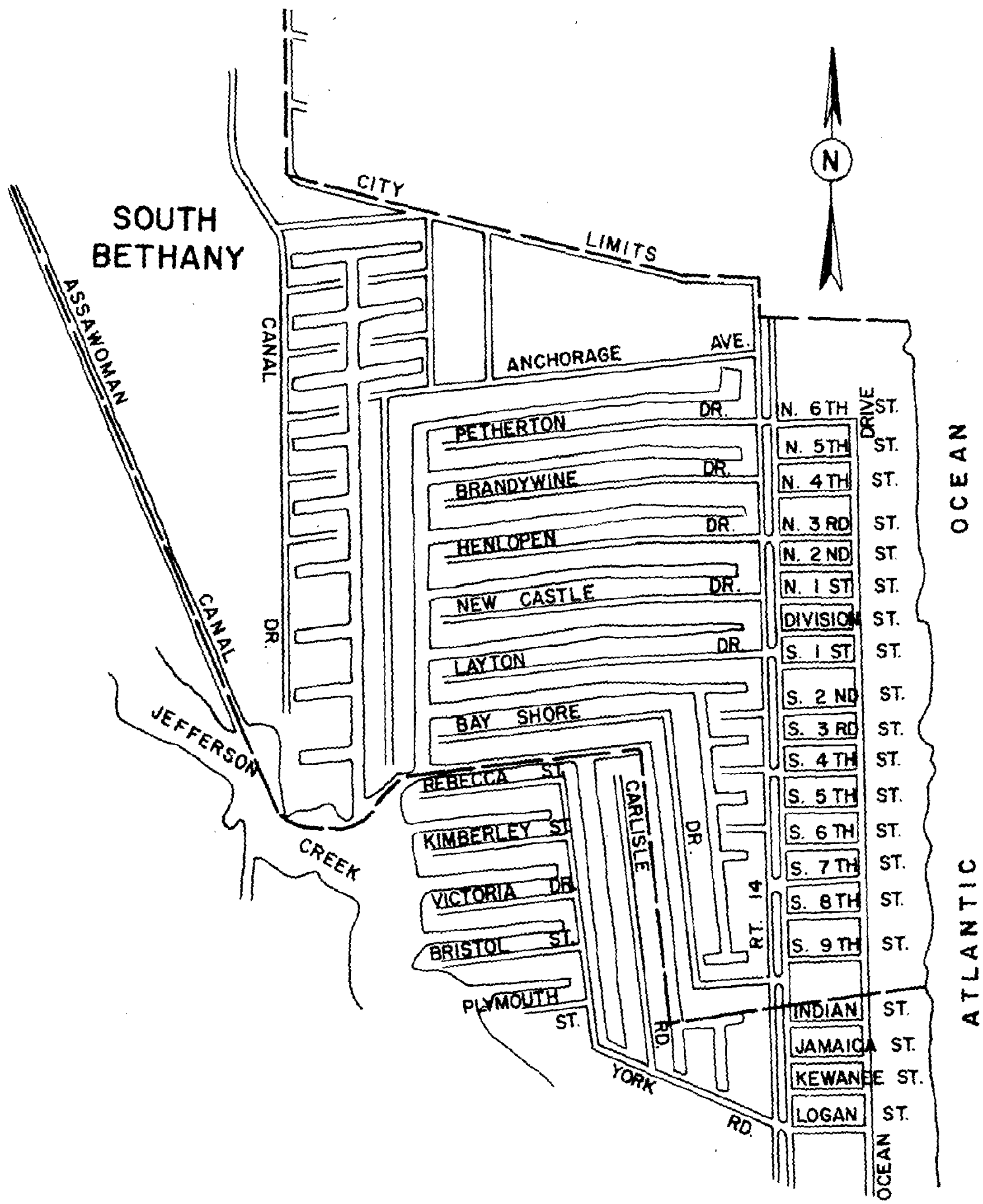
The South Bethany flood damage map suggests an approximate division along Route 14 with areas receiving structural damage located to the east or on the ocean side, and those receiving interior damage located to the west or towards the bay. Nevertheless, the actual flood experience of the community has been considerable and the entire study area would be expected to represent a "zone of concern" as defined earlier. Some gradation in intensity of perception might be expected as one proceeds away from the oceanfront. Actually, however flood experience and perception as stated by the residents is more complicated and frequently in conflict with this simple, hypothesized distinction.

Flooding is perceived as a local problem by most respondents north of Henlopen Drive and by those residents south of South Ninth Street. The majority of residents interviewed west of York Road also believe coastal flooding is a problem (11)*. The majority of respondents have never experienced sea or bay water on their property. West of Route 14, between Bristol Road and New Castle Drive, flooding was believed to occur as often

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I and Appendix II.

FIGURE 31

SOUTH BETHANY



as once a year (24). Property owners east of Route 14 and those north of New Castle Drive are most likely to have taken protective measures, often prior to damage (35). Most respondents who hold Federal Flood Insurance reside in a broad band, stretching southwest from the ocean front to the canals (47). In general, the SYMAP computer maps suggest a number of identifiable areas within the community in which attitudes and opinions differ.

1. North-central: in the Petherton Drive vicinity. The population here is composed largely of those who were present for the 1962 flood (9). They are among the residents who perceive flooding to be a problem yet admit that this realization came only after damage occurred. They also undertook preventive measures after damage had occurred (35). Although they believe floodwaters to be quite high when they occur (27), they perceive such occurrences to be unlikely (24) and do not expect such conditions with any frequency in the future (39). This may explain why most of the respondents do not bother with Federal Flood Insurance (47).

2. Northeast: between the ocean front and Route 14. This area experienced flooding during the 1974 northeaster. Their experience is reflected in their view that past floods occurred with higher frequency than the north-central area (24) and at higher levels (27). They believe they have experienced moderate levels of damage (29), and have the feeling that such conditions could recur again in the near future (39). Their greater sensitivity to flood hazards is borne out by the number who have taken preventive measures prior to the occurrence of damage (35) and who also

carry Federal Flood Insurance (47).

3. The Western bay shore area from Bristol Road to New Castle Drive. This was the third and last area to experience substantial flooding (10) and to perceive it as a problem (11). Flooding here appears to be of variable frequency (24), although at low levels (27). Yet this part of the community has no opinion on the likelihood of future flooding (39). Perhaps because of this indecision, some have taken no protective measures (35) and do not carry Federal Flood Insurance (47).

4. Central area. In this area, west of Route 14 near Bayshore Drive. This area produced the greatest inconsistencies in response. It is generally an area that has experienced flooding (10) but the respondents do not believe flooding to be a problem (11). Yet, the area reportedly experiences floodwater most frequently (24), although these waters are of the lowest levels (27). While they claim to have encountered the most damage (29), and expecting flooding in the near future to be highly probable (39), a considerable proportion of the residents have neither taken preventive measures (35) nor acquired Federal Flood Insurance (47). In general, it appears to be an area in which there is a decided awareness of the potential for a flood, yet, this is not sufficient to generate a protective reaction.

5. Southeast area: south of South Ninth Street, and east of Route 14. This is the converse of the central area. For the most part, the inhabitants of the southeast claim not to have flood experience (10), yet, they view flooding as a problem (11), and believe waters will reach their properties with great frequency (24), although at a moderate level (27).

But in contrast to the central area, this area is quite sensitive to protective measures. Thus, the inhabitants carry Federal Flood Insurance (47) and have taken preventive measures prior to damage occurring (35). From their statements alone, one would conclude that the inhabitants of this section of the community may have had less experience of flooding conditions, yet are more highly sensitive to the need for protective measures.

6. Conclusion. Since the east-central area along the waterfront (approximately in the area of Division Street) has almost no respondents, it can be generalized that a greater awareness of flooding and the need for protection occurs oceanward of Route 14. The bayward side of the community seems to have less concern and awareness of the possibilities of flood damage, with the exception of those who experienced the 1962 flood. In this latter case, awareness remains, but consequent action appears to have diminished with time. One final point which emerges is the influence on the community of the greater flood potential in the northeast section rather than the southeast. This directional effect can also be discerned in a number of the maps, such as the one indicating perceptions of the likelihood of future flooding (39). It is also suggested by the orientation of the map indicating past highest flood levels (27) and, together, they may explain a similar directional orientation to those who presently carry Federal Flood Insurance (47).

j. Fenwick Island

The town of Fenwick Island, flanked on the east by the Atlantic Ocean and on the west by Little Assawoman Bay, experiences fairly frequent storm tide flooding and beach erosion (see "Storm Chronicle")

Some coastal storm flooding has occurred in this area nearly every year since 1960. High water, encroaching from both sea and bay shores, caused widespread destruction in the "northeaster" of March 1962. Structural damage, varying from demolished houses to broken porches and steps, stretched inland from the Atlantic beaches to the bay shore in the northern sector of the community. In the area south of Farmington Street, structural damage was mainly confined to the eastern side of Route 14. The remainder of Fenwick Island suffered flooding and damage to interior furnishings and grounds in this storm. Damages from more recent storms, including that of December 1974, were much less significant; and were primarily confined to beach erosion and minor flooding.

If only the accompanying damage maps are considered (see "Flood Damage"), one would expect that property owners east of Route 14 would express greatest concern for the flood hazard and those west of Route 14 would show a lesser degree of concern. However, this hypothesized trend does not appear to hold true when responses to the questionnaire (Appendix I) are examined by SYMAP computer analysis.

Perception of flooding as a regional concern is most prevalent on the western side of Route 14 (11)*. Although several respondents east of Route 14 also think flooding is a problem, this area exhibits more uncertainty in the opinions expressed. Property to the west of Route 14 is perceived by those interviewed as more flood-prone than that east of Route 14 (24). Residents interviewed on the ocean side (east) of Route 14 claim they receive water on their property on an average of once every five years, whereas

*Numbers in parentheses refer to the appropriate question from the questionnaire, Appendix I.

almost half of the bay side residents (west of Route 14) interviewed have flooding about once a year.

The majority of inhabitants interviewed who have taken preventive measures against flood damage reside west of Route 14 along the canal system (35). The greatest percentage of these measures were taken prior to the occurrence of flood damage. East of Route 14, most property owners sampled had taken no protective action or only had done so after suffering damage. In contrast, Federal Flood Insurance is carried primarily by home owners on the ocean side of Route 14 (47). Several bay side residents interviewed consider flood insurance as an additional protective measure, especially along South Carolina Street, Bay Street, Schultz Street and Farmington Street.

In Fenwick Island, attitudinal areas do not appear to be distinct. Much overlap occurs in the opinions expressed, thus interpretations must necessarily be very generalized. Several sections have been identified which appear to have some degree of consistency. Interviews were conducted throughout the community. The total number of property owners sampled included 33 percent of the total estimated resident population in 1974; therefore, the computer maps present an accurate, yet complex, overview of the opinions held by residents.

1. <u>Southern coastal area</u> - east of Route 14 and south of Virginia Street. The ocean block from Virginia Street north to Atlantic Street also is included in this area. A large percentage of the population interviewed were present in March 1962 (9), and they are the same people who claim to have experienced flooding (10). Past water levels of over three feet (27) and widespread structural damage are indicated (29). Water inundates the land at least once every two to five years (24).

In spite of such extensive flood experience, few home owners sampled believe that coastal flooding is a significant problem (11). Their confidence is reflected in a lack of protective measures (35) or Federal Flood Insurance (47).

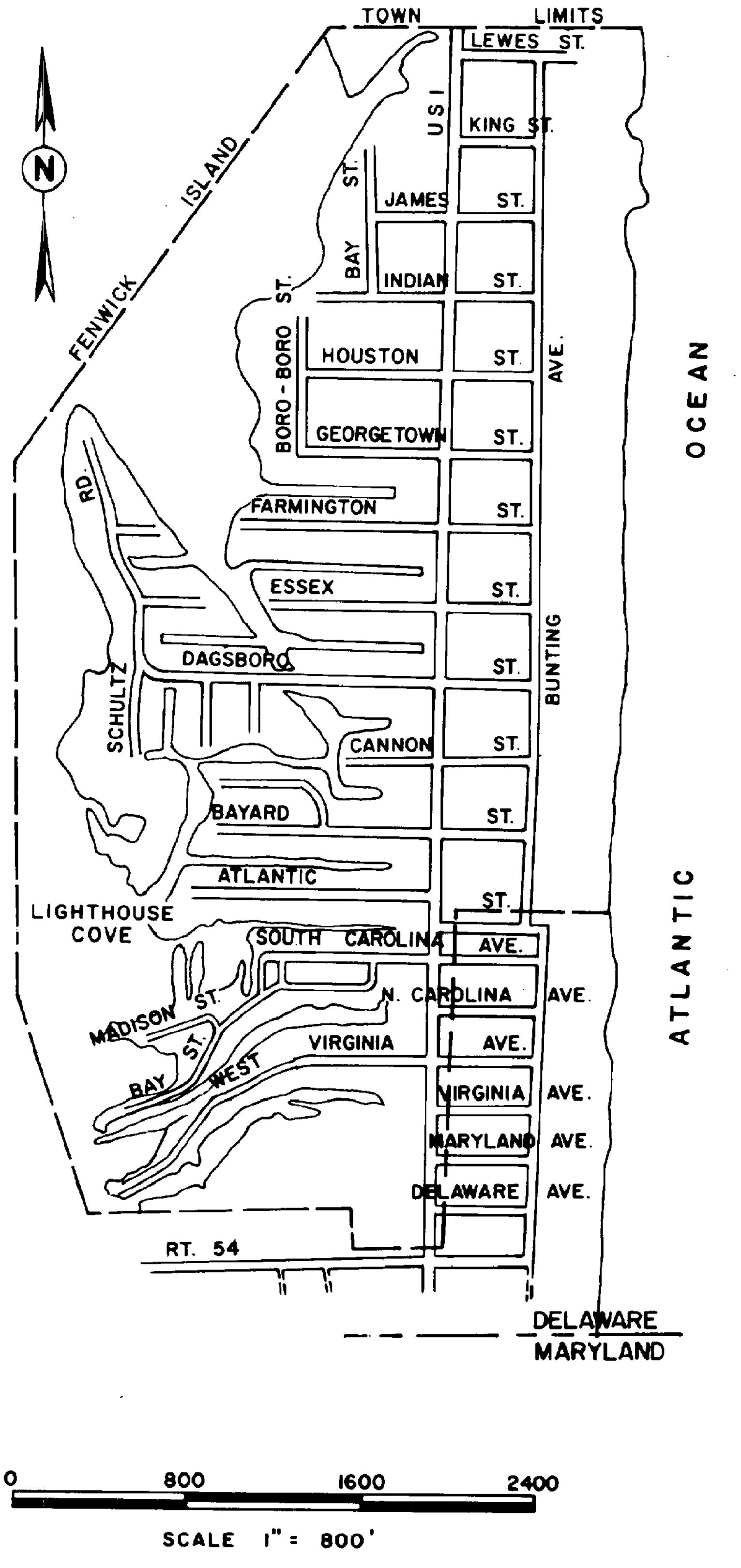
2. Northern area - east of Route 14 from Virginia Street to King Street and west of Route 14 from Indian Street north. Substantial water depths (27) and associated damages, ranging from cracked foundations to sand deposition (29), were suffered here in 1962. Few home owners interviewed personally experienced the March 1962 storm (9, 10), which may help explain their limited concern for the flooding hazard (11). Most residents have Federal Flood Insurance (47), but protective action, when taken, was primarily after these residents had experienced damage to their property (35).

3. Central bay area - west of Route 14 between Houston Street and Cannon Street. The population here composes a large portion of those who were present for the 1962 flood (9) and who have substantial flood experience. Flooding occurs frequently (24) and at moderate levels (27). The majority of residents were aware of a flood hazard prior to damage and took protective action (11, 35). However, Federal Flood Insurance was not a popular form of protection among those interviewed (47).

4. Bayard Street to South Carolina Street and west of Route 14. The inhabitants interviewed in this area claim to have flood experience (10) and believe waters reach their properties at least once a year (24). A large proportion of those interviewed do not perceive a flood problem (11), possibly because few of them were

FIGURE 32

FENWICK ISLAND



present in March 1962 (9) and had never suffered flood-related damage (29). Even though few residents admitted their community's flood potential, virtually all had taken preventive measures (35).

5. Southwest area-west of Route 14 from North Carolina Street to the State line. This area, a large portion of which comprises a trailer park, is essentially new since 1962 (9). Residents report the least flood experience of any portion of Fenwick Island (10). The majority of people interviewed have never had water on their property (24) and thus have had no flood experience. Only half of these people have taken protective action (35) and none carry Federal Flood Insurance (47).

6. Conclusion. Attitudinal regions in Fenwick Island appear inconsistent in terms of their concern for coastal flooding. Those areas which have received the most severe destruction from flooding (29) rely primarily on the Federal government for financial protection (47). Individual preventive measures (35) were employed by residents suffering less severe damage (29). There is some evidence that flooding is more likely to be perceived as a problem if the respondent was physically present for the storm of March 1962. The emotions experienced during an actual storm seem to make a greater impression on an individual than observations of damage after a storm has occurred. Frequency of flooding appears to have a more direct bearing on flood concern than does the extent of damage sustained. The bay side of Fenwick, with the exception of the southeast area, experiences the most frequent flooding and also exhibits the greatest degree of hazard concern.

The trailer park in the southwest area appears to be a danger zone for future flood damage. The people in this region have very limited flood experience and have taken few preventive measures, yet on the north side of Route 54, the land is low in elevation (less than five feet above mean sea level) and located next to the bay. Some flooding did occur here in 1962.

V. CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

The present survey of the magnitude and extent of storm damage and coastal flooding as well as of the individual and community reaction to storm hazards must be viewed in the light of Delaware's somewhat unique position in regards to coastal storm damage potential and the real flooding experience of its inhabitants. A detailed study of the storm hazard potential along the entire east coast of the United States led Mather, et al., (1967) to conclude that the Delmarva peninsula and the New Jersey coastal area had a "low" storm hazard potential based on the frequency of damaging storms from 1935 to 1964. Occasional severe storms do occur on "low" hazard coasts but relative to such areas of "high" hazard potential as Cape Cod, Massachusetts, or the outer banks of North Carolina, Delaware's coast is much less likely to experience devastation from storms.

While the loss of life from hurricanes and other coastal storms has been greatly reduced over the past few decades, largely as a result of better storm warning systems, communications, and transportation routes, property losses from such storms have greatly increased as a result of the tremendous building boom that has occurred in the coastal area. Such a trend is likely to continue at least in the near future as incomes and leisure time increase. In 90 percent of the cases, the loss of life that occurs in coastal storms is the result of drowning in the floodwaters of the storm surge.

During the period from 1960 to 1970, the population of the United States increased by about 12 percent. The population of the east coast states, of the coastal counties, of the coastal subdivisions, and finally of the beach subdivisions all increased substantially more than did the population of the

United States. Population of beach subdivisions increased by some 42 percent during the 1960-1970 period (see Figure 34).

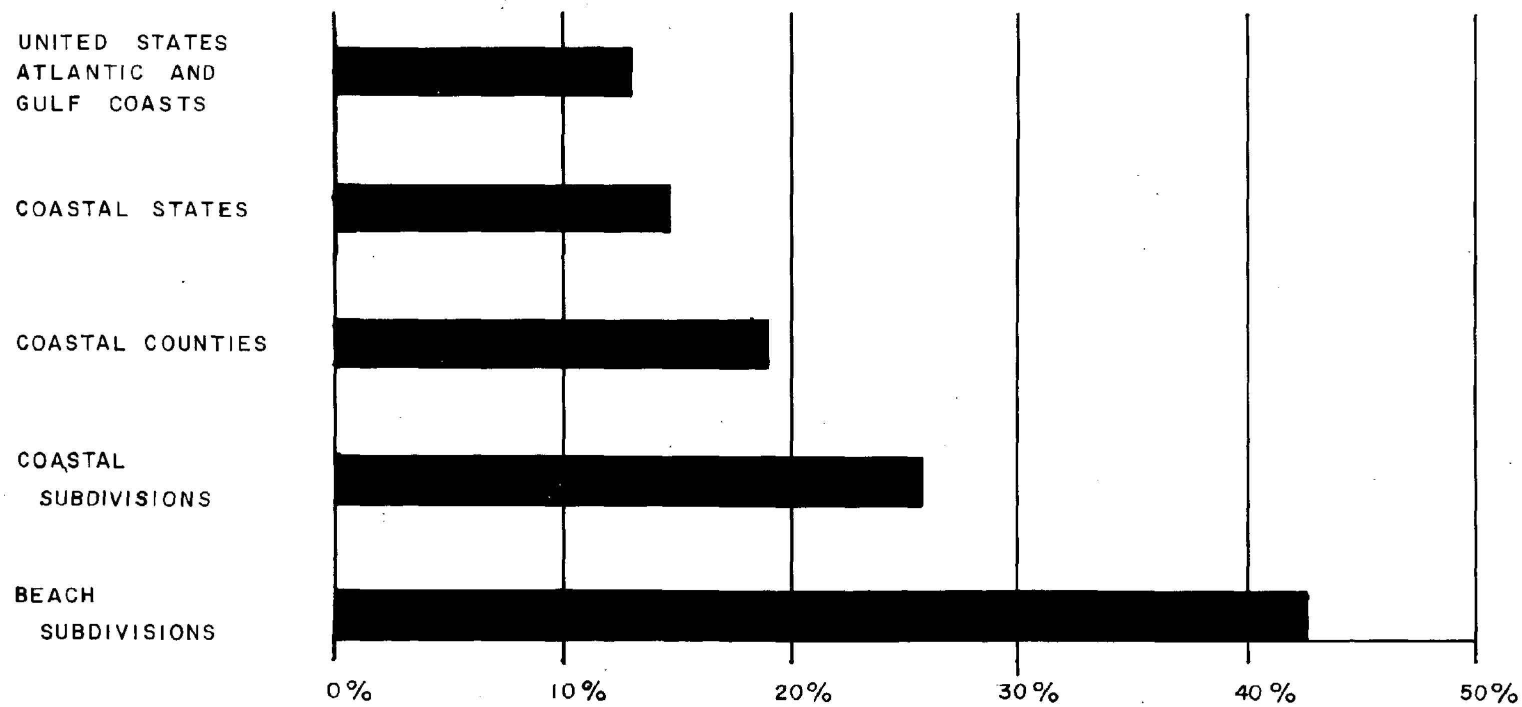
Studies of the coastal states from Maine to Texas, carried out by the National Hurricane Center in Miami, Florida, showed that almost 62 percent (nearly 21 million people) of the population in the coastal counties of these states have never experienced a moderately strong hurricane. Most individuals who go through a hurricane only experience "fringe" conditions rather than the more severe core conditions. This leads to a false sense of security and a resistance to warnings about the need for positive protective measures (see Table). In the last fifty years, the coast of Delaware has not experienced a direct hit by a hurricane; most such storms pass by offshore as they move northward. Virtually none of the present coastal dwellers of Delaware, therefore, have experienced the damage and destruction of a severe hurricane (Frank, 1974).

Kraft (1976) has described the general environmental and geologic conditions presently existing along the Delaware coast. Of interest to this project is the fact that the sea level is rising slowly relative to the land. Evidence of this continued and long-term inundation of the coast is well documented in the surface and subsurface geologic record. The natural response of the coastline is one of landward retreat. However, with human development on the "ocean floodplain", attempts have been made to halt the natural erosive forces and the retreat of the coast. All such projects and attempts are ultimately doomed to failure unless the present trend of sea level rise reverses.

Storm waves and surges punctuate the normal slow coastal erosion with periods of intensive energy, bringing major changes to the coast regardless

FIGURE 33

POPULATION CHANGE IN THE UNITED STATES BY STATES, COUNTIES, AND SUBDIVISIONS, 1960-1970



SOURCE: THE INSTITUTE OF BEHAVIORAL SCIENCE, UNIVERSITY OF COLORADO (FROM FRANK, 1974)

TABLE 9

Coastal Population With no Moderate or Severe Hurricane Experience

County Population by State (Coastal Counties)

State	1970	At Last[1] Major Hurricane	Increase	Percent to 1970 Total
Texas	2,899,895	2,362,466	537,429	18.5
Louisiana	1,385,438	1,145,440	239,998	17.3
Mississippi	239,944	167,463	72,481	30.2
Alabama	376,690	136,330	240,360	63.8
Florida	5,388,107	1,667,304	3,720,803	69.1
Georgia	281,108	-	281,108	100.0
S. Carolina	429,900	377,764	52,226	12.1
N. Carolina	414,850	380,930	33,920	8.2
Virginia	674,068	-	674,068	100.0
Maryland	1,357,393	-	1,357,393	100.0
Delaware	548,104	-	548,104	100.0
New Jersey	3,498,389	-	3,498,389	100.0
New York	9,802,763	2,984,651	6,818,112	69.6
Connecticut	1,882,926	1,071,157	811,769	43.1
Rhode Island	946,725	744,766	201,959	21.3
Massachusetts	2,862,290	1,838,913	1,023,377	35.8
New Hampshire	138,951	-	138,951	100.0
Maine	464,883	-	464,883	100.0
All	33,592,424	-	20,715,330	61.7

[1]State totals are based on individual county populations at time of last major hurricane (different years).

Coastal population which has never experienced a direct hit by a major hurricane. The 1970 population total was used when the last major hurricane was prior to 1900.

Source: Frank, 1974.

of whether man's works are present or not. Thus periodic devastation of portions of the Atlantic coast is a certainty not just a probability. Viewing the situation in a long-term (50-100 years) perspective, storms will likely have an increasingly profound effect as encroachment by the sea places the shoreline closer to the core of the communities lining the Atlantic coastline.

LIMITATIONS IN THE PRESENT STUDY

The present fifteen month study of coastal communities in Delaware has provided a significant body of new knowledge concerning damage from coastal storms and flooding as well as human reactions to flood hazards. While the study has been carried out as carefully as possible, certain limitations exist that must be pointed out in order that the results can be viewed most objectively.

A. A limited number of people from each community make up the sample for the research data. This selective group of respondents could possibly bias the image of the community if their flood experience was greatly different from the community as a whole. Although we feel that the sample used for this project is representative, similar research projects should be repeated in coastal communities every few years to act as a check on the consistency of previous results and as an assessment of changing attitudes and perceptions.

B. Gaps exist in the completed study of a whole community in those areas where there were no houses or land development in 1962. The type of damage that could have occurred in those areas cannot be reported. There is also limited information for certain areas that were developed in 1962 but were not owned by the current residents. Many of the respondents who were not present for the 1962 storm could provide little damage or water level information about their house during floods. Local officials cooperated significantly in this respect by providing a great deal of information about community flooding and damage patterns. Project workers were all agreed that the cooperation by elected officials helped to fill many of the gaps in our knowledge of flooding patterns in a community and to smooth the survey work.

C. The communities that comprise this research study represent only a portion of Delaware's coastal zone that could be devasted by coastal storms and flooding. Many of the small communities, both incorporated and unincorporated, along the ocean and bay were not included in this study of storms and flood hazards. These areas should be considered as sites for further flood research projects, so that the storm and flood hazard information for the entire Delaware coast is complete.

D. There is a general lack of adequate, large scale contour maps for many of the coastal communities. No large scale contour maps were available for the communities along Delaware Bay, and there were none for the unincorporated coastal communities included in this study. Additional contour maps, of a quality equal to the Sewer District maps, should be made available for all coastal communities within the regions of the Coastal Management Program.

E. Incomplete tide gage records and meteorological data on storm winds and wave action made the study of coastal storms and their effects on communities difficult. Detailed meteorologic data would be necessary if work on estimating the actual extent of flooding and flood levels were to be attempted particularly for non-hurricane events.

F. The chronicle of storm events prepared during the project was greatly hampered by the lack of any systematic local documentation of storm events. National Weather Service records and newspaper accounts were used, but coverage by local newspapers was incomplete and often provided only generalized information.

G. The prediction of the 100-year storm is really not possible because of the numerous meteorological and oceanographic variables that are required for such a prediction. Prediction of 100-year storm tide levels is possible but whether the 1962 storm damage was a once in 100-year event cannot be determined since damage done depends on the exact combination of wind direction, duration, angle of wave attack, fetch, air pressure, tidal condition, community development, and other conditions at the time of the storm.

FUTURE RESEARCH NEEDS

The present study has, of course, pointed up a number of areas in which significant future research is needed. Chief among these are the following:

A. In order to update and confirm the information and results of this study, similar studies should be conducted every few years to survey a different sample of residents of coastal Delaware.

B. The developed areas and communities on Delaware's coast that were not included in the present project should be the first objective for future storm and flood hazard projects. A complete study of all of Delaware's coastal communities, in regard to coastal storm hazards, should be the goal of any continuing research in this area.

C. A detailed review and evaluation of the current building codes in the different coastal communities, and their effect in providing protection for homes from storms, should be undertaken.

D. Future research should include a study of the role of canals (including those in marinas and bay shore developments) in the flooding potential of coastal communities. The flood hazards from construction of canals in these communities should be determined before permitting the construction of more canals, or the enlargement of present ones.

E. All construction projects proposed for the coastal area should be reviewed in light of beach protection and erosion forces. The potential damage that storms could cause to these structures, the cost of repair or maintenance of such structures, the value of such structures in protecting the coastal inhabitant or dwelling should all be considered in such a study. It would appear that many construction projects (such as for jetties, groins, bulkheads) are suggested without adequate (and realistic) cost-benefit projections and with no real understanding of future costs to maintain the structure in a condition to provide adequate protection to the coastal area.

RECOMMENDATIONS FOR POLICY CHANGES

Many different and often conflicting views were expressed by coastal dwellers concerning present and future programs recommended by local, State, or Federal authorities for the protection and development of the coast. A synthesis of the more significant recommendations for future coastal policies, developed from a study and evaluation of the results of the present investigation, follow:

A. One or more volunteer observers should be selected in each coastal community to document all storms and any consequent damage and/or beach erosion. This observer should be instructed to record and collect all available records of coastal flooding, storm damage, water depths, meteorologic conditions, photographs, accounts, etc., during and after all flooding events in order to begin to build an adequate coastal storm impact study for each community.

B. A State agency should be established to act as a clearinghouse for all storm information in Delaware. For example, this agency would gather and record the storm data which would be sent in by all volunteer community observers. The Delaware Geological Survey seems to have undertaken some of these functions at present. A clear designation of the responsible agency to serve as a clearinghouse should be made to avoid confusion or duplication of effort.

C. The State of Delaware should strictly enforce conservation measures such as maintaining snow fencing and dune vegetation that are so necessary to keep coastal sand dunes from being eroded or breached. This requires constant vigilance by both State and local individuals. Observing and reporting problem areas could be an important duty of the above-mentioned community observers.

D. It is especially important to maintain sand dunes at the ends of streets which run perpendicular to the beach and "dead end" at the dune line. People weaken the dunes at these spots by walking over them. Some of the first places that ocean water broke through the dune line during the March 1962 and December 1974 storms were at the ends of such streets which subsequently caused washover fans and flooding along these streets and into the communities. Therefore, it is recommended that construction and maintenance of pedestrian crossovers be encouraged. They should be carefully designed to encourage people to use them to cross the dunes in order to reduce dune deterioration.

E. In general, only natural defenses against storm damage should be built or maintained along Delaware's coast. These include improving sand dunes, planting dune vegetation, and hydraulic pumping of sand to maintain the normal size of the beach/dune system. Some jetties and groins have clearly been effective but many bulkheads and other elaborate man-made devices tend to be expensive, difficult to maintain, and although they may provide some benefit to the beach in one particular area, they may result in problems in other areas. An example is the Indian River Inlet jetties which cause accretion of sand on the south side, with subsequent erosion of beach sand on the north side.

People who live along the coast or who are familiar with the beach also tend to favor natural protection rather than man-made protection. Most of the survey respondents suggested maintaining the dune line, when asked to name protective measures which could be taken to prevent storm damage. Opinion was much more divided on whether such things as bulkheads and jetties would be of any help.

Another problem with building and maintaining protective devices, natural or man-made, is that they generally act to build-up confidence among coastal dwellers, so they believe that no storm will be able to breach whatever protective device has been built. Thus, more and more people are encouraged to build in the coastal area and when a storm finally does breach the protective device, the damage is greatly increased simply because of the concentration of inhabitants and dwellings. The <u>Beach Erosion Control and</u>

Hurricane Protection plan which is being considered for Delaware would involve building massive, reinforced bulkheads along Delaware's coast. If implemented, not only would yearly maintenance costs be prohibitively high, but the presence of such a man-made defense would tend to build a false confidence as mentioned above and the inevitable resulting damage would be disastrous.

A final recommendation concerning natural defenses against storm damage is that it is important to maintain the existing tidal marshes which act as buffer zones to absorb wave energy and to help reduce flooding via the inland bays, rivers, creeks, and canals.

F. The State of Delaware should develop regulations and building standards which only permit structures and land use options that are deemed compatable with the natural storm hazard potential of the areas. Contingency plans should also be developed which would provide for a rational rebuilding or a prohibition of new construction in some areas if another storm similar to that of March 1962 again devastates the coastal communities. These plans and building standards should be prepared for oceanfront areas as well as for places which are subject to bay, river, and/or canal flooding on an individual community basis. Each one has its own storm hazard problems which require different regulations based on considerations of location, topography, past flood history, and future flood hazard potential.

G. Trailers and mobile homes should receive special attention concerning construction and anchoring. They are more easily damaged by storms than most other residential structures, and can potentially do damage by floating off their foundations and battering other buildings. Mobile homes are not satisfactory places in which to ride out storms since their walls are easily crushed or pierced by floating debris. At the same time, trailers and mobile homes should not be moved at times of flood warnings since evacuation highways should be kept open for passenger and emergency vehicles. Thus, residents of trailer courts and mobile home parks must be carefully instructed concerning their actions and responsibilities at times of flood warnings. Special building and evacuation rules should be established.

H. All newcomers to the coastal areas who plan to buy property or to build homes should be informed of any flood hazard potential in the area as well as the past flood history of the property that he/she intends to purchase. All flood hazard zone maps and damage reports which have been drawn up for that area should be made available so that all new residents are fully informed about local flooding conditions.

I. The early warning system in use during recent hurricane Belle seemed to be quite effective. However, great care must be exercised in the handling of future emergencies for too many warnings followed by no flooding or damage can only serve to erode public confidence in the warning system and will result in less future reaction by coastal dwellers to storm warnings. Thus, State and local Civil Defense directors must be fully briefed by those who issue storm warnings, so that there is complete understanding concerning the meaning of each term such as "watch" or "warning". Civil Defense directors should have a series of contingency plans for each level of seriousness of the storm, so that they do not over react to storm warnings. Every effort should be made to improve communications between the National Weather Service personnel and local officials charged with executing evacuation plans.

J. Many coastal dwellers do not fully understand the Federal Flood Insurance Program. Many confuse it with Federal Disaster Loans at low interest rates. Therefore, part of the education program that should be made available for coastal dwellers should be to explain fully the benefits and provisions of the Federal Flood Insurance Program.

K. The State of Delaware should strictly enforce its present policy not to use State (public) funds to protect private beach front property from natural hazards such as storms, erosion or flooding. Those individuals wishing to develop and occupy the "oceanic floodplain" must be willing to accept personally the risks involved. Taxpayers throughout Delaware should not be burdened with having to support or subsidize the rebuilding of privately owned structures or the building and maintenance of protective works that will benefit only those residents choosing to live within this high risk area.

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APPENDIX I

Personal Interview Questionnaire

STATE OF DELAWARE DEPARTMENT OF PLANNING
COASTAL FLOODING PROJECT
DEPARTMENT OF GEOGRAPHY

PERSONAL INTERVIEW

SECTION I

1. Age

    1)
    2)
    3)

    Used as guide only to assure some age balance among respondents (not tabulated).

2. Sex

    1) female
    2) male

3. Do you own property in this community?

    1) yes
    2) no

4. If yes, what type? (Read)

    1) living accommodations
    2) undeveloped land
    3) business

5. What are your living accommodations within this community at present?

    1) house
    2) apartment
    3) mobile home or trailer
    4) hotel or motel
    5) camping
    6) none of the above

6. How much time do you spend in this community over a one year period?

    1) less than two weeks
    2) two weeks to a month
    3) one to three months
    4) over three months
    5) permanent resident

7. During what part of the year are you here?

    1) summer
    2) fall
    3) winter
    4) spring

8. How long have you been a resident or coming to this community?

1) over ten years
2) five to ten years
3) three to five years
4) one to two years
5) this is the first year

9. Were you here for the storm of March 1962?

1) yes
2) no
3) uncertain

SECTION III

10. Have you ever experienced a flood?

1) yes, here
2) yes, elsewhere along coast
3) yes, river or other
4) no

11. Do you think flooding is a problem in this area?

1) yes
2) no
3) no opinion

12. Which of these conditions would you consider to be a flood? (Read)

1) water level above normal but not in inhabited areas
2) standing water in the streets
3) water on your property
4) minor structural damage due to water level
5) major structural damage
6) other

13. How often does flooding occur in this community?

1) more than once a year
2) once a year
3) once every few years
4) once every five years
5) once every ten years
6) less than once in ten years
7) never
8) no idea

14. If there were a flood this year in this community, what would you expect next year? Would there be a greater or lesser risk of flood or would it make no difference?

    1) greater
    2) lesser
    3) no difference
    4) don't know

15. Where have you found out about the flooding potential of this community? (Read)

    1) neighbors, friends, family
    2) newspaper
    3) radio, television
    4) real estate agents
    5) Chamber of Commerce
    6) government
    7) personal observations
    8) volunteer groups
    9) other
    10) can't remember

16. What measures do you think can be effective in reducing damages from storms and flooding in this community? (Do not suggest possibilities)

    1) flood proofing of homes
    2) protective devices (levees, dunes)
    3) zoning
    4) early warning
    5) none
    6) no idea
    7) other

17. What measures do you think can be effective in reducing damages from storms and flooding in this community? (Read)

    1) flood proofing of homes
    2) protective devices (levees, dunes)
    3) zoning
    4) early warning
    5) none
    6) no idea
    7) other

18. Who should be responsible for providing money to rebuild a flood-damage community?

1) federal government
2) state government
3) county government
4) city government
5) individual
6) federal insurance
7) private insurance
8) other

19. Would experiencing a flood in the future in this community make you change your plans about returning in other years or living here?

1) yes
2) no
3) depends on degree of flooding

20. Blank - Never used space (no question).

SECTION III

21. What type of dwelling do you reside in?

1) single-family house: single-story
2) single family house: split-level
3) single-family house: multiple-story
4) town house
5) apartment/hotel
6) motel
7) motor home/camper
8) trailer
9) farm
10) other

22. Which of the following features apply to your dwelling? (Read)

1) raised structure but not on pilings
2) piling
3) basement
4) wood
5) concrete block
6) stone
7) brick
8) none of the above

23. Is the value of your residence in this community:

1) below $30,000
2) above $30,000

24. How frequently does sea and/or bay water reach your property?

1) more than once a year
2) one time a year
3) approximately once every two years
4) approximately once every five years
5) approximately once every ten years
6) never experienced
7) don't know

25. When was the last time that sea and/or bay water reached your property?

26. Did sea and/or bay water reach your property at any other time?

27. What is the highest level sea and/or bay water has reached? (Put answer in lesser category)

1) on property, but not up to residence
2) on the house - 6 inches
3) 6 - 12 inches
4) 1 - 2 feet
5) 2 - 3 feet
6) over three feet
7) don't know

* 28. Has any flooding that you have experienced or heard of in this community occurred during any particular season of the year?

1) winter
2) spring
3) summer
4) fall
5) none

29. What, if any, specific damages were incurred on your property or belongings during sea and/or bay flooding? (Read)

1) structural
2) interior furnishings
3) grounds
4) none

30. If structural damage was incurred, was it: (Read)

1) concentrated in specific areas
2) foundation breaking or shifting
3) exterior fixtures broken, such as porches, shutters, lamps
4) fracturing or tearing away of walls or entire structure

31. If interior furnishing damages were incurred, were they: (Read)

1) damaged or destroyed simply by the presence of standing water
2) damaged or destroyed by flowing water and/or waves
3) damaged due to the presence of mud and/or sand
4) not sure
5) damaged due to saltwater

32. If ground damages were incurred, were they: (Read)

1) due to the presence of standing water
2) due to the movement of water
3) due to the presence of sand and/or mud
4) not sure
5) damaged due to saltwater

33. To the best of your recollection, during any sea and/or bay flooding you have experienced on your property, were any of the following observable and where? (Read)

1) standing water
2) running water
3) wave action
4) don't know

* 34. What preventive measures have you taken to reduce damages?

1) boarding up of your home
2) securing the structure
3) sand bags
4) bulkheads and seawalls
5) protective dunes
6) pilings and raising structures
7) storing belongings in a safe place
8) nothing

35. If you have taken any preventive measures, were they: (Read)

1) before damage occurred
2) after damage occurred

* 36. What action would you take if a flood were forecast?

1) evacuate
2) move belongings to a safe place
3) secure belongings
4) boarding up of house
5) seek shelter
6) keep informed of warnings and precautions
7) pray
8) nothing
9) other

* 37. Have you noticed a change in the frequency of sea and/or bay water flooding in this community?

1) stayed the same
2) increased
3) decreased
4) don't know

* 38. If you have noticed a change, do you think there is a reason for it?

1) urbanization
2) channelization
3) dune destruction
4) natural causes
5) preventive measures
6) other

* 39. What do you think are the chances of sea and/or bay waters reaching your property next year? (Read)

1) not likely	(less than 30%)
2) probable	(31% - 60%)
3) highly probable	(more than 60%)
4) no opinion	

40. Have you ever sought aid after sea and/or bay flooding?

1) yes
2) no

41. If yes, from whom? If no response, suggest:

1) federal government
2) state government
3) county government
4) local government
5) family
6) friends
7) volunteer groups (specify)

42. Were you satisfied overall with the help you received from these sources:

1) completely
2) somewhat
3) not at all

* 43. Do you know anyone who has left this community due to their experiences with sea and/or bay flooding?

1) yes
2) no

* 44. Did they give a specific reason why? Explain.

* 45. Were you aware of the fact that this community did or did not have a potential for sea and/or bay flooding before you move here?

    1) yes
    2) no

* 46. If no, would it have affected your decision to move here?

    1) yes
    2) no
    3) don't know

* 47. Do you have Federal Flood Insurance?

    1) yes
    2) no
    3) don't know

APPENDIX II

Responses to Selected Questions by Community

Bowers Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	28%	72%	16%	84%	73%	10%	76%	24%	90%	10%		
Total Number	8	21	5	25	21	3	22	7	26	3	33	
3. 1)	50%*	86%	60%	80%	81%	67%	100%	0%	77%	67%	29	76%
2)	50	14	40	20	19	33	0	100	23	33		24
9. 1)	38	38	40	38	52	0	41	29	42	0	29	38
2)	62	62	60	62	48	100	59	71	58	100		62
3)	-	-	-	-	-	-	0	0	0	0		0
10. 1)	75	95	80	92	100	33	91	86	100	0	29	90
4)	25	5	20	8	0	67	9	14	0	100		10
11. 1)	100	75	100	78	90	100	81	85	84	67	28	82
2)	0	10	0	9	5	0	9	0	8	0		7
3)	0	15	0	13	5	0	9	14	8	33		11
13. 1)	25	4	40	4	14	0	9	14	11	0	29	10
3)	62	33	60	37	43	33	36	57	42	33		41
5)	0	52	0	45	38	33	45	14	38	33		38
7)	-	-	-	-	-	-	0	0	0	0		0
8)	12	9	0	12	4	33	9	14	8	33		10
16. 2)	37	52	40	50	52	66	50	43	50	33	29	48
4)	12	0	20	0	-	-	4	0	4	0		3
5)	25	14	0	20	14	0	18	14	19	0		17
6)	12	19	20	16	10	33	18	14	11	67		17
7)	-	-	-	-	-	-	0	0	0	0		0
1,2)	12	0	20	0	-	-	0	14	4	0		3
2,3)	-	-	-	-	-	-	0	0	0	0		0
2,7)	-	-	-	-	-	-	4	0	4	0		3
1,2,7)	-	-	-	-	-	-	0	0	0	0		0
17. 1)	37	9	20	17	19	0	14	29	19	0	29	17
2)	12	0	20	0	-	-	4	0	4	0		3
3)	25	4	40	4	14	0	9	14	11	0		10
4)	0	14	0	12	-	-	9	14	7	33		10
5)	0	19	0	16	19	0	18	0	15	0		14
6)	-	-	-	-	-	-	0	0	0	0		0
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,3)	-	-	-	-	-	-	0	0	0	0		0
1,4)	12	19	0	20	14	66	18	14	15	33		17
2,4)	-	-	-	-	-	-	4	14	7	0		7
3,4)	-	-	-	-	-	-	4	0	4	0		3

Bowers Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
17. (continued)												
1,2,3)	- *	- %	- %	- %	- %	- %	4%	0%	4%	0%		4%
1,3,4)	12	4	-	-	0	33	9	0	4	33		7
1,2,3,4)	-	-	-	-	-	-	0	0	0	0		0
18. 1)	12	30	20	26	25	33	29	14	24	33	28	25
2)	25	15	20	17	20	0	14	29	20	0		18
5)	50	0	60	4	10	33	14	14	12	33		14
6)	-	-	-	-	-	-	5	0	4	0		4
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,2,5)	-	-	-	-	-	-	5	0	4	0		4
1,2,6)	-	-	-	-	-	-	0	0	0	0		0
1,2,3,7)	-	-	-	-	-	-	5	0	4	0		4
1,2,3,4)	0	15	0	13	10	0	5	29	12	0		11
24. 1)	71	38	60	41	-	-	45	50	50	0	31	49
3)	14	14	20	12	-	-	9	33	15	0		13
5)	0	43	0	37	-	-	36	17	31	50		29
6)	14	4	20	8	-	-	9	0	4	50		10
7)	-	-	-	-	-	-	0	0	0	0		0
27. 1)	33	24	50	22	-	-	29	17	23	100	29	24
2)	16	9	25	8	-	-	9	17	11	0		10
3)	16	0	-	-	-	-	0	17	4	0		3
4)	0	24	0	22	-	-	24	0	19	0		21
5)	33	24	25	26	-	-	24	33	27	0		28
6)	0	19	0	17	-	-	14	17	15	0		14
7)	-	-	-	-	-	-	0	0	0	0		0
29. 1)	-	-	-	-	-	-	0	0	0	0	30	0
2)	-	-	-	-	-	-	5	0	4	0		3
3)	33	35	50	30	-	-	33	40	36	0		30
4)	-	-	-	-	-	-	5	0	0	100		7
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,3)	0	15	0	13	-	-	14	0	12	0		10
2,3)	66	30	50	35	-	-	33	60	40	0		40
1,2,3)	0	10	-	-	-	-	9	0	8	0		10
34. 2)	0	5	-	-	-	-	5	0	4	0	29	3
4)	-	-	-	-	-	-	0	0	0	0		3
6)	57	0	80	0	-	-	9	33	16	0		14
7)	0	25	0	.22	-	-	19	17	20	0		17
8)	43	65	20	68	-	-	62	50	56	100		59

Bowers Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
35. 1)	50%*	75%	50%	75%	-	-	78%	33%	67%	33%	13	61%
2)	50	25	50	25	-	-	22	67	0	0		38
36. 1)	0	33	0	30	24	0	23	33	27	0	28	25
2)	14	24	20	22	24	50	27	0	23	0		21
3)	-	-	-	-	-	-	0	0	0	0		0
6)	-	-	20	8	9	50	9	17	7	50		11
8)	57	14	60	17	28	0	18	50	27	0		25
9)	-	-	-	-	-	-	0	0	0	0		0
1,2)	0	19	0	17	-	-	18	0	11	50		14
39. 1)	29	36	40	27	-	-	25	33	21	100	27	30
2)	14	10	20	9	-	-	10	17	12	0		11
3)	57	37	40	41	-	-	45	33	46	0		41
4)	0	26	0	23	-	-	20	17	21	0		18
40. 1)	17	30	25	27	25	100	29	20	28	0	26	27
2)	83	70	75	73	75	0	71	80	72	100		73
41. 1)	0	17	0	17	0	100	17	0	14	0	7	14
6)	0	33	0	33	40	0	33	0	29	0		29
7)	0	50	0	50	40	0	33	100	43	0		43
2,5,6,7)	100	0	100	0	20	0	17	0	14	0		14
42. 1)	50	50	100	43	60	0	50	50	50	0	7	57
2)	50	33	0	43	40	0	33	50	37	0		29
3)	0	17	0	14	0	100	17	0	12	0		14
47. 1)	-	50	-	50	0	100	50	0	50	0	2	50
2)	-	50	-	50	100	0	50	0	50	0		50
3)	-	0	-	0	0	0	0	0	0	0		0

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Slaughter Beach	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
Percentage	57%	43%	36%	64%	77%	6%	83%	17%	73%	27%		
Total Number	20	15	12	21	27	2	29	6	24	9	35	
3. 1)	74%*	93%	75%	86%	92%	0%	100%	0%	83%	78%	35	83%
2)	26	7	25	14	8	100	0	100	17	22		17
9. 1)	37	36	42	33	48	0	41	17	50	0	35	37
2)	58	64	58	62	48	100	59	66	50	89		60
3)	5	0	0	5	4	0	0	17	0	11		3
10. 1)	68	78	66	75	72	50	74	67	100	0	33	73
4)	32	22	34	25	28	50	26	33	0	100		27
11. 1)	79	79	83	76	80	50	82	67	75	89	35	77
2)	21	21	17	24	20	50	18	33	25	11		23
3)	0	0	0	0	0	0	0	0	0	0		0
13. 1)	10	23	16	15	20	0	19	0	13	22	34	18
3)	47	30	50	35	33	50	39	50	43	33		42
5)	16	23	25	15	20	0	19	17	17	22		18
7)	-	-	-	-	-	-	0	0	0	0		0
8)	26	23	8	35	25	50	23	33	26	22		24
24. 1)	47	38	40	45	44	-	41	67	36	62	32	44
3)	23	23	40	15	20	-	22	33	23	25		22
5)	23	30	20	30	32	-	30	0	32	12		28
6)	0	7	-	-	4	-	4	0	4	0		3
7)	6	0	-	-	-	-	4	0	4	0		3
27. 1)	18	50	30	33	30	-	35	0	29	43	30	30
2)	12	0	-	-	-	-	4	50	9	0		7
3)	0	16	0	11	-	-	8	0	5	14		13
4)	37	0	40	11	22	-	23	0	19	29		20
5)	-	-	-	-	4	-	4	0	5	0		3
6)	25	33	20	33	34	-	27	50	33	14		27
7)	-	-	-	-	-	-	0	0	0	0		0
29. 1)	-	-	-	-	-	-	4	0	4	0	30	3
2)	-	-	-	-	-	-	4	0	4	0		3
3)	35	23	40	25	20	-	26	67	32	25		30
4)	23	23	30	20	28	-	26	0	18	38		23
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,3)	12	15	20	10	16	-	15	0	14	12		13
2,3)	17	15	10	20	16	-	15	33	18	12		17
1,2,3)	6	15	0	15	12	-	11	0	9	12		10

Slaughter Beach	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
39. 1)	33%*	46%	40%	38%	29%	-	36%	67%	33%	57%	30	37%
2)	13	23	20	17	17	-	20	0	19	14		20
3)	33	23	30	28	30	-	28	33	33	14		30
4)	20	8	10	17	13	-	16	0	14	14		13
16. 2)	84	57	83	66	72	50	78	50	71	78	33	73
4)	-	-	-	-	-	-	0	0	0	0		0
5)	10	14	16	9	12	0	7	33	17	0		12
6)	0	21	0	14	8	50	7	17	4	22		9
7)	-	-	-	-	-	-	0	0	0	0		-
1,2)	-	-	-	-	-	-	4	0	4	0		3
2,3)	-	-	-	-	-	-	0	0	0	0		-
2,7)	-	-	-	-	-	-	4	0	4	0		-
1,2,7)	-	-	-	-	-	-	0	0	0	0		3
17. 1)	42	14	50	19	36	0	30	33	29	33	33	30
2)	-	-	-	-	-	-	4	0	4	0		3
3)	-	-	-	-	-	-	0	0	0	0		-
4)	0	-	-	-	-	0	11	0	8	11		9
5)	26	21	0	14	12	0	26	0	21	22		21
6)	-	14	8	28	24	-	4	0	4	0		3
1,2)	-	-	-	-	-	-	0	0	0	0		3
1,3)	-	-	-	-	-	-	4	0	4	0		-
1,4)	-	-	-	-	-	-	0	0	0	0		-
2,4)	-	-	-	-	-	-	0	0	0	0		-
3,4)	-	-	-	-	-	-	0	0	0	0		-
1,2,3)	-	-	-	-	0	50	0	17	0	11		3
1,3,4)	16	7	16	9	0	50	11	17	17	0		12
1,2,3,4)	10	7	16	5	12	0	0	0	8	11		9
34. 2)	11	0	10	5	-	-	4	33	9	0	30	7
4)	12	0	10	5	-	-	7	0	9	0		7
6)	6	15	0	15	-	-	11	0	9	12		10
7)	-	-	-	-	-	-	0	0	0	0		47
8)	41	54	40	50	-	-	52	0	45	50		-
35. 1)	40	67	50	50	54	-	46	67	50	50	16	50
2)	60	33	50	50	46	-	54	33	50	50		50

Slaughter Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
36. 1)	29%*	58%	40%	42%	-	-	46%	0%	38%	50%	29	41%
2)	-	-	-	-	-	-	4	0	5	0		3
3)	12	8	20	5	-	-	8	33	10	12		10
6)	12	0	10	5	-	-	8	0	5	12		7
8)	0	17	0	0	48	-	8	0	10	0		14
9)	-	-	10	10	-	-	4	0	5	0		7
1,2)	18	8	0	21	-	-	11	33	19	0		3
18. 1)	11	14	8	14	16	0	11	17	8	22	33	12
2)	26	14	8	28	24	0	22	17	25	11		21
5)	16	14	25	9	16	0	18	0	17	11		15
6)	5	14	0	14	0	50	7	17	8	11		9
1,2)	26	14	33	14	16	50	18	33	21	22		21
1,2,5)	-	-	-	-	-	-	0	0	0	0		-
1,2,6)	-	-	-	-	-	-	0	0	0	0		-
1,2,3,7)	-	-	-	-	-	-	0	0	0	0		-
1,2,3,4)	-	-	-	-	-	-	0	0	0	0		-
40. 1)	19	25	10	28	26	-	24	0	24	14	30	20
2)	81	75	90	72	74	-	76	100	76	86		80
41. 1)	33	0	0	20	17	-	17	0	20	0	6	18
2)	33	67	100	40	50	-	50	0	40	100		50
7)	33	33	0	40	33	-	33	0	40	0		33
42. 1)	67	0	100	20	33	-	33	0	20	100	6	33
2)	0	0	0	0	0	-	0	0	0	0		-
3)	33	100	0	80	67	-	67	0	80	0		67
47. 1)	60	37	50	44	42	-	46	0	50	40	13	46
2)	40	50	50	44	50	-	46	0	37	60		46
3)	0	13	0	11	8	-	8	0	13	0		8

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Broadkill Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	57%	43%	20%	80%	60%	26%	87%	13%	57%	43%		
Total Number	13	13	6	24	18	8	26	4	17	13	30	
3. 1)	88%*	84%	83%	87%	94%	62%	100%	0%	88%	85%	30	87%
2)	12	16	17	13	6	38	0	100	12	15		13
9. 1)	29	25	16	30	44	0	32	0	41	8	29	28
2)	71	75	83	70	56	100	68	100	59	92		72
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	59	54	16	66	72	25	58	50	100	0	30	57
4)	41	46	84	34	28	75	42	50	0	100		43
11. 1)	58	30	50	45	50	12	54	0	53	38	30	47
2)	30	62	33	45	44	62	46	25	41	46		43
3)	12	8	16	8	5	25	0	75	6	15		10
13. 1)	29	15	16	25	28	0	27	0			30	24
3)	6	30	16	16	22	12	19	0				16
5)	41	8	33	25	28	25	27	25				27
7)	0	15	-	-	11	0	8	0				7
8)	24	30	33	25	11	62	19	75				27
16. 2)	70	39	50	58	61	37	58	50	53	61	30	57
4)	-	-	-	-	-	-	0	0	0	0		0
5)	11	23	16	16	16	25	15	25	23	7		17
6)	5	50	16	16	6	38	15	25	12	23		17
7)	-	-	-	-	-	-	4	0	6	0		3
1,2)	11	0	16	4	-	-	8	0	6	8		7
2,3)	-	-	-	-	-	-	0	0	0	0		0
2,7)	-	-	-	-	-	-	0	0	0	0		0
1,2,7)	-	-	-	-	-	-	0	0	0	0		0
17. 1)	29	15	33	20	28	25	23	25	23	23	30	23
2)	-	-	-	-	-	-	4	0	6	0		3
3)	-	-	-	-	-	-	8	0	12	0		7
4)	0	15	-	-	6	12	4	25	6	8		7
5)	-	-	0	12	11	12	8	25	6	15		10
6)	-	-	-	-	-	-	0	0	0	0		0
1,2)	6	15	0	12	11	0	11	0	18	0		10
1,3)	18	0	16	8	-	-	11	0	6	15		10
1,4)	0	15	-	-	0	25	8	0	0	15		7

Broadkill Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
17. (continued)												
2,4)	- *	-	-	-	-	-	0%	0%	0%	0%		0%
3,4)	-	-	16	0	-	-	4	0	0	7		3
1,2,3)	-	-	-	-	-	-	0	0	0	0		0
1,3,4)	-	-	-	-	11	0	8	0	12	0		7
1,2,3,4)	-	-	16	0	-	-	4	0	0	8		3
18. 1)	41	0	33	28	28	0	23	25	29	15	30	23
2)	6	15	0	12	11	12	8	25	6	15		10
5)	23	23	0	29	22	38	23	25	29	15		23
6)	-	-	-	-	-	-	4	0	6	0		3
1,2)	6	38	16	20	16	25	19	25	18	23		20
1,2,5)	-	-	-	-	-	-	0	0	0	0		0
1,2,6)	-	-	-	-	-	-	0	0	0	0		0
1,2,3,4)	-	-	-	-	-	-	0	0	0	0		0
1,2,3,7)	-	-	-	-	-	-	0	0	0	0		0
24. 1)	33	8	20	21	-	-	19	50	29	9	30	23
3)	-	-	-	-	-	-	0	0	0	0		0
5)	26	23	40	21	-	-	27	0	29	18		23
6)	26	38	40	30	-	-	31	50	18	54		33
7)	13	30	0	26	-	-	23	0	23	18		20
27. 1)	60	25	66	40	-	-	41	100	43	50	19	47
2)	20	0	0	13	-	-	12	0	14	0		10
3)	0	12	-	-	-	-	6	0	0	25		5
4)	20	12	33	13	-	-	18	0	21	0		16
5)	0	25	0	13	-	-	12	0	7	25		10
6)	-	-	-	-	-	-	0	0	0	0		0
7)	0	25	0	13	-	-	12	0	14	0		10
29. 1)	-	-	-	-	-	-	0	0	0	0	26	0
2)	0	16	0	10	-	-	9	0	7	10		8
3)	50	25	25	40	-	-	35	100	50	20		38
4)	25	58	25	45	-	-	43	0	29	60		42
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,3)	-	-	25	0	-	-	4	0	0	10		4
2,3)	-	-	-	-	-	-	4	0	7	0		4
1,2,3)	-	-	25	0	-	-	4	0	7	0		4
34. 2)	-	-	-	-	-	-	0	0	0	0	30	0
4)	-	-	-	-	-	-	0	0	0	0		0
6)	60	38	60	48	-	-	54	0	35	73		47
7)	-	-	-	-	-	-	0	0	0	0		0
8)	13	54	20	35	-	-	27	100	41	18		37

Broadkill Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
35. 1)	83%*	100%	100%	85%	83%	100%	88%	0%	80%	100%	17	88%
2)	17	0	0	14	17	0	12	0	20	0		12
36. 1)	60	33	80	40	50	42	48	50	44	54	27	48
2)	-	-	-	-	-	-	0	0	0	0		0
3)	-	-	-	-	-	-	0	0	0	0		0
6)	-	-	-	-	12	0	8	0	12	0		7
8)	0	33	0	18	6	28	16	0	12	18		15
9)	-	-	-	-	0	14	0	50	6	0		4
1,2)	13	8	0	13	6	14	12	0	6	18		11
39. 1)	53	84	80	65	58	85	69	50	59	82	23	68
2)	13	0	0	8	12	0	8	0	12	0		7
3)	20	16	20	17	23	14	15	50	18	18		18
4)	13	0	0	8	6	0	8	0	12	0		7
40. 1)	0	10	0	5	6	0	4	0	0	10	26	4
2)	100	90	100	95	94	100	96	100	100	90		96
41. 1,2)	0	100	0	100	100	0	100	0	0	100	1	100
42. 1)	0	0	0	0	0	0	0	0	0	0	1	0
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	100	0	100	100	0	100	0	0	100		100
47. 1)	17	50	33	33	22	66	33	0	14	60	12	33
2)	50	50	33	55	55	33	50	0	71	20		50
3)	33	0	33	11	22	0	17	0	14	20		17

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or was less then 10 percent, the response was omitted and indicated with a -.

North Shores and Henlopen Acres	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	67%	33%	26%	74%	74%	15%	77%	23%	43%	57%		
Total Number	26	13	10	29	29	6	30	9	16	21	39	
3. 1)	69%*	92%	20%	97%	90%	33%	100%	0%	94%	62%	39	77%
2)	31	8	80	-	10	67	0	100	6	38		23
9. 1)	42	46	10	55	59	0	57	0	69	19	39	43
2)	58	54	90	45	41	100	43	100	31	81		56
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	44	42	11	54	48	50	54	11	100	0	37	43
4)	56	58	89	46	52	50	46	89	0	100		57
11. 1)	36	54	10	54	43	50	52	11	53	29	38	42
2)	44	46	50	43	50	17	45	44	40	52		45
3)	20	0	40	-	7	33	3	44	7	19		13
16. 2)	60	54	67	56	54	100	59	50	50	60	31	58
4)	-	0	17	0	-	0	0	25	0	-		-
5)	-	-	0	-	-	0	-	0	-	-		-
6)	20	18	17	20	19	0	18	25	14	27		19
7)	0	0	0	0	0	0	0	0	0	0		0
1,2)	10	0	0	-	-	0	-	0	14	0		-
2,3)	0	0	0	0	0	0	0	0	0	0		0
2,7)	0	18	0	-	-	0	-	0	14	0		-
1,2,7)	0	0	0	0	0	0	0	0	0	0		0
17. 1)	-	0	11	0	-	0	0	11	0	-	32	-
2)	-	0	0	-	-	0	-	0	-	-		-
3)	0	0	0	0	0	0	0	0	0	0		0
4)	0	0	0	0	0	0	0	0	0	0		0
5)	0	0	0	0	0	0	0	0	0	0		0
6)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	0	0	0	0	0	0	0	0	0	0		0
1,4)	17	11	22	13	22	0	17	11	-	10		16
2,4)	0	11	0	-	-	0	-	0	0	-		-
3,4)	-	33	0	17	13	0	17	0	-	16		12
1,2,3)	-	11	11	-	0	40	0	22	0	10		-
1,3,4)	-	22	11	13	-	20	13	11	18	10		12
1,2,3,4)	26	0	33	13	13	40	13	33	27	16		19

North Shores and Henlopen Acres	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
18. 1)	35%*	46%	56%	29%	38%	50%	29%	56%	36%	33%	30	37%
2)	-	20	0	14	-	33	-	11	18	-		10
5)	-	20	0	14	14	0	14	0	-	11		10
6)	-	0	11	0	-	0	0	11	0	-		-
1,2)	20	0	0	19	14	0	19	0	18	11		13
1,2,5)	0	0	0	0	0	0	0	0	0	0		0
1,2,6)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,4)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	17	17	0	18	10	67	13	100	18	18	24	17
3)	0	0	0	0	0	0	0	0	0	0		0
5)	33	8	50	18	26	0	22	0	36	0		21
6)	42	75	50	59	58	33	61	0	45	73		58
7)	8	0	0	4	-	0	4	0	0	9		4
27. 1)	30	50	100	33	36	50	33	100	20	60	16	37
2)	0	17	0	-	-	0	7	0	0	20		6
3)	30	0	0	20	21	0	20	0	20	20		19
4)	10	0	0	-	-	0	7	0	10	0		6
5)	10	17	0	13	-	50	13	0	20	0		12
6)	20	0	0	13	14	0	13	0	20	0		12
7)	0	17	0	-	-	0	7	0	10	0		6
29. 1)	-	0	50	0	-	0	-	0	0	0	29	-
2)	12	0	0	-	-	0	-	0	14	0		-
3)	19	0	0	11	12	0	11	0	14	-		10
4)	50	85	50	67	62	67	64	100	50	85		65
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	-	-	0	-	-	0	-	0	-	-		-
2,3)	-	-	0	-	-	33	-	0	14	0		-
1,2,3)	0	0	0	0	0	0	0	0	0	0		0
34. 2)	-	0	0	-	-	0	-	0	-	0	28	-
4)	0	-	0	-	-	0	-	0	0	-		-
6)	60	23	50	42	43	33	44	0	43	50		43
7)	0	0	0	0	0	0	0	0	0	0		0
8)	27	62	50	42	39	67	41	100	36	42		43
35. 1)	89	100	100	92	92	100	93	0	87	100	14	93
2)	11	0	0	8	8	0	7	0	12	0		7

North Shores and Henlopen Acres	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
36. 1)	37%*	23%	50%	30%	37%	0%	32%	0%	29%	38%	29	31%
2)	0	0	0	0	-	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
6)	-	-	0	-	-	0	-	0	-	-		-
8)	25	38	0	33	33	0	32	0	43	15		31
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
39. 1)	87	77	100	81	87	33	86	0	71	92	29	83
2)	6	7	0	-	-	33	4	100	-	-		7
3)	0	0	0	0	0	0	0	0	0	0		0
4)	6	15	0	11	-	33	10	0	21	0		10
40. 1)	12	0	0	9	10	0	9	0	18	0	23	9
2)	87	100	100	91	89	100	91	100	82	100		91
41. 1)	100	0	0	100	100	0	100	0	100	0	1	100
2)	0	0	0	0	0	0	0	0	0	0		0
7)	0	0	0	0	0	0	0	0	0	0		0
42. 1)	50	0	0	50	50	0	50	0	50	0	2	50
2)	50	0	0	50	50	0	50	0	50	0		50
3)	0	0	0	0	0	0	0	0	0	0		0
47. 1)	69	25	50	50	43	67	52	0	50	50	28	50
2)	31	75	50	50	56	33	43	100	50	50		50
3)	0	0	0	0	0	0	0	0	0	0		0

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Rehoboth Beach (1)	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
Percentage	97%	3%	89%	11%	52%	26%	9%	91%	47%	53%		
Total Number	241	8	222	27	130	66	22	224	117	131	250	
3. 1)	8%*	50%	6%	33%	12%	1%	100%	0%	10%	9%	246	9%
2)	92	50	94	67	88	99	0	100	90	91		91
9. 1)	7	62	6	37	17	0	32	7	18	1	250	9
2)	92	38	93	63	82	100	64	92	80	99		90
3)	1	0	1	0	1	0	4	4	2	0		1
10. 1)	46	87	44	78	50	44	50	47	100	0	248	47
4)	54	13	56	22	50	56	50	53	0	100		53
11. 1)	26	50	24	48	35	18	36	25	29	25	250	27
2)	33	37	32	41	40	20	45	32	38	28		33
3)	41	13	44	11	25	62	18	43	33	47		40
16. 2)	20	62	20	30	24	16	28	21	25	19	218	22
4)	2	0	2	0	2	2	0	0	2	2		2
5)	10	0	11	4	10	13	6	10	8	13		10
6)	30	38	30	30	28	31	22	31	24	36		30
7)	15	0	14	18	15	13	11	15	16	13		14
1,2)	2	0	3	0	2	3	0	3	5	0		2
2,3)	2	0	3	0	3	2	6	2	3	2		2
2,7)	1	0	1	4	1	0	6	1	2	0		1
1,2,7)	0	0	0	0	0	0	0	0	0	0		0
17. 1)	6	25	6	12	6	6	27	4	5	7	233	6
2)	6	0	6	7	6	5	0	7	5	7		6
3)	2	0	1	4	1	3	0	2	4	0		2
4)	4	0	3	7	3	5	0	4	6	2		4
5)	1	0	1	0	2	0	0	1	1	1		1
6)	2	0	1	4	1	3	0	2	1	2		2
1,2)	9	13	9	7	9	10	0	10	7	10		9
1,3)	4	12	3	7	6	2	4	4	5	2		4
1,4)	4	12	3	11	5	2	9	4	5	3		4
2,4)	3	0	3	0	2	3	0	3	3	2		3
3,4)	5	0	5	0	6	2	0	5	6	3		5
1,2,3)	7	0	7	0	6	5	4	6	5	7		6
1,3,4)	9	13	10	4	9	10	9	10	9	10		9
1,2,3,4)	18	0	19	11	20	14	14	18	16	20		18

Rehoboth Beach (1)	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
18. 1)	20%*	25%	20%	18%	21%	20%	18%	21%	21%	21%	249	21%
2)	13	12	13	13	12	9	9	13	12	14		13
5)	4	0	4	0	4	5	9	4	3	2		4
6)	1	0	1	0	1	2	0	1	0	0		1
1,2)	11	25	13	7	12	15	9	13	12	12		12
1,2,5)	1	0	1	0	0	1	0	1	0	1		1
1,2,6)	1	0	1	0	1	0	0	1	1	1		1
1,2,3,4)	1	0	1	0	1	0	0	1	1	1		1
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	0	0	0	0	0	0	0	0	0	0	5	0
3)	0	0	0	0	0	0	0	0	0	0		0
5)	0	0	0	0	0	0	0	0	0	0		0
6)	100	100	100	100	100	0	100	0	100	100		100
7)	0	0	0	0	0	0	0	0	0	0		0
27. 1)	0	0	0	0	0	0	0	0	0	0	0	
2)	0	0	0	0	0	0	0	0	0	0		
3)	0	0	0	0	0	0	0	0	0	0		
4)	0	0	0	0	0	0	0	0	0	0		
5)	0	0	0	0	0	0	0	0	0	0		
6)	0	0	0	0	0	0	0	0	0	0		
7)	0	0	0	0	0	0	0	0	0	0		
29. 1)	0	0	0	0	0	0	0	0	0	0	4	0
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
4)	100	0	100	100	100	0	100	0	100	100		100
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	0	0	0	0	0	0	0	0	0	0		0
2,3)	0	0	0	0	0	0	0	0	0	0		0
1,2,3)	0	0	0	0	0	0	0	0	0	0		0
34. 2)	0	0	0	0	0	0	0	0	0	0	4	0
4)	0	0	0	0	0	0	0	0	0	0		0
6)	67	0	0	67	33	0	50	0	50	50		50
7)	0	0	0	0	67	0	0	0	0	0		0
8)	33	100	100	33	0	0	50	0	50	50		50
35. 1)	67	0	0	67	50	0	67	0	50	100	3	67
2)	0	0	0	33	50	0	33	0	50	0		33

Rehoboth Beach (1)	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
36. 1)	50%*	100%	0%	75%	50%	0%	60%	0%	67%	50%	5	60%
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
6)	0	0	0	0	0	0	0	0	0	0		0
8)	25	0	100	0	25	0	20	0	0	50		20
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
39. 1)	100	0	100	75	75	0	80	0	67	100	5	80
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
4)	0	100	0	25	25	0	20	0	33	0		20
40. 1)	0	0	0	0	0	0	0	0	0	0	5	0
2)	100	100	100	100	100	0	100	0	100	100		100
41. 1)	0	0	0	0	0	0	0	0	0	0	0	
2)	0	0	0	0	0	0	0	0	0	0		
7)	0	0	0	0	0	0	0	0	0	0		
42. 1)	0	0	0	0	0	0	0	0	0	0	0	
2)	0	0	0	0	0	0	0	0	0	0		
3)	0	0	0	0	0	0	0	0	0	0		
47. 1)	25	0	0	25	0	0	20	0	0	50	5	20
2)	50	100	100	50	75	0	60	0	67	50		60
3)	25	0	0	25	25	0	20	0	33	0		20

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Rehoboth Beach (2)	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	62%	38%	34%	66%	82%	5%	82%	18%	56%	44%		
Total Number	24	15	13	25	32	2	33	7	21	17	39	
3. 1)	78%*	87%	61%	39%	93%	50%	100%	0%	86%	76%	39	82%
2)	22	13	92	8	7	50	0	100	14	24		18
9. 1)	52	73	46	53	74	0	71	29	67	53	39	61
2)	48	27	68	32	25	100	14	86	33	47		39
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	61	47	61	52	58	50	58	43	100	0	38	56
4)	39	53	38	48	42	50	42	57	0	100		44
11. 1)	26	47	15	44	32	50	35	29	29	41	39	36
2)	65	53	69	56	64	0	61	57	62	59		59
3)	9	0	15	0	3	50	3	14	9	0		5
16. 2)	45	43	42	46	45	0	45	43	53	35	36	44
4)	4	0	0	4	3	0	3	0	0	6		3
5)	9	27	0	25	21	0	21	0	21	12		17
6)	9	7	17	4	10	0	7	14	11	6		8
7)	14	7	17	8	3	100	7	27	5	18		11
1,2)	0	0	0	0	0	0	0	0	0	0		0
2,3)	9	7	8	8	10	0	10	0	10	6		8
2,7)	0	0	0	0	0	0	0	0	0	0		0
1,2,7)	0	0	0	0	0	0	0	0	0	0		0
17. 1)	4	20	0	15	12	0	12	0	12	7	32	9
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	10	0	5	0	0	0	14	0	7		3
4)	4	0	8	0	4	0	4	0	6	0		3
5)	0	10	0	5	4	0	4	0	0	7		3
6)	4	0	8	0	4	0	4	0	0	7		3
1,2)	0	10	0	5	4	0	4	0	6	0		3
1,3)	9	0	8	5	8	0	4	14	6	7		6
1,4)	14	10	25	5	12	0	12	14	23	0		12
2,4)	4	0	8	0	4	0	4	0	0	7		3
3,4)	14	0	8	10	12	0	12	0	12	7		9
1,2,3)	0	0	0	0	0	0	0	0	0	0		0
1,3,4)	14	20	8	20	12	0	16	14	6	27		16
1,2,3,4)	14	0	8	10	12	0	12	0	18	0		9

Rehoboth Beach (2)	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
18. 1)	32%*	43%	25%	42%	38%	0%	41%	14%	33%	40%	36	36%
2)	27	0	33	8	17	3	10	43	9	27		17
5)	9	14	8	12	14	0	14	0	19	0		11
6)	0	0	0	0	0	0	0	0	0	0		0
1,2)	14	29	17	21	14	50	14	0	19	20		19
1,2,5)	0	0	0	0	0	0	0	0	0	0		0
1,2,6)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,4)	4	0	0	4	0	50	3	0	0	7		3
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	6	7	0	8	7	0	7	0	12	0	32	6
3)	12	7	28	4	7	0	7	100	12	7		9
5)	41	50	57	42	50	0	47	0	35	57		47
6)	29	36	14	37	32	100	33	0	35	29		31
7)	12	0	0	8	3	0	6	0	6	6		6
27. 1)	27	22	33	21	21	0	21	100	10	40	21	24
2)	9	0	17	0	5	0	5	0	0	10		5
3)	0	22	0	14	10	0	11	0	10	10		9
4)	27	11	17	21	21	0	21	0	20	20		19
5)	18	11	33	7	16	0	16	0	30	0		14
6)	18	33	0	36	26	0	26	0	30	0		26
7)	0	0	0	0	0	0	0	0	0	0		0
29. 1)	0	0	0	0	0	0	0	0	0	0	31	0
2)	12	7	0	12	11	0	10	0	6	14		10
3)	23	7	43	8	18	0	17	0	12	21		16
4)	47	50	43	50	43	100	47	100	47	50		48
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	0	0	0	0	0	0	0	0	0	0		0
2,3)	6	21	0	17	14	0	13	0	18	7		13
1,2,3)	12	14	14	12	14	0	13	0	18	7		13
34. 2)	0	0	0	0	0	0	0	0	0	0	30	0
4)	0	0	0	0	0	0	0	0	0	0		0
6)	41	31	57	30	41	0	38	0	50	21		37
7)	0	0	0	0	0	0	0	0	0	0		0
8)	59	61	43	65	56	100	57	100	50	71		60
35. 1)	100	60	100	75	80	0	80	0	83	75	11	73
2)	0	40	0	25	20	0	20	0	17	25		27

Rehoboth Beach (2)	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
36. 1)	41%*	15%	43%	26%	30%	100%	31%	0%	25%	36%	30	30%
2)	6	8	0	9	7	0	7	0	12	0		7
3)	0	0	0	0	0	0	0	0	0	0		0
6)	6	38	15	22	22	0	21	0	19	21		20
8)	6	31	14	17	15	0	14	100	12	21		17
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
39. 1)	69	64	71	65	64	100	65	100	56	79	31	64
2)	12	7	0	13	11	0	10	0	12	7		13
3)	19	14	28	13	18	0	17	0	25	7		16
4)	0	14	0	9	7	0	7	0	6	7		6
40. 1)	6	14	14	8	11	0	10	0	18	0	32	12
2)	94	86	86	92	89	100	90	100	82	100		87
41. 1)	0	100	0	100	100	0	100	0	100	0	1	100
2)	0	0	0	0	0	0	0	0	0	0		0
7)	0	0	0	0	0	0	0	0	0	0		0
42. 1)	0	0	0	0	0	0	0	0	0	0	3	0
2)	0	100	0	100	67	0	67	0	67	0		67
3)	100	0	100	0	33	0	33	0	33	0		33
47. 1)	39	21	37	29	31	100	32	0	39	21	33	33
2)	56	79	62	67	65	0	64	100	56	79		64
3)	5	0	0	4	3	0	3	0	5	0		3

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Dewey Beach Area	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	50%	50%	26%	74%	85%	4%	85%	15%	56%	44%		
Total Number	33	33	17	49	56	3	56	10	37	29	67	
3. 1)	73%*	97%	71%	90%	87%	33%	100%	0%	86%	83%	66	85%
2)	27	3	29	10	12	67	0	100	13	17		15
9. 1)	45	70	47	61	68	0	62	30	76	34	66	58
2)	54	30	53	39	32	100	37	70	24	65		42
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	39	73	29	65	62	33	57	50	100	0	66	56
4)	61	27	71	35	37	67	43	50	0	100		44
11. 1)	18	33	18	29	27	0	30	0	32	17	66	26
2)	76	64	76	67	70	67	66	90	65	76		70
3)	6	3	6	-	4	33	-	10	-	-		4
16. 2)	31	39	35	35	38	33	38	20	43	25	65	35
4)	-	-	-	-	-	0	-	0	0	11		5
5)	12	15	-	17	14	0	13	20	11	18		14
6)	22	-	29	10	13	33	13	30	-	25		15
7)	16	-	12	12	13	0	11	20	16	-		12
1,2)	0	-	0	-	-	0	-	0	-	0		-
2,3)	0	-	0	-	-	0	-	0	-	0		-
2,7)	0	-	0	-	-	0	-	0	-	0		-
1,2,7)	0	0	0	0	0	0	0	0	0	0		0
17. 1)	-	-	-	-	-	0	-	0	-	-	53	-
2)	-	0	12	0	-	0	-	11	0	-		-
3)	-	0	-	0	-	0	-	0	0	-		-
4)	10	12	12	11	11	33	11	11	11	12		11
5)	0	0	0	0	0	0	0	0	0	0		0
6)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	-	0	-	-	0	-	0	0	-		-
1,3)	-	-	0	-	-	0	-	0	-	0		-
1,4)	-	-	-	-	-	0	-	11	-	0		-
2,4)	-	-	0	-	-	0	-	0	-	-		-
3,4)	10	-	12	-	-	33	-	0	-	12		-
1,2,3)	-	-	0	-	-	0	-	11	-	-		-
1,3,4)	10	21	12	17	18	0	18	0	21	-		15
1,2,3,4)	17	0	-	11	-	0	-	33	-	12		-

Dewey Beach Area	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
18. 1)	31%*	-	37%	13%	19%	50%	13%	56%	20%	18%	62	19%
2)	19	10	-	17	13	0	15	11	-	22		14
5)	-	-	-	-	-	0	-	0	-	11		-
6)	0	-	0	-	-	0	-	0	-	-		-
1,2)	22	17	19	20	21	0	23	0	20	18		19
1,2,5)	0	0	0	0	0	0	0	0	0	0		0
1,2,6)	0	-	0	-	-	0	-	11	-	-		-
1,2,3,4)	0	-	0	-	-	0	-	0	-	-		-
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	-	0	-	0	-	0	0	50	-	0	54	2
3)	0	0	0	0	0	0	0	0	0	0		0
5)	-	14	0	12	-	0	-	0	17	0		9
6)	92	86	92	88	90	0	90	50	79	100		89
7)	0	0	0	0	0	0	0	0	0	0		0
27. 1)	100	44	100	54	67	0	50	100	58	0	12	58
2)	0	11	0	-	-	0	10	0	-	0		8
3)	0	0	0	0	0	0	0	0	0	0		0
4)	0	33	0	27	18	0	30	0	25	0		25
5)	0	11	0	-	-	0	10	0	-	0		8
6)	0	0	0	0	0	0	0	0	0	0		0
7)	0	0	0	0	0	0	0	0	0	0		0
29. 1)	-	0	0	-	-	0	-	0	0	-	56	-
2)	0	-	0	-	-	0	-	0	-	0		-
3)	-	-	0	-	-	0	-	0	-	0		-
4)	92	90	100	89	90	100	91	100	87	96		91
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	0	0	0	0	0	0	0	0	0	0		0
2,3)	0	0	0	0	0	0	0	0	0	0		0
1,2,3)	0	0	0	0	0	0	0	0	0	0		0
34. 2)	0	0	0	0	0	0	0	0	0	0	59	0
4)	0	0	0	0	0	0	0	0	0	0		0
6)	22	-	-	17	15	0	16	0	21	-		15
7)	0	0	0	0	0	0	0	0	0	0		0
8)	78	87	92	81	83	100	82	100	77	92		83
35. 1)	100	67	0	87	86	0	87	0	83	100	8	87
2)	0	33	0	12	14	0	12	0	17	0		12

Dewey Beach Area	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
36. 1)	39%*	16%	46%	21%	24%	0%	29%	0%	29%	24%	60	27%
2)	11	-	0	-	-	0	-	50	-	12		-
3)	-	-	0	-	-	0	-	0	-	0		-
6)	0	19	0	13	-	100	11	0	11	-		10
8)	14	41	-	34	32	0	30	0	31	24		28
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	-	0	-	-	0	-	0	0	-		-
39. 1)	96	94	92	95	96	100	95	100	94	96	60	95
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
4)	-	-	-	-	-	0	5	0	-	-		5
40. 1)	100	100	0	0	0	0	0	0	0	0	60	0
2)	0	0	100	100	100	100	100	100	100	100		100
41. 1)	0	0	0	0	0	0	0	0	0	0	0	0
2)	0	0	0	0	0	0	0	0	0	0		0
7)	0	0	0	0	0	0	0	0	0	0		0
42. 1)	0	0	0	0	0	0	0	0	0	0	0	0
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
47. 1)	11	16	0	17	13	0	14	0	18	-	59	13
2)	78	72	83	72	73	100	73	100	71	80		74
3)	11	12	17	11	13	0	12	0	12	12		12

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Oak Orchard	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
Percentage	46%	54%	21%	79%	87%	8%	83%	17%	62%	38%		
Total Number	11	13	5	19	21	2	20	4	15	9	24	
3. 1)	73%*	92%	40%	95%	86%	50%	100%	0%	87%	78%	24	83%
2)	27	8	60	5	14	50	0	100	13	22		17
9. 1)	54	69	20	74	67	50	65	50	80	33	24	62
2)	46	31	80	26	33	50	35	50	20	67		38
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	54	69	40	68	62	50	65	50	100	0	24	62
4)	46	31	60	32	38	50	35	50	0	100		38
11. 1)	36	58	20	56	45	50	53	25	57	33	23	48
2)	45	42	60	39	50	0	42	50	43	44		43
3)	18	0	20	6	5	50	5	25	0	22		9
16. 2)	20	39	0	37	30	50	32	25	33	25	23	30
4)	0	0	0	0	0	0	0	0	0	0		0
5)	50	23	50	32	35	0	32	50	27	50		35
6)	10	31	25	21	20	50	21	25	20	25		22
7)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
2,3)	0	0	0	0	0	0	0	0	0	0		0
2,7)	10	0	0	5	5	0	5	0	7	0		4
1,2,7)	0	0	0	0	0	0	0	0	0	0		0
17. 1)	0	17	0	9	8	0	10	0	0	14	13	8
2)	14	0	50	0	0	100	0	33	0	14		8
3)	0	0	0	0	0	0	0	0	0	0		0
4)	14	17	0	18	17	0	20	0	33	0		15
5)	14	0	0	9	8	0	10	0	0	14		8
6)	14	0	50	0	8	0	0	33	0	14		8
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,3)	29	0	0	18	17	0	20	0	33	0		15
1,4)	0	17	0	9	8	0	0	33	17	0		8
2,4)	0	0	0	0	0	0	0	0	0	0		0
3,4)	0	0	0	0	0	0	0	0	0	0		0
1,2,3)	0	0	0	0	0	0	0	0	0	0		0
1,3,4)	14	17	0	18	17	0	20	0	0	29		15
1,2,3,4)	0	0	0	0	0	0	0	0	0	0		0
18. 1)	0	31	0	21	20	0	16	25	27	0	23	17
2)	10	8	0	10	5	50	10	0	7	12		9

Oak Orchard	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
18. (continued)												
5)	10%*	15%	0%	16%	15%	0%	16%	0%	13%	12%		13%
6)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
1,2,5)	0	0	0	0	0	0	0	0	0	0		0
1,2,6)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,4)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	0	31	0	22	10	100	21	0	21	14	21	9
3)	12	15	0	17	16	0	16	0	21	0		9
5)	38	31	67	28	37	0	26	100	43	14		33
6)	50	15	33	28	32	0	32	0	14	57		29
7)	0	8	0	6	5	0	5	0	0	14		5
27. 1)	0	9	0	8	8	0	0	50	8	0	15	7
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
4)	25	18	50	15	23	0	15	50	25	0		20
5)	0	36	0	31	23	0	31	0	25	33		27
6)	50	36	0	46	38	100	46	0	33	67		40
7)	25	0	50	0	8	0	8	0	8	0		7
29. 1)	17	0	0	6	6	0	6	0	7	0	19	5
2)	0	8	0	6	6	0	6	0	0	20		5
3)	0	0	0	0	0	0	0	0	0	0		0
4)	50	31	100	29	41	0	29	100	36	40		37
1,2)	17	0	0	6	6	0	6	0	7	0		5
1,3)	0	0	0	0	0	0	0	0	0	0		0
2,3)	0	31	0	23	18	0	23	0	21	20		21
1,2,3)	17	31	0	29	23	100	29	0	29	20		26
34. 2)	0	8	0	6	6	0	6	0	7	0	18	6
4)	17	8	0	12	12	0	12	0	7	25		11
6)	67	58	50	62	56	100	69	0	57	75		61
7)	0	0	0	0	0	0	0	0	0	0		0
8)	17	18	50	12	19	0	6	100	21	0		17
35. 1)	80	60	100	64	61	100	67	0	64	75	15	67
2)	20	40	0	36	39	0	33	0	36	25		33
36. 1)	33	18	50	20	20	0	19	100	31	0	17	23
2)	0	9	0	7	7	0	6	0	8	0		6
3)	0	0	0	0	0	0	0	0	0	0		0
6)	0	18	0	13	13	0	12	0	15	0		12

Oak Orchard	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
36. (continued)												
8)	17%*	9%	0%	13%	13%	0%	12%	0%	0%	50%		12%
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	0	0	0	0	0	0	0	0	0	0		0
39. 1)	60	46	50	50	56	0	50	50	46	60	18	50
2)	20	38	50	31	25	100	31	50	31	40		33
3)	0	0	0	0	0	0	0	0	0	0		0
4)	20	15	0	13	19	0	19	0	23	0		17
40. 1)	0	8	0	6	6	0	6	0	0	20	18	6
2)	100	92	100	94	94	100	94	100	100	80		94
41. 1)	0	0	0	0	0	0	0	0	0	0	1	0
2)	0	0	0	0	0	0	0	0	0	0		0
7)	0	100	0	100	100	0	100	0	0	100		100
42. 1)	0	100	0	100	100	0	100	0	0	100	1	100
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
47. 1)	25	33	33	29	22	100	33	0	31	29	20	20
2)	62	50	33	59	61	0	50	100	46	71		60
3)	12	17	33	12	17	0	17	0	23	0		20

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Bethany Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	86%	14%	71%	29%	70%	18%	47%	53%	50%	50%		
Total Number	116	19	82	33	95	24	64	72	66	67	136	
3. 1)	39%*	95%	23%	98%	61%	8%	100%	0%	60%	34%	136	47%
2)	61	5	77	2	39	92	0	100	40	66		53
9. 1)	15	63	10	46	31	0	42	3	41	1	136	21
2)	85	37	90	54	69	100	58	97	58	98		79
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	46	79	43	67	50	48	63	38	100	0	133	50
4)	54	21	57	33	50	52	37	62	0	100		50
11. 1)	60	63	57	68	62	50	70	52	62	58	135	60
2)	22	32	22	26	24	12	25	22	28	21		24
3)	18	5	21	5	12	37	5	26	11	21		16
13. 1)	11	28	11	20	14	4	14	12			135	13
3)	25	55	21	45	40	0	49	11				29
5)	7	16	3	20	7	12	13	4				8
7)	-	-	-	-	-	-	3	1				2
8)	55	0	62	15	36	79	21	71				47
16. 2)	30	39	25	42	36	18	45	19	34	32	122	32
4)	-	-	-	-	-	-	0	0	0	0		0
5)	-	-	-	-	-	-	3	5	2	7		4
6)	26	5	31	8	15	45	10	35	19	27		23
7)	15	16	18	10	14	27	10	21	17	13		16
1,2)	-	-	-	-	-	-	8	3	3	7		6
2,3)	-	-	-	-	-	-	2	0	2	0		1
2,7)	6	11	5	10	9	0	10	3	8	5		7
1,2,7)	1	11	-	-	-	-	5	0	5	0		2
17. 1)	-	-	5	11	-	-	9	4	8	3	127	6
2)	-	-	-	-	-	-	0	0	0	0		0
3)	-	-	-	-	-	-	3	0	3	0		2
4)	-	-	-	-	-	-	2	1	2	2		2
5)	-	-	-	-	-	-	0	0	0	0		0
6)	-	-	-	-	-	-	2	1	3	0		2
1,2)	-	-	-	-	-	-	3	7	3	8		5
1,3)	-	-	-	-	-	-	7	6	7	6		6
1,4)	5	12	2	13	-	-	12	1	8	5		6
2,4)	-	-	-	-	-	-	2	0	2	0		1

Bethany Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
17. (continued)												
3,4)	- *	-	-	-	10%	4%	12%	6%	5%	13%		9%
1,2,3)	6	18	7	11	8	13	7	9	8	8		8
1,3,4)	18	25	17	22	20	22	24	16	18	11		20
1,2,3,4)	18	6	21	8	11	26	9	23	20	13		16
18. 1)	10	26	8	20	11	17	14	10	14	11	132	12
2)	14	0	13	10	13	13	11	13	9	15		12
5)	2	21	2	10	1	13	6	3	6	3		4
6)	-	-	-	-	-	-	8	0	6	1		4
1,2)	17	10	19	7	12	22	8	23	14	18		16
1,2,5)	-	-	-	-	-	-	3	1	2	3		2
1,2,6)	-	-	-	-	-	-	2	0	2	0		1
1,2,3,7)	-	-	-	-	-	-	0	0	0	0		0
1,2,3,4)	-	-	-	-	-	-	2	0	2	0		1
24. 1)	12	10	10	12	10	50	10	100	10	5	62	11
3)	4	10	-	-	5	50	6	0	10	0		7
5)	36	52	35	45	43	0	41	0	49	29		40
6)	33	16	40	20	27	0	30	0	18	52		29
7)	14	10	10	15	13	0	13	0	13	14		13
27. 1)	-	-	-	-	-	-	4	0	6	0	50	4
2)	-	-	-	-	-	-	0	0	0	0		0
3)	-	-	-	-	-	-	2	0	3	0		2
4)	18	18	0	24	18	0	18	0	15	21		18
5)	15	25	26	15	20	0	20	0	21	21		20
6)	48	44	53	45	43	100	45	100	50	36		46
7)	12	6	6	12	10	0	10	0	6	21		10
29. 1)	-	-	-	-	-	-	0	0	0	0	50	0
2)	9	12	12	10	10	0	10	0	9	7		10
3)	21	12	29	12	16	50	18	0	18	13		18
4)	24	25	6	35	25	0	24	0	24	27		24
1,2)	9	12	17	9	12	0	12	0	9	20		12
1,3)	-	-	6	10	-	-	8	0	12	0		8
2,3)	9	18	0	12	10	50	12	0	12	13		12
1,2,3)	18	12	29	9	16	0	16	0	15	20		16
34. 2)	-	-	-	-	-	-	0	0	0	0	56	0
4)	-	-	-	-	-	-	2	0	0	5		2
6)	28	5	10	20	19	0	20	0	20	20		20
7)	-	-	-	-	-	-	0	0	0	0		0
8)	42	84	52	63	57	50	58	0	51	70		57

Bethany Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
35. 1)	71%*	67%	71%	80%	68%	100%	70%	100%	72%	50%	24	71%
2)	29	33	29	20	32	0	30	0	28	50		29
36. 1)	35	33	50	30	34	50	36	0	19	67	59	36
2)	-	-	-	-	-	-	3	0	6	0		3
3)	-	-	-	-	-	-	0	0	0	0		0
6)	2	11	-	-	-	-	5	0	3	9		5
8)	-	-	-	-	-	-	5	0	6	5		5
9)	-	-	-	-	-	-	0	0	0	0		0
1,2)	15	11	15	13	14	0	14	0	19	0		14
39. 1)	50	60	53	54	54	0	54	0	42	76	56	54
2)	17	13	21	11	15	50	16	0	18	14		16
3)	15	0	10	11	10	50	11	0	15	0		11
4)	17	27	16	23	21	0	20	0	24	9		20
40. 1)	12	26	17	18	17	0	15	100	14	25	53	17
2)	88	74	83	82	83	100	85	0	86	75		83
41. 1)	50	100	100	67	75	-	71	100	50	100	8	75
2)	25	0	0	16	12	-	14	0	25	0		12
7)	25	0	0	16	12	-	14	0	25	0		12
42. 1)	50	60	33	67	55	-	50	100	60	50	8	56
2)	25	20	33	16	22	-	25	0	40	0		22
3)	25	20	33	16	22	-	25	0	0	50		22
47. 1)	56	57	68	52	59	0	57	100	58	57	61	57
2)	31	42	16	42	32	100	35	0	34	33		34
3)	12	0	16	5	9	0	8	0	8	9		8

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

South Bethany Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	94%	6%	56%	44%	62%	28%	56%	44%	48%	52%		
Total Number	60	4	36	28	40	18	36	28	31	33	64	
3. 1)	57%*	50%	33%	86%	72%	16%	100%	0%	58%	54%	64	56%
2)	43	50	67	14	28	84	0	100	42	46		44
9. 1)	10	50	6	21	20	0	19	4	23	3	64	13
2)	90	50	94	79	80	100	81	96	77	97		87
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	45	100	42	57	45	44	50	46	100	0	64	48
4)	55	0	58	43	55	56	50	54	0	100		52
11. 1)	38	100	33	54	47	27	44	39	52	33	64	42
2)	40	0	33	42	42	22	50	21	26	48		38
3)	21	0	33	4	10	50	6	39	22	18		20
13. 1)	16	0	16	14	20	0	22	7	19	12	64	16
3)	22	25	11	35	35	0	31	11	19	24		22
5)	10	25	5	18	12	5	17	4	13	9		11
7)	-	-	11	4	2	16	6	11	3	12		8
8)	43	50	55	28	30	79	25	68	45	42		44
16. 2)	35	33	41	26	30	41	34	36	38	32	60	35
4)	-	-	-	-	-	-	3	0	4	0		2
5)	10	33	12	11	13	12	9	14	10	13		12
6)	14	0	20	4	8	29	3	25	14	13		13
7)	-	-	-	-	0	11	3	11	7	6		7
1,2)	-	-	-	-	-	-	3	4	4	3		3
2,3)	12	0	3	23	18	0	22	0	7	16		12
2,7)	3	33	0	11	-	-	9	0	7	3		5
1,2,7)	-	-	-	-	-	-	0	0	0	0		0
17. 1)	19	0	15	20	22	12	23	12	17	18	57	17
2)	-	-	-	-	-	-	0	0	0	0		0
3)	-	-	-	-	0	12	7	8	10	4		7
4)	-	-	-	-	-	-	3	0	0	4		2
5)	30	25	0	12	-	-	10	0	3	7		5
6)	-	-	-	-	0	12	0	8	7	0		3
1,2)	7	25	3	16	14	0	10	8	13	4		9
1,3)	-	-	-	-	-	-	7	4	3	7		5
1,4)	-	-	-	-	-	-	13	4	3	15		9
2,4)	0	25	-	-	-	-	3	0	3	0		2

South Bethany Beach	Time Spent in Community? (Question 6)		Part of the Year? (Question 7)		Length of Residence or Visit? (Question 8)		Property Ownership? (Question 3)		Ever Experienced a Flood? (Question 10)		Total Community Respondents	
	Not Permanently	Resident	Summer	Other	Long	Short	Owner	Nonowner	Flood Experience	No Experience	Number	Percent
17. (Continued)												
3,4)	2%*	25%	-	-	-	-	3%	4%	7%	0%		3%
1,2,3)	-	-	-	-	-	-	3	8	7	4		5
1,3,4)	22	0	31	8	22	25	16	30	17	30		21
1,2,3,4)	-	-	-	-	-	-	0	0	0	0		0
18. 1)	-	-	16	18	12	28	17	18	16	18	64	17
2)	-	-	16	10	15	16	11	18	10	18		14
5)	-	-	11	4	-	-	6	11	6	9		8
6)	-	-	-	-	-	-	6	0	3	3		3
1,2)	-	-	11	18	15	11	17	11	26	3		14
1,2,5)	-	-	-	-	-	-	0	4	3	0		2
1,2,6)	-	-	-	-	-	-	3	0	3	0		2
1,2,3,7)	-	-	-	-	-	-	0	4	3	0		2
1,2,3,4)	-	-	-	-	-	-	0	0	0	0		0
24. 1)	12	50	27	8	14	0	15	0	18	12	34	16
3)	12	0	9	13	11	33	12	0	23	0		12
5)	22	50	27	22	29	0	24	0	29	18		23
6)	50	0	36	52	40	66	47	0	29	65		47
7)	-	-	0	4	-	-	3	0	0	0		3
27. 1)	25	50	14	36	31	0	28	0	42	0	18	28
2)	-	-	-	-	-	-	0	0	0	0		0
3)	18	0	28	9	18	0	17	0	0	50		17
4)	25	0	0	36	25	0	22	0	25	17		22
5)	-	-	14	0	-	-	6	0	8	0		6
6)	12	50	28	9	12	0	17	0	17	17		17
7)	12	0	14	9	6	100	11	0	8	17		11
29. 1)	8	0	12	5	5	0	8	0	15	0	26	8
2)	16	0	37	5	20	0	15	0	15	15		15
3)	16	0	0	22	20	0	15	0	23	8		15
4)	56	0	37	61	45	100	54	0	39	70		54
1,2)	-	-	-	-	-	-	0	0	0	0		0
1,3)	-	-	-	-	-	-	0	0	0	0		0
2,3)	-	-	12	0	-	-	4	0	0	8		4
1,2,3)	0	100	0	5	-	-	4	0	8	0		4
34. 2)	-	-	-	-	-	-	0	0	0	0	31	0
4)	17	0	11	18	16	0	16	0	25	7		16
6)	24	50	33	22	24	100	26	0	19	33		26
7)	-	-	-	-	-	-	0	0	0	0		0
8)	34	50	33	36	44	0	35	0	37	33		35

South Bethany Beach	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
35. 1)	82%*	0%	83%	75%	71%	100	78	0	56	100	18	78
2)	17	100	17	25	29	0	22	0	44	0		22
36. 1)	45	50	60	39	50	0	46	0	4	44	33	45
2)	-	-	-	-	-	-	0	0	0	0		0
3)	-	-	-	-	-	-	0	0	0	0		0
6)	-	-	10	8	7	33	9	0	6	12		9
8)	13	0	20	8	4	66	12	0	18	6		12
9)	0	50	-	-	-	-	3	0	6	0		3
1,2)	-	-	10	8	-	-	9	0	6	12		9
39. 1)	54	0	50	52	50	67	52	0	35	69	33	51
2)	12	0	20	8	11	33	12	0	18	6		12
3)	12	100	10	21	19	0	18	0	29	6		18
4)	19	0	20	17	19	0	18	0	18	18		18
40. 1)	-	-	-	-	-	-	0	0	0	0	20	0
2)	100	100	100	100	100	100	100	0	100	100		100
41. 1)	0	0	0	0	0	0	0	0	0	0	0	0
2)	0	0	0	0	0	0	0	0	0	0		0
7)	0	0	0	0	0	0	0	0	0	0		0
42. 1)	0	0	0	0	0	0	0	0	0	0	0	0
2)	0	0	0	0	0	0	0	0	0	0		0
3)	0	0	0	0	0	0	0	0	0	0		0
47. 1)	64	50	80	56	61	66	64	0	59	69	33	64
2)	29	50	20	35	30	33	30	0	35	25		30
3)	7	0	0	9	7	0	6	0	6	6		6

*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

Fenwick Island	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
Percentage	88%	12%	55%	45%	81%	9%	63%	37%	51%	49%		
Total Number	142	19	84	68	130	14	101	59	78	76	158	
3. 1)	58%*	61%	45%	82%	70%	31%	100%	0%	69%	56%	160	63%
2)	42	39	55	18	30	69	0	100	31	41		37
9. 1)	24	56	14	43	33	8	43	3	49	7	160	29
2)	76	44	85	57	67	92	57	97	51	93		71
3)	0	0	0	0	0	0	0	0	0	0		0
10. 1)	49	67	46	56	52	57	56	42	100	0	154	50
4)	51	33	54	44	48	43	44	58	0	100		50
11. 1)	35	44	35	40	37	36	40	31	43	30	160	37
2)	53	56	49	54	55	36	52	53	47	58		52
3)	12	6	16	6	8	29	8	15	10	12		11
16. 2)	38	29	34	40	40	23	42	29	37	37	150	37
4)	0	0	0	0	0	0	0	0	0	0		0
5)	8	18	10	9	-	-	11	7	10	8		9
6)	23	23	27	17	21	38	16	32	20	25		23
7)	-	-	-	-	-	-	-	-	10	5		8
1,2)	4	18	-	-	-	-	-	-	-	-		6
2,3)	0	0	0	0	0	0	0	0	0	0		0
2,7)	-	-	-	-	-	-	-	-	-	-		5
1,2,7)	0	0	-	-	-	-	-	-	-	-		-
17. 1)	-	-	-	-	-	-	-	-	-	-	146	5
2)	-	12	-	-	-	-	-	-	-	-		2
3)	-	-	-	-	-	-	-	-	-	-		1
4)	-	-	-	-	-	-	-	-	-	-		4
5)	-	-	-	-	-	-	-	-	-	-		1
6)	-	-	-	-	-	-	0	11	-	-		4
1,2)	-	-	-	-	-	14	-	-	-	-		3
1,3)	9	12	4	16	12	0	11	7	8	11		10
1,4)	10	6	11	8	10	14	10	9	11	8		10
2,4)	-	-	-	-	-	-	-	-	-	-		5
3,4)	-	-	-	-	5	14	6	11	-	-		7
1,2,3)	-	-	-	-	-	-	-	-	-	-		3
1,3,4)	17	23	17	17	19	14	22	11	17	19		18
1,2,3,4)	13	18	17	10	13	21	12	16	14	14		14

Fenwick Island	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
18. 1)	19%*	11%	25%	9%	17%	29%	16%	23%	15%	21%	154	18%
2)	12	6	14	9	9	29	10	14	11	11		12
5)	-	-	-	-	10	0	11	5	8	10		9
6)	-	-	-	-	-	-	-	-	3	4		3
1,2)	10	17	8	15	12	7	10	10	14	8		11
1,2,5)	-	-	-	-	-	-	-	-	4	3		3
1,2,6)	0	0	0	0	0	0	0	0	0	0		0
1,2,3,4)	-	-	-	-	-	-	-	-	0	4		2
1,2,3,7)	0	0	0	0	0	0	0	0	0	0		0
24. 1)	30	40	28	33	32	40	32	27	38	25	99	30
3)	1	7	3	2	1	20	3	9	4	0		4
5)	26	40	19	33	30	0	32	0	34	23		29
6)	35	13	44	26	32	20	29	54	19	45		30
7)	7	0	6	5	5	20	5	9	4	7		6
27. 1)	11	7	16	8	9	25	11	0	10	11	82	10
2)	3	6	0	2	3	0	1	25	2	4		2
3)	10	21	12	12	11	25	12	0	10	14		11
4)	19	21	16	20	21	0	18	50	21	18		21
5)	16	14	20	14	16	25	15	25	17	14		16
6)	27	29	24	31	30	0	29	0	31	21		29
7)	13	7	12	12	10	25	12	0	8	18		11
29. 1)	8	0	12	2	-	-	7	0	-	-	96	6
2)	9	12	12	9	11	0	11	0	14	5		9
3)	10	19	0	19	11	40	13	0	14	9		11
4)	44	37	54	36	40	40	36	100	26	63		43
1,2)	6	0	3	7	6	0	6	0	-	-		6
1,3)	13	19	15	14	15	0	16	0	20	7		13
2,3)	5	6	3	7	5	20	6	0	8	2		5
1,2,3)	4	6	0	7	-	-	5	0	4	5		5
34. 2)	-	-	-	-	-	-	1	18	-	-	59	3
4)	12	12	14	10	10	40	11	18	9	13		11
6)	42	37	46	37	44	20	41	45	45	38		40
7)	-	-	-	-	-	-	-	-	-	-		2
8)	27	31	29	29	28	40	29	18	31	24		29
35. 1)	72	67	71	70	68	100	68	87	60	83	65	71
2)	28	33	29	30	32	0	31	12	40	15		29

Fenwick Island	Time Spent in Community? (Question 6) Not Permanently	Resident	Part of the Year? (Question 7) Summer	Other	Length of Residence or Visit? (Question 8) Long	Short	Property Ownership? (Question 3) Owner	Nonowner	Ever Experienced a Flood? (Question 10) Flood Experience	No Experience	Total Community Respondents Number	Percent
36. 1)	57%*	25%	63%	45%	51%	60%	54%	30%	53%	50%	95	52%
2)	-	12	0	5	3	0	-	-	-	-		3
3)	0	0	0	0	0	0	0	0	0	0		0
6)	4	12	-	5	6	0	-	-	-	-		5
8)	4	6	-	5	5	0	2	20	-	-		4
9)	0	0	0	0	0	0	0	0	0	0		0
1,2)	9	19	3	15	9	20	11	10	8	14		10
39. 1)	56	50	58	52	55	46	54	70	46	66	101	54
2)	10	12	6	14	12	0	12	0	10	11		11
3)	17	31	12	24	18	40	18	30	24	14		19
4)	17	6	24	10	15	20	17	0	20	9		15
40. 1)	8	14	11	8	7	50	9	0	13	3	78	9
2)	92	86	89	92	93	50	90	100	87	97		91
41. 1)	50	50	67	33	50	50	50	0	50	0	6	50
2)	25	0	33	0	25	0	17	0	17	0		17
7)	0	50	0	33	0	50	17	0	17	0		17
1,7)	25	0	0	33	25	0	17	0	17	0		17
42. 1)	20	100	50	40	33	100	43	0	60	0	6	50
2)	60	0	50	40	50	0	43	0	40	50		33
3)	20	0	0	20	17	0	14	0	0	50		17
47. 1)	36	47	34	40	39	40	43	0	37	39	99	37
2)	55	40	31	53	54	40	48	91	55	50		53
3)	9	13	14	7	7	20	9	9	8	11		9

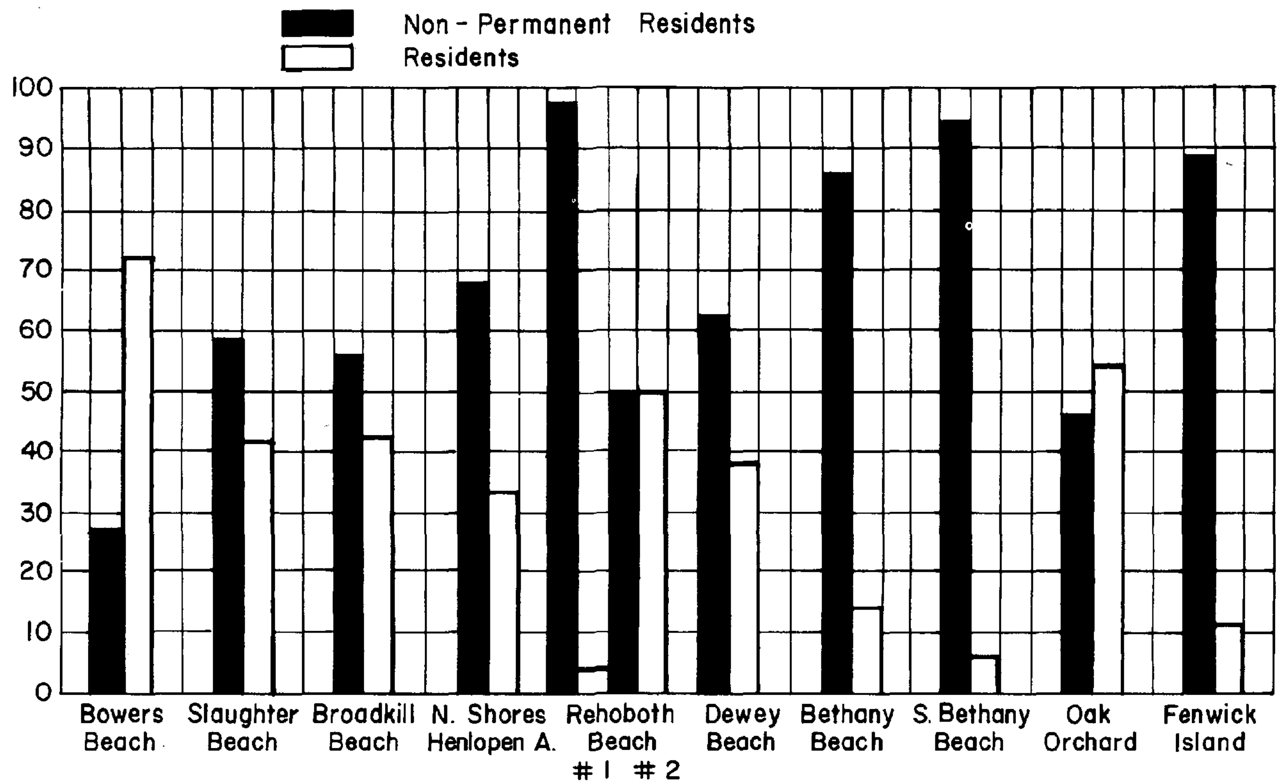
*Figures represent percentages of responses to selected questions by column label (i.e., not permanently resident, permanent resident, etc.). In most cases, the percentages do not total 100 percent since if the total for at least one category (i.e., not permanently resident or permanent resident) was less then 10 percent, the response was omitted and indicated with a -.

APPENDIX III

Graphical Comparisons of Selected Responses Between Communities

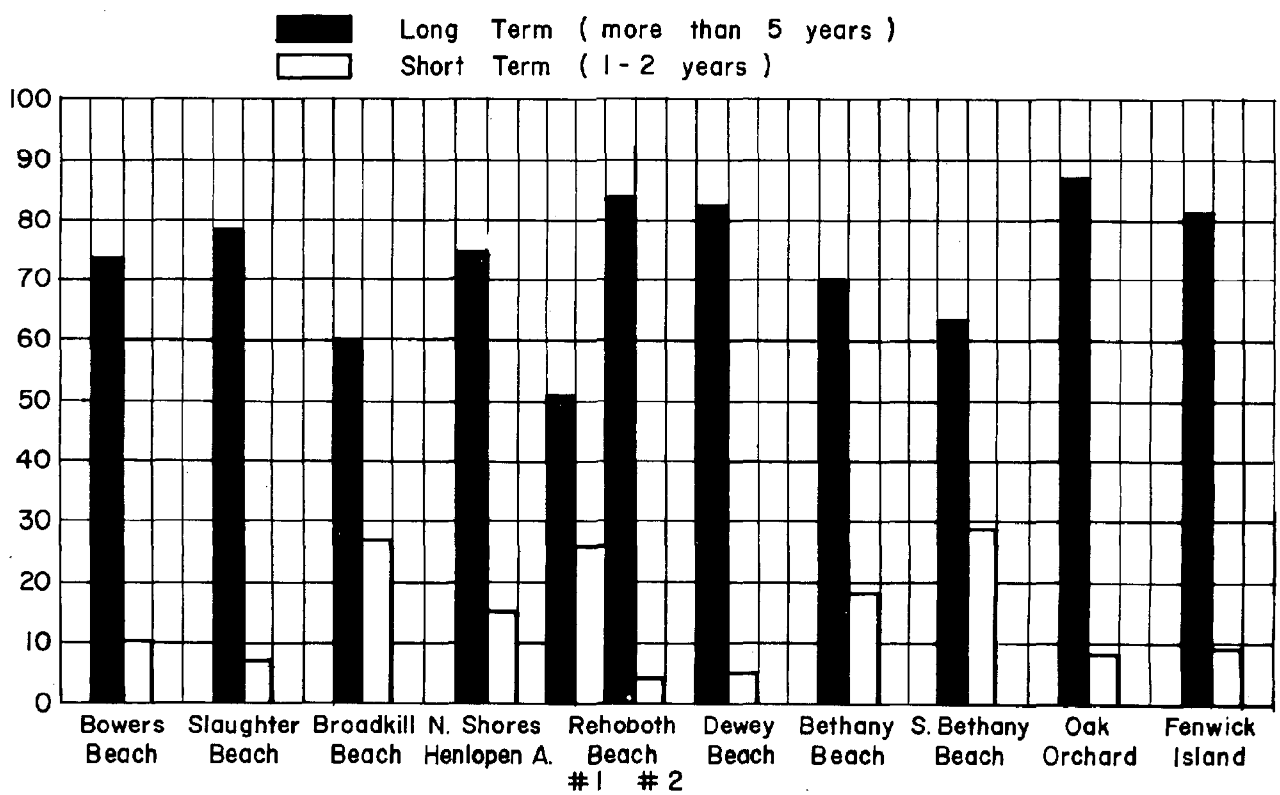
QUESTION 6

Percentage of Respondents Who were Residents vs. Non-Permanent Residents and Visitors.



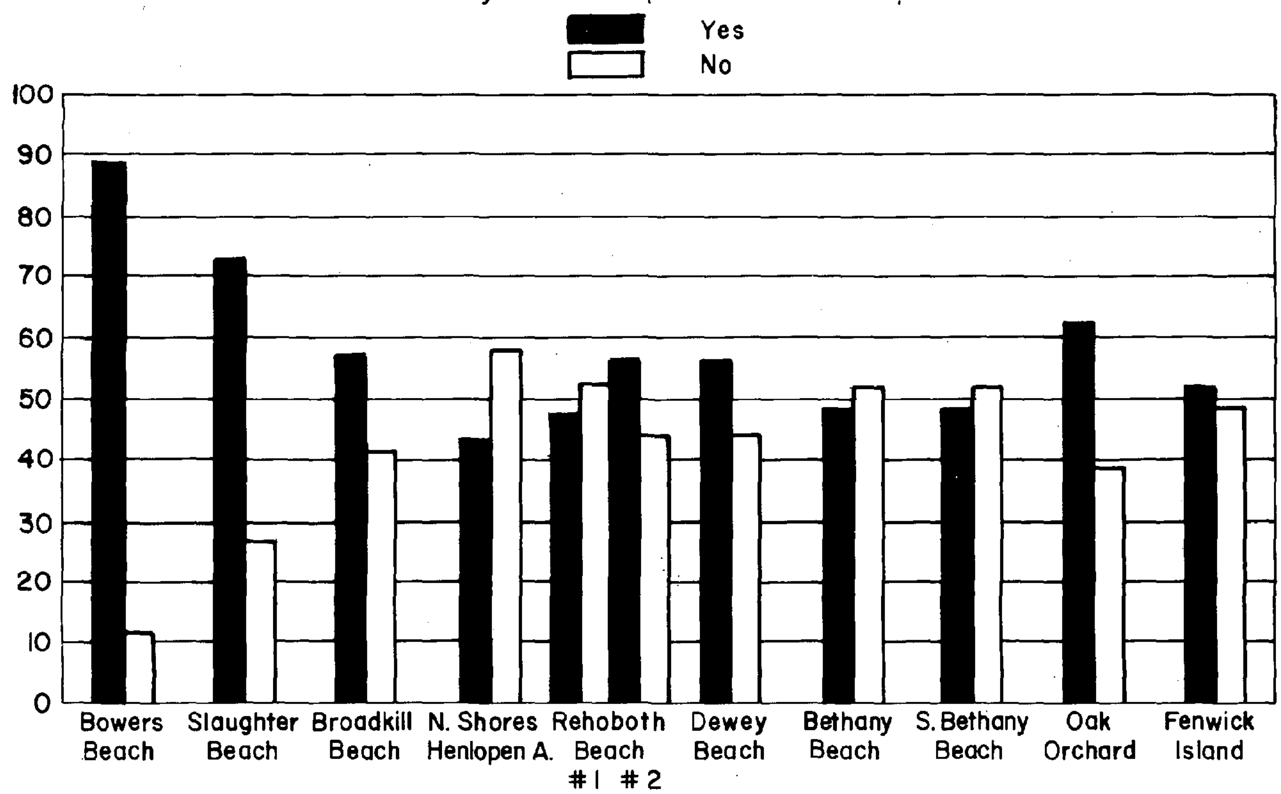
QUESTION 8

How long have you been a resident or coming to this community ?



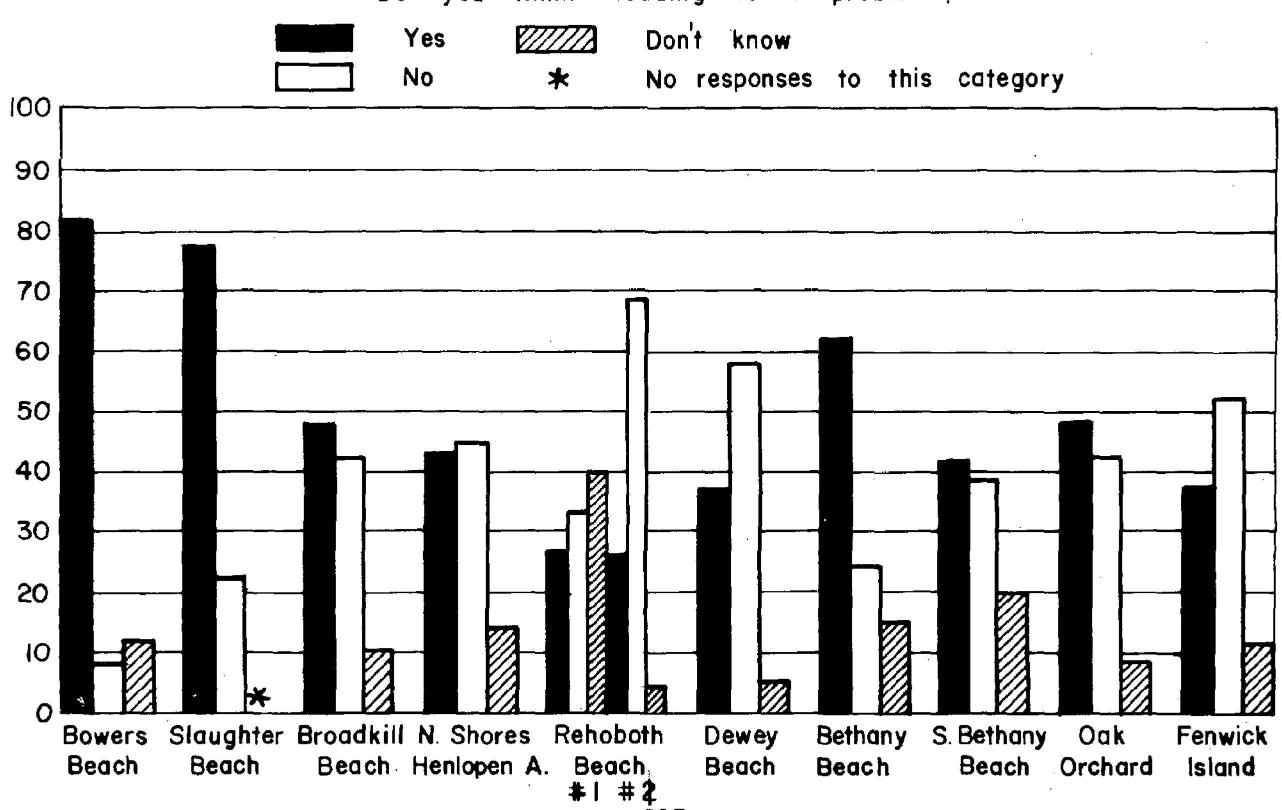
QUESTION 10

Have you ever experienced a flood?



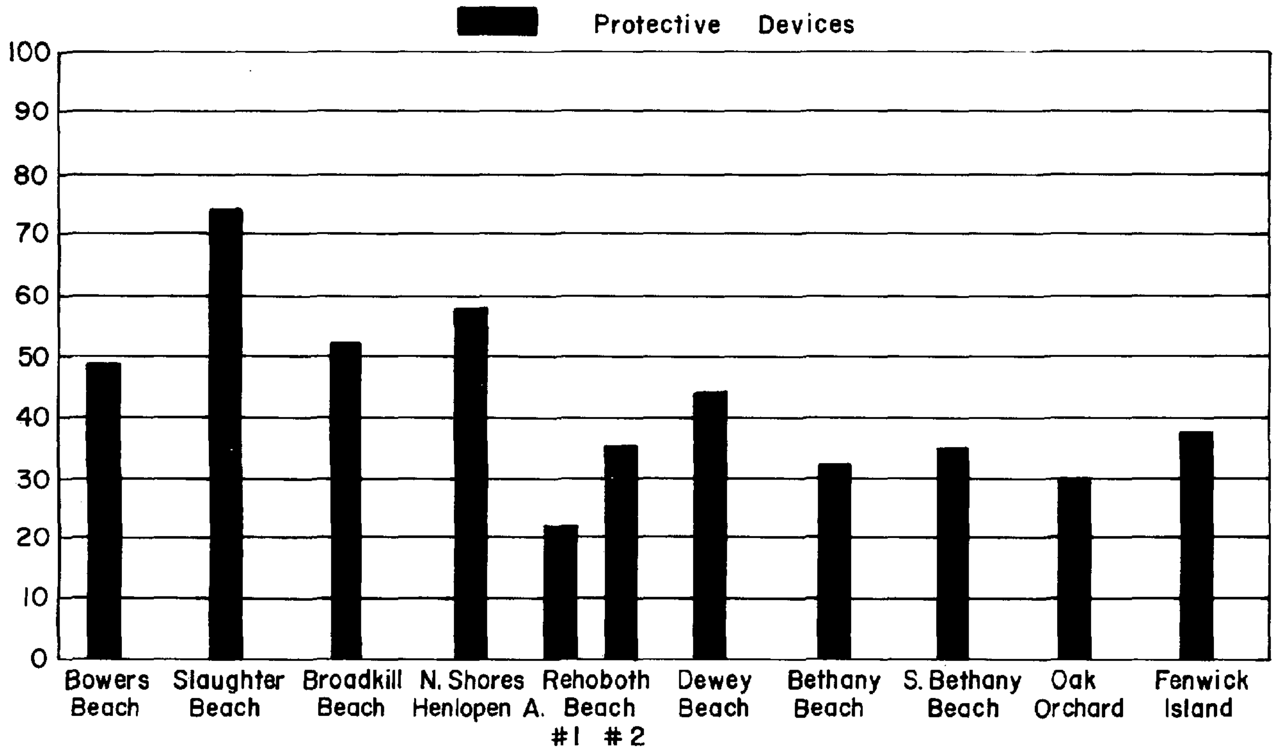
QUESTION 11

Do you think flooding is a problem?



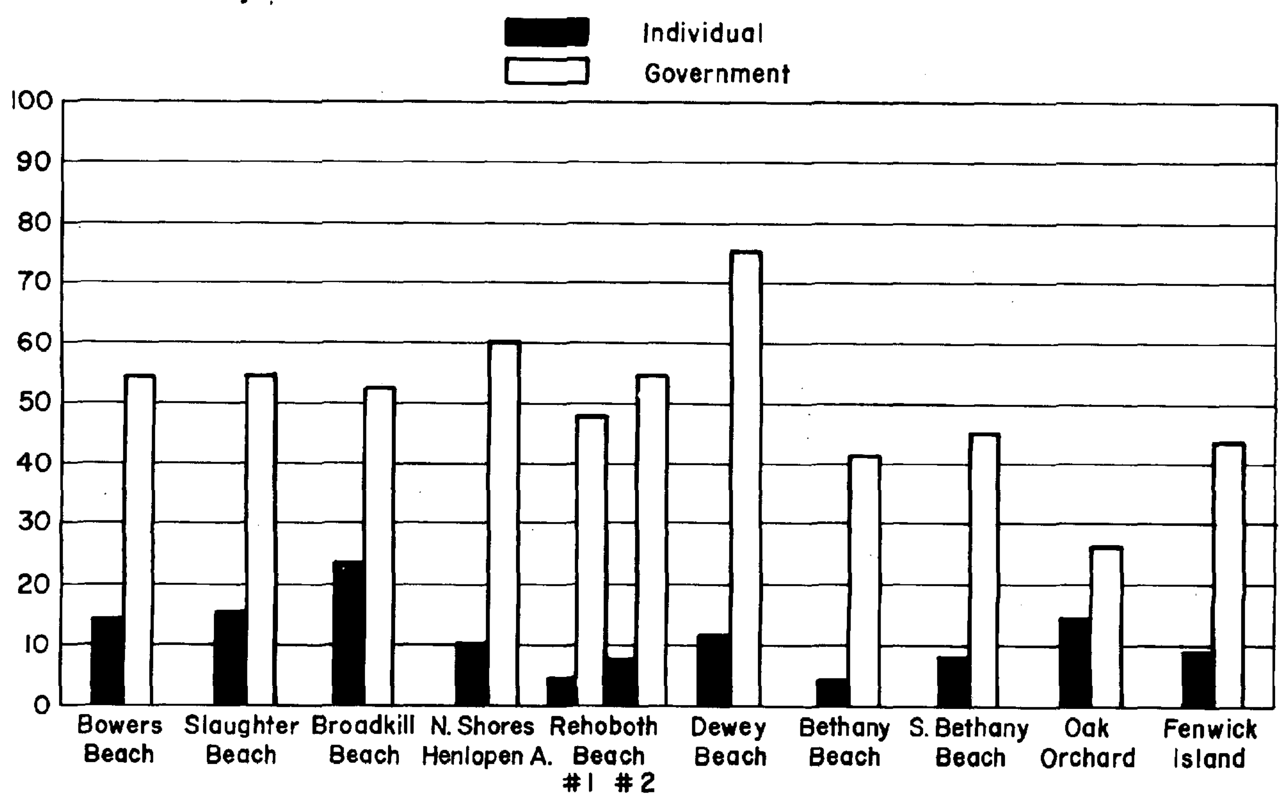
QUESTION 16

What measures do you think can be effective in reducing damages from storms and flooding in this community ?



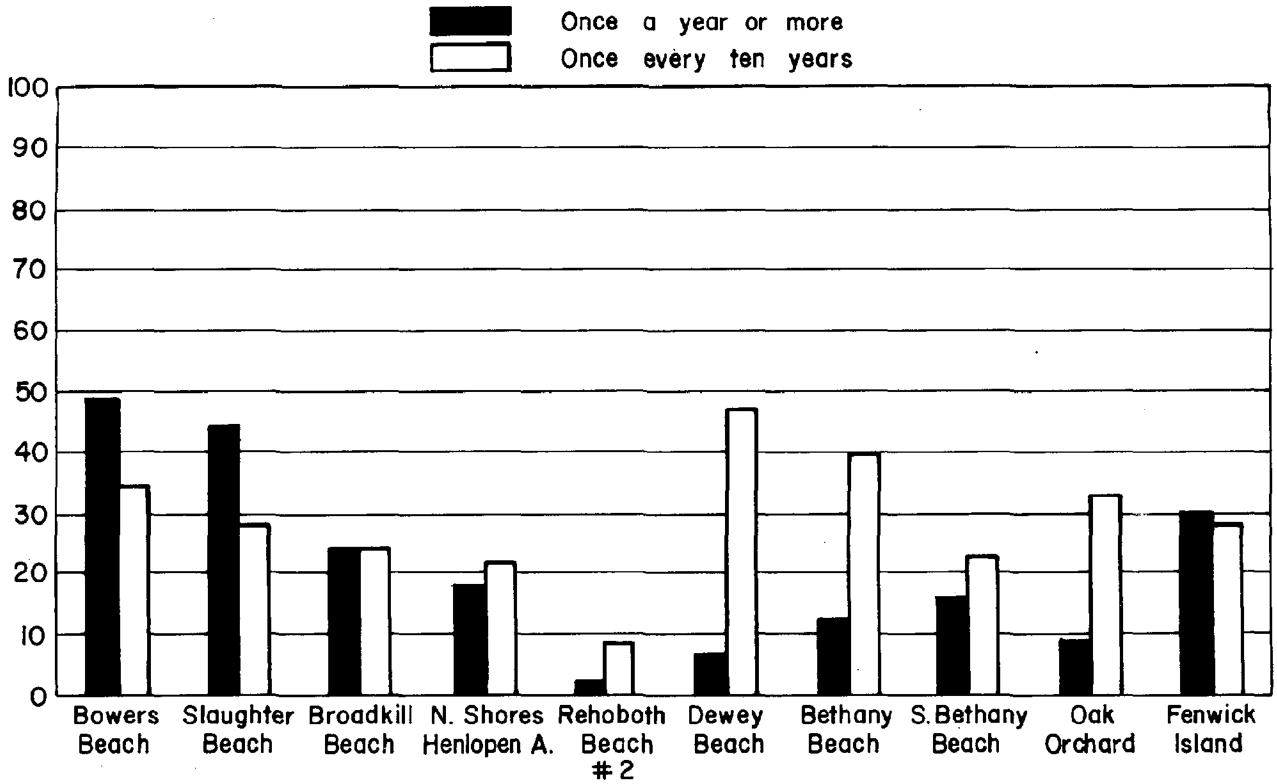
QUESTION 18

Who should be responsible for providing money to rebuild a flood damaged community ?



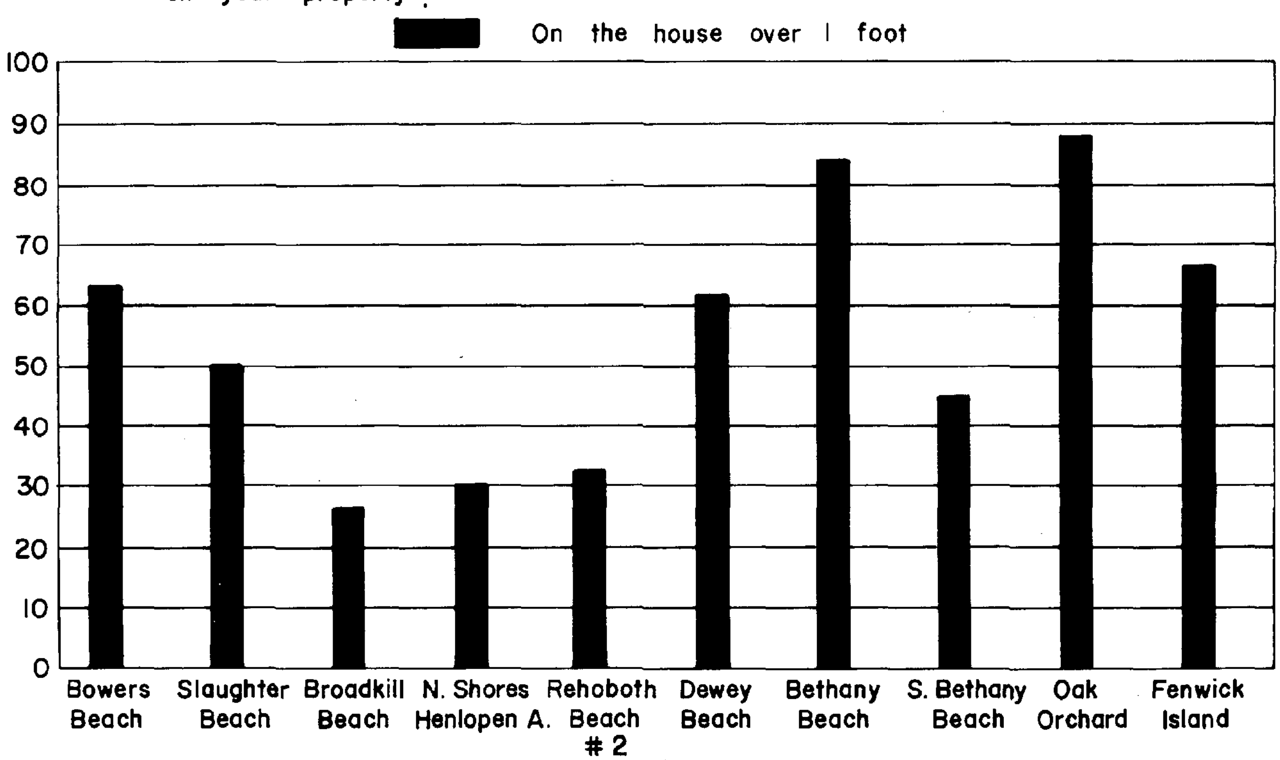
QUESTION 24

How frequently does sea and / or bay water reach your property ?



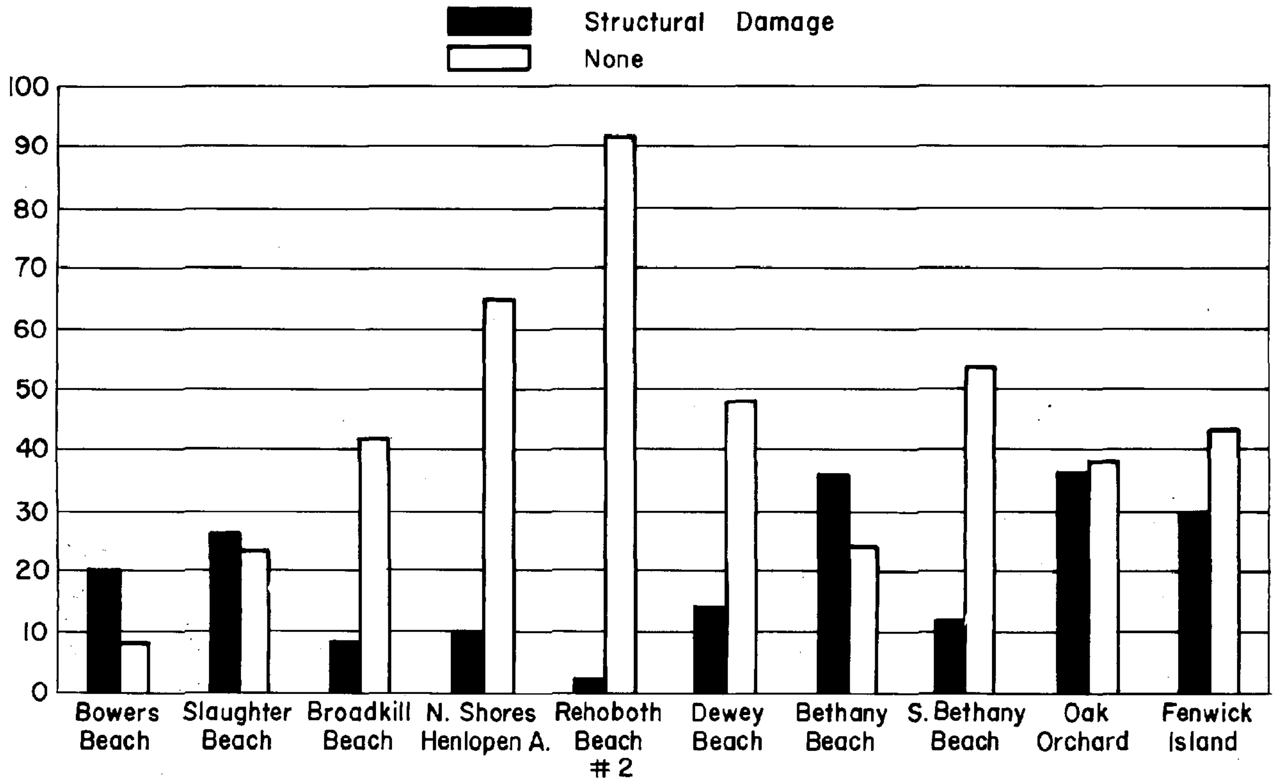
QUESTION 27

What is the highest level sea and / or bay water has reached on your property ?



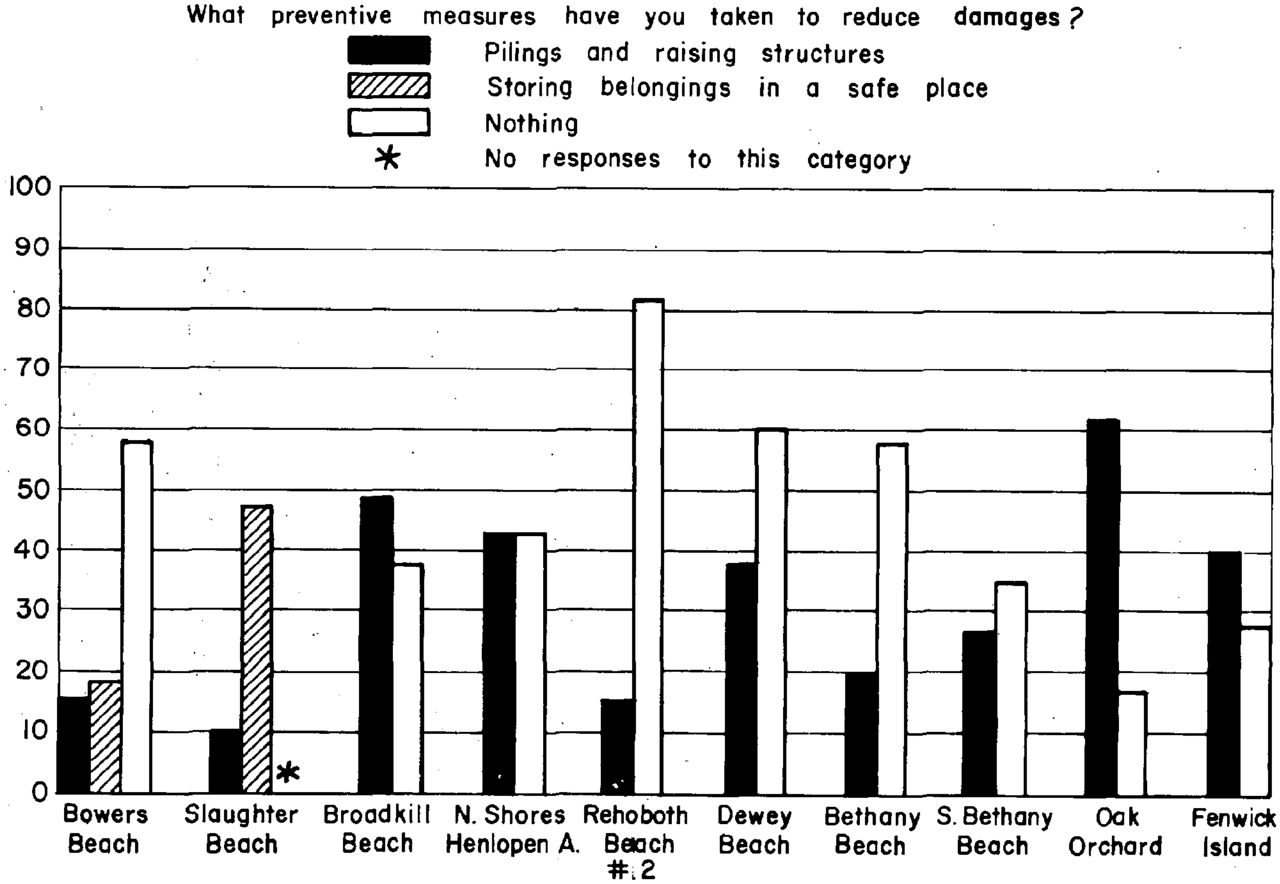
QUESTION 29

What, if any, specific damages were incurred on your property or belongings during sea and / or bay flooding?



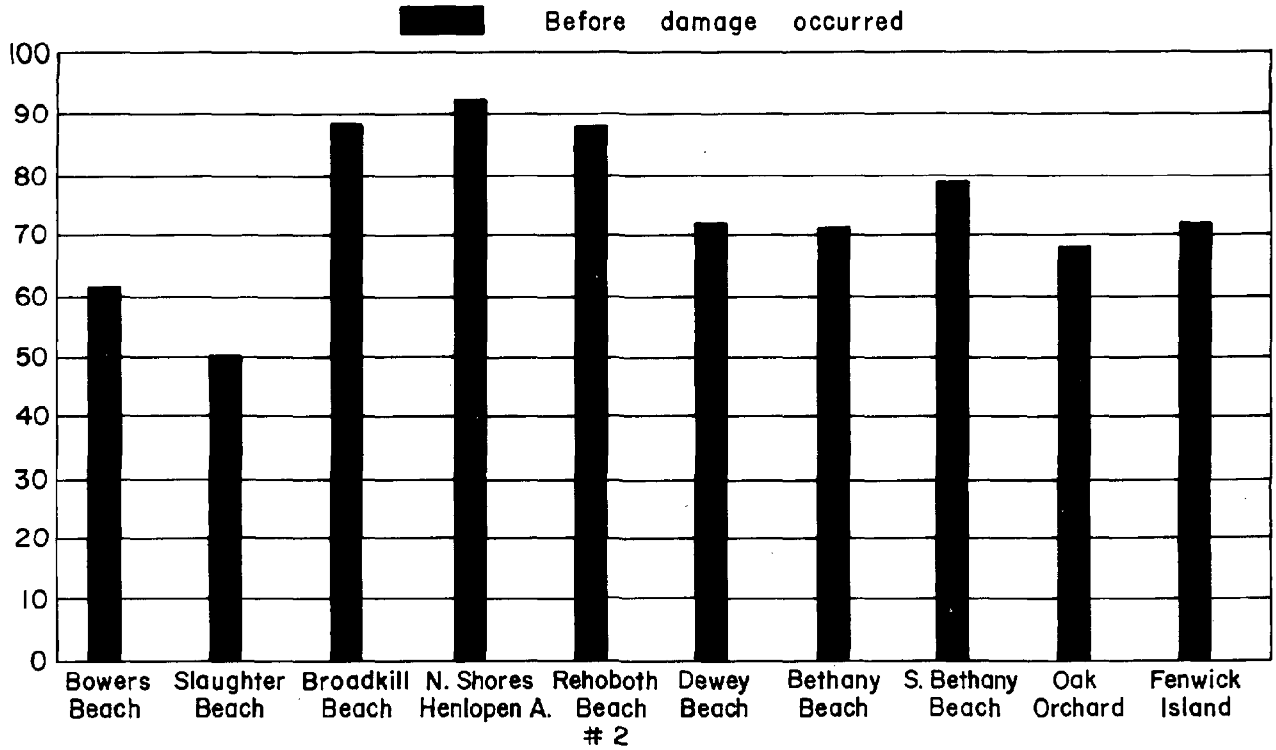
QUESTION 34

What preventive measures have you taken to reduce damages?



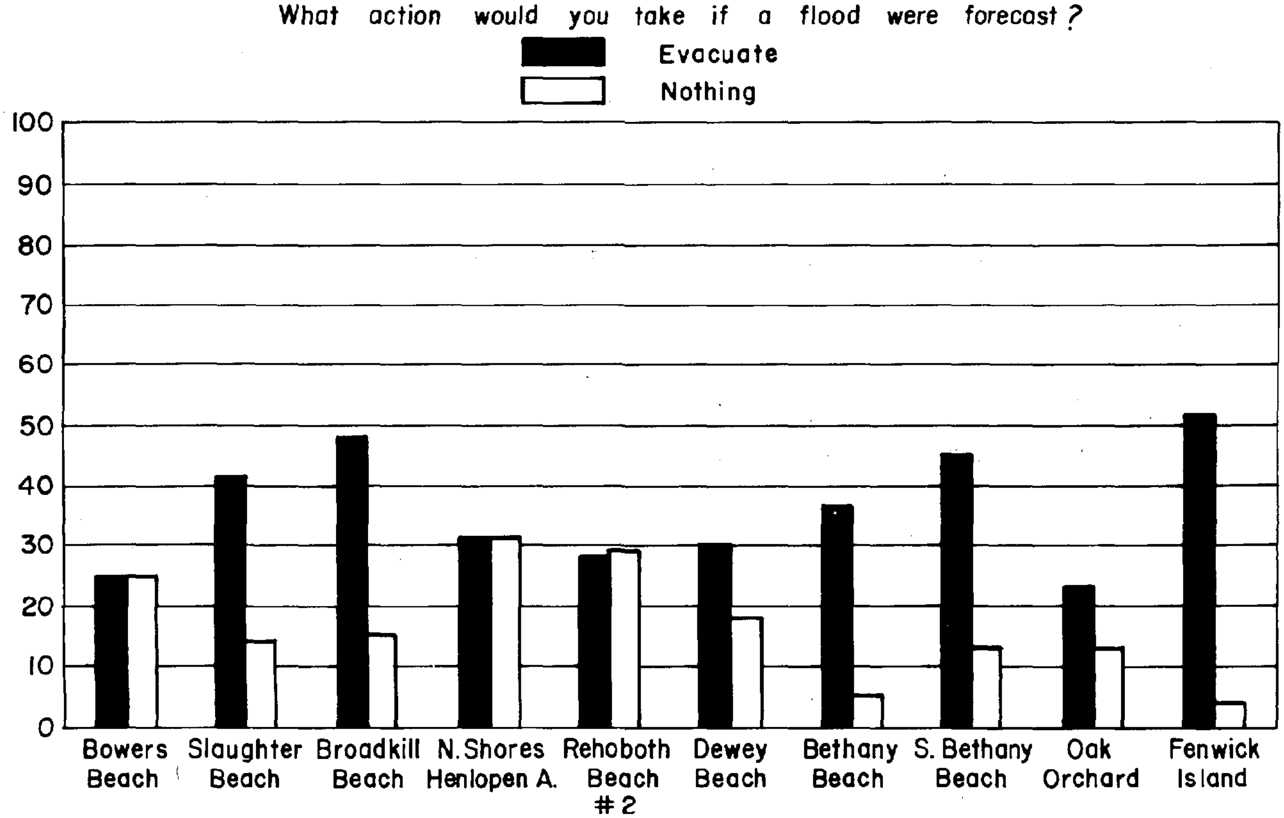
QUESTION 35

If you have taken any preventive measures, were they taken before or after damage occurred ?



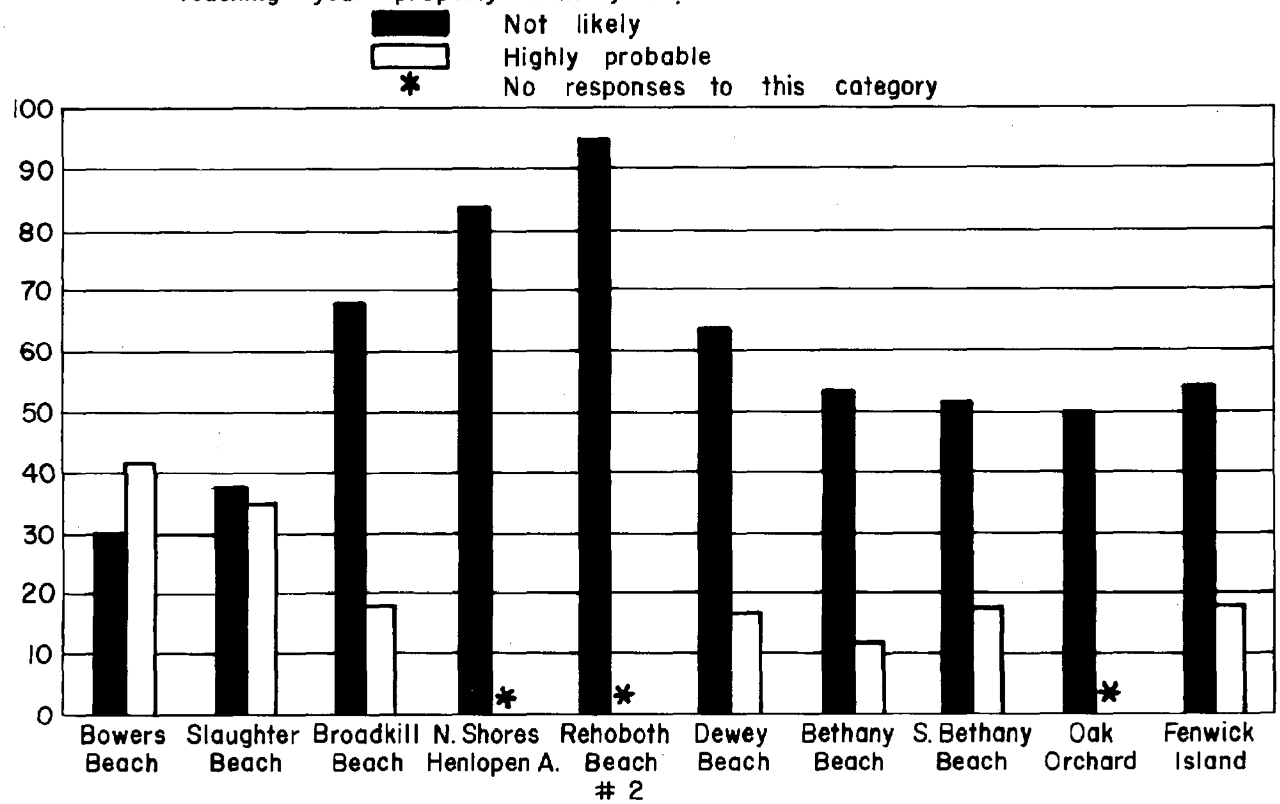
QUESTION 36

What action would you take if a flood were forecast ?



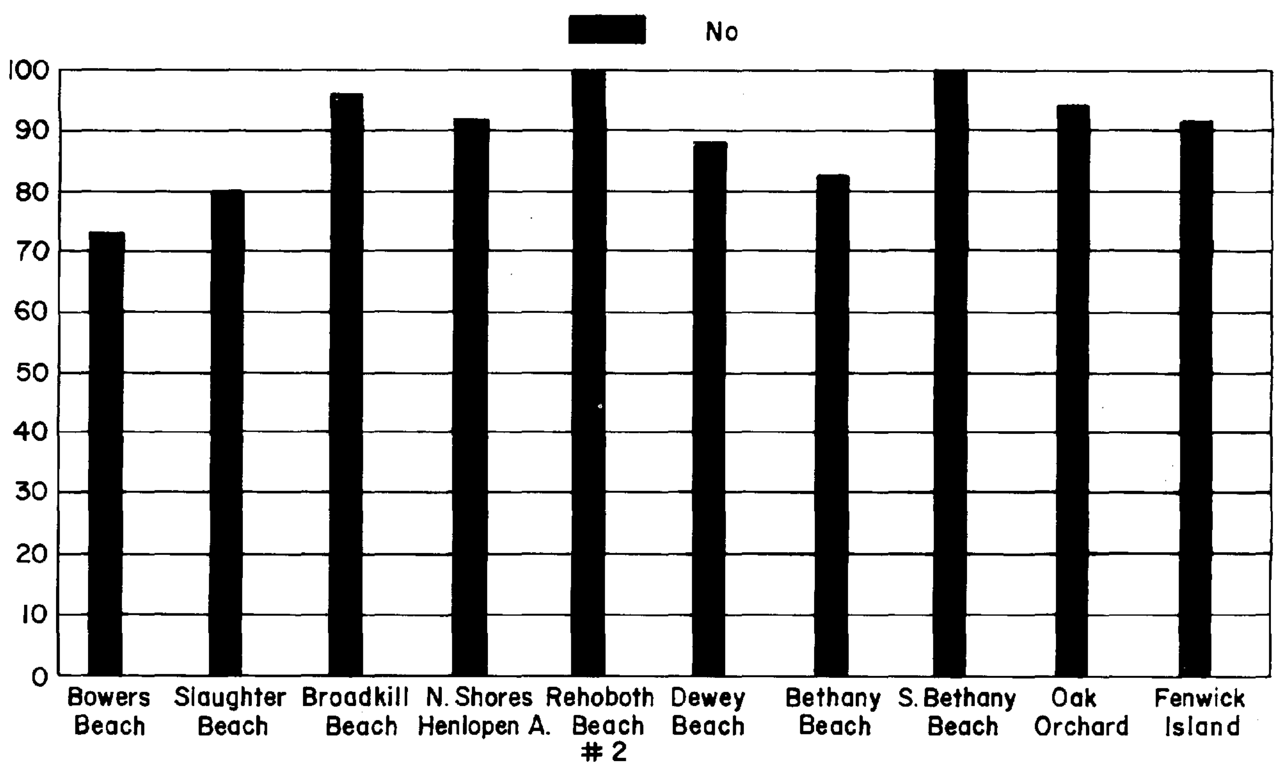
QUESTION 39

What do you think are the chances of sea and / or bay water reaching your property next year?



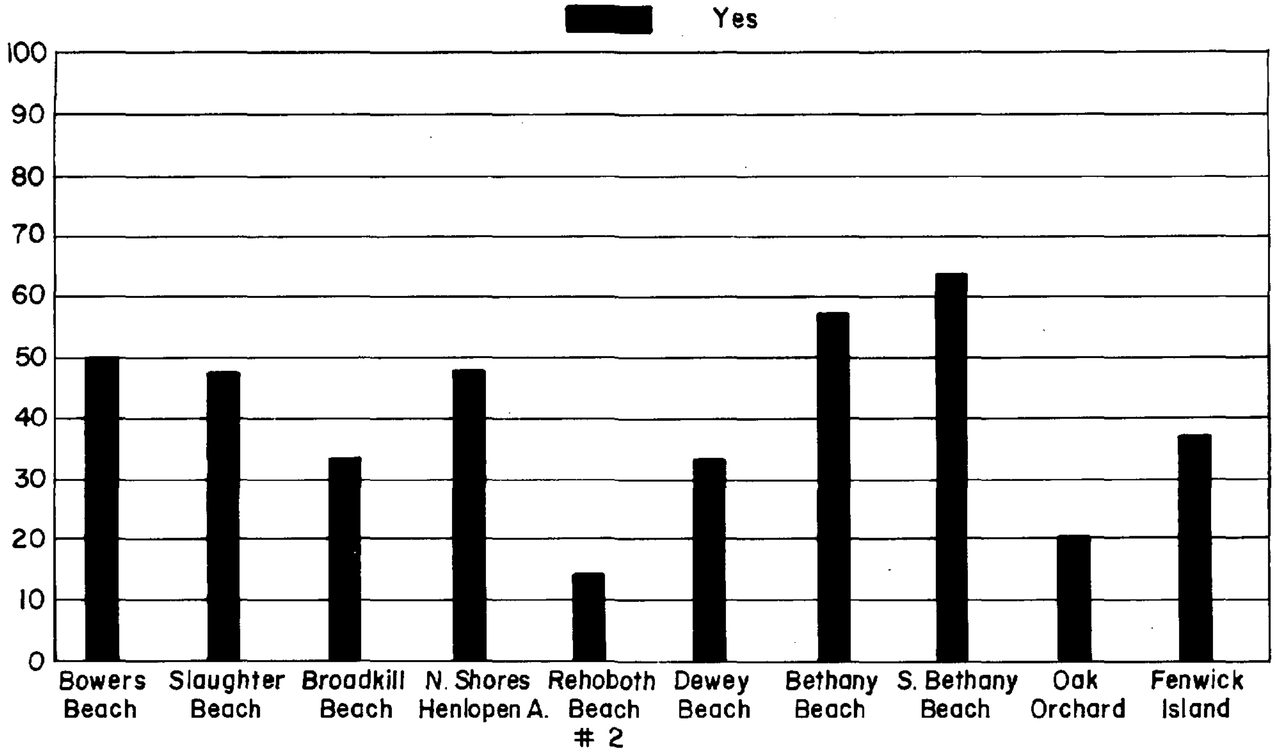
QUESTION 40

Have you ever sought aid after sea and / or bay flooding?



QUESTION 47

Do you have Federal Flood Insurance ?



APPENDIX IV

Graphical Representation of Storm Tide Data, Delaware Coast

Plotted on the graphs are: a) the normal astronomical tide regime; b) the actual (recorded) tidal and/or storm surge conditions that prevailed during the storm period; c) the difference (storm surge) between the predicted normal tides and the actual tide conditions during the storm.

Figure A, B, C, D below are examples that illustrate typical plots for some significant coastal storms. Each plot uses mean low water as the zero datum. Mean tide (sea) level is also plotted on the graphs for each tide station. These plots are also repeated in the Storm Chronicle.

At present, continuous tide level recording stations in the project area exist only at Reedy Point, Indian River Coast Guard Station, and the Indian River Power Plant. The gage at Lewes has not been operated since the pier on which it was located was destroyed by fire in 1974.

The Chronicle is organized in chronological order beginning with 1952 data at Breakwater Harbor. The legends for all plots are consistent with those shown on Figure A. The plots presented here are not a complete record of tide data at all observation points, but rather a selection of significant events corresponding to the occurrence of damaging storms.

FIGURE A

Reedy Point, DELAWARE

March 4-6, 1962

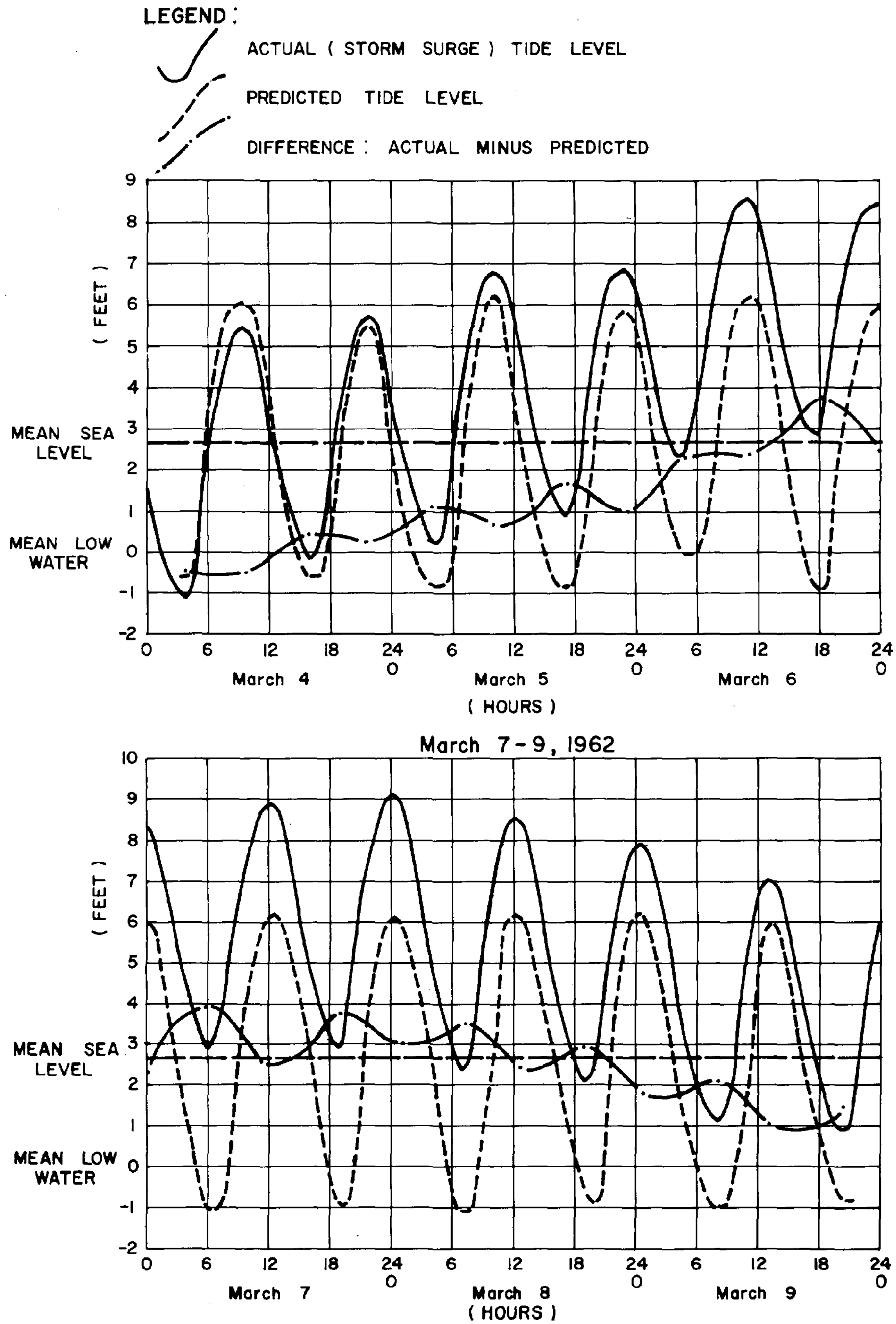


FIGURE B

Indian River Power Plant, INDIAN RIVER, DE.

May 26-29, 1968

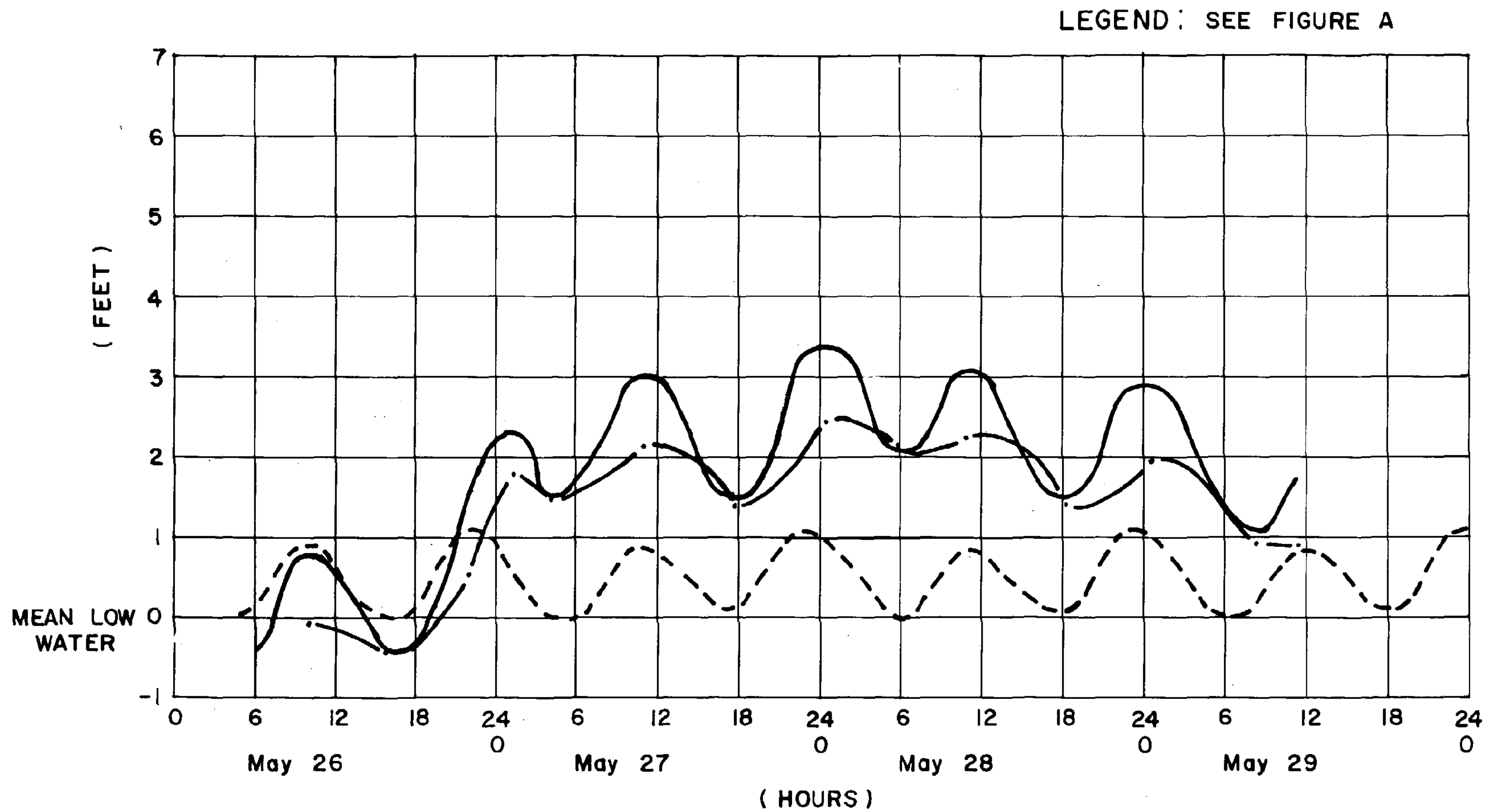
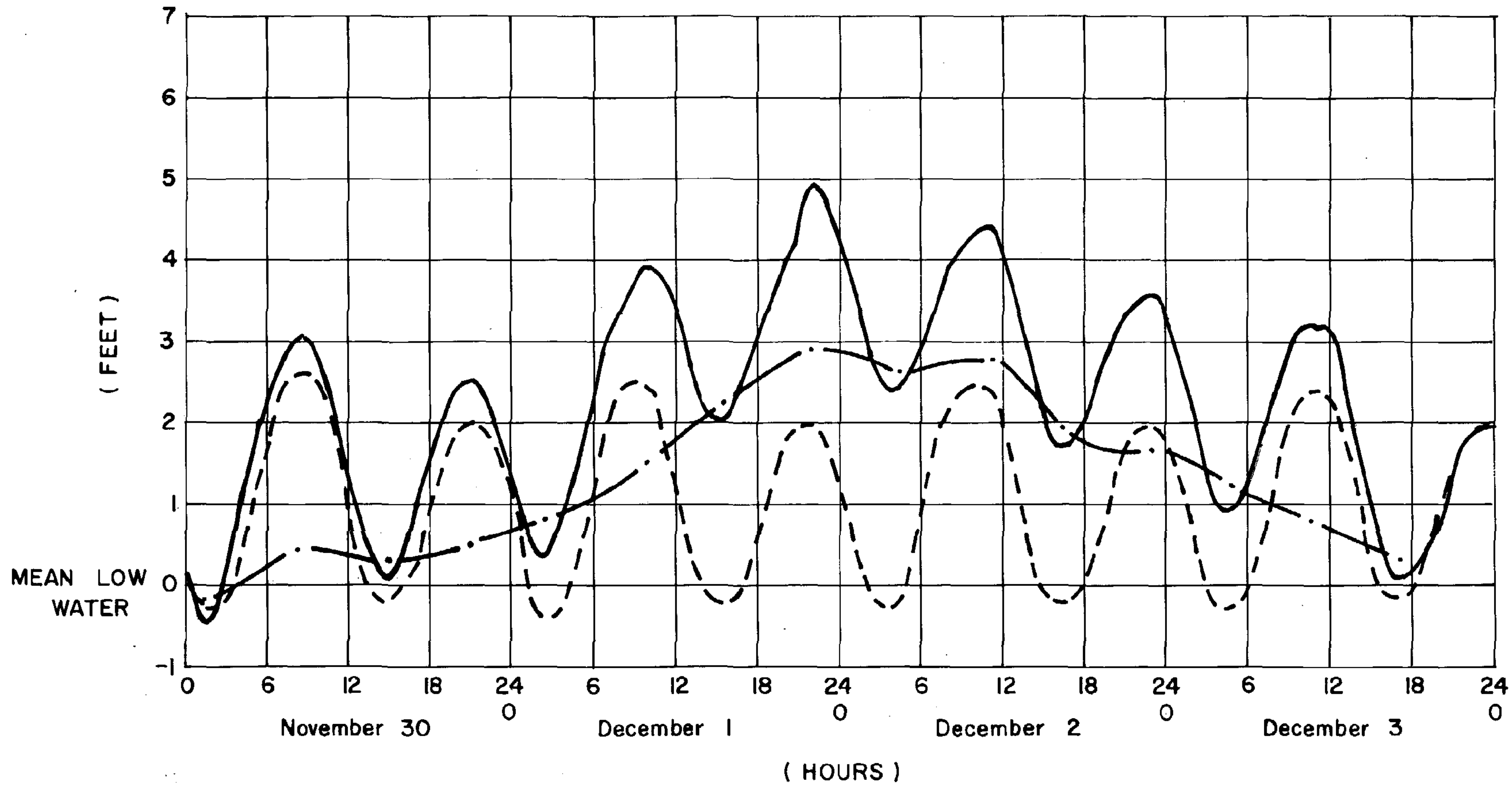


FIGURE C

Indian River Inlet, U.S. Coast Guard Station

November 30 - December 3, 1974



ACTUAL (STORM SURGE) TIDE LEVEL

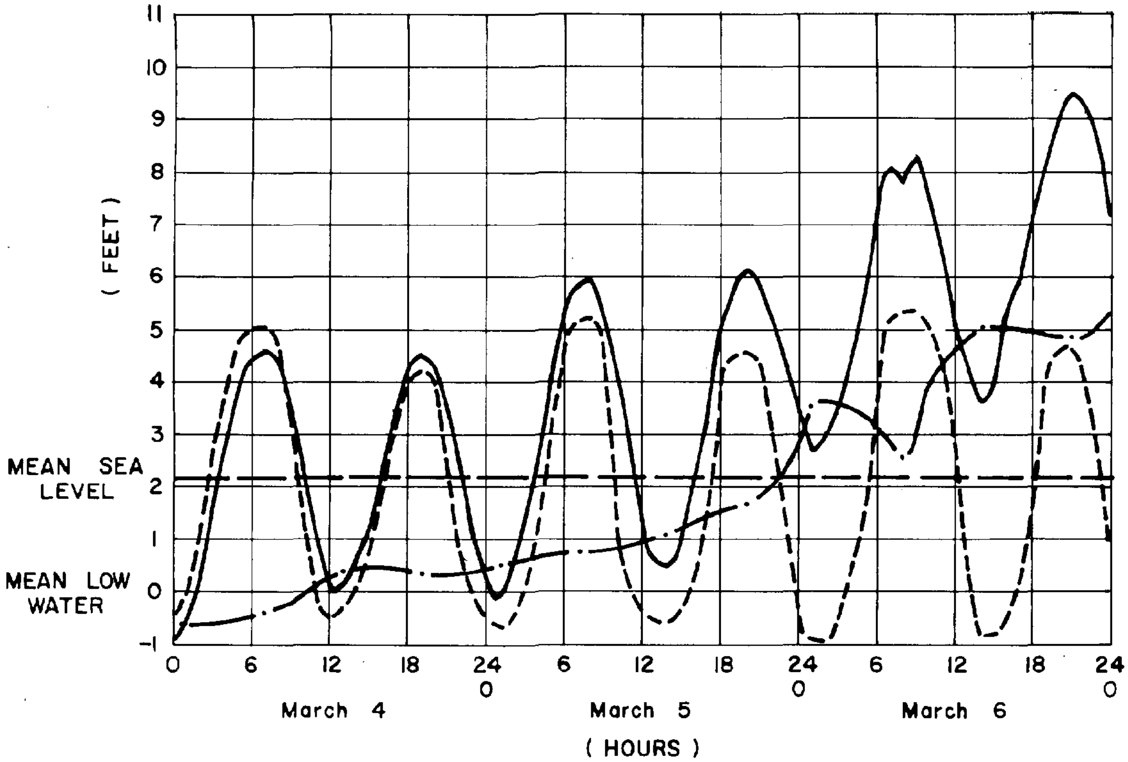
PREDICTED TIDE LEVEL

DIFFERENCE: ACTUAL MINUS PREDICTED

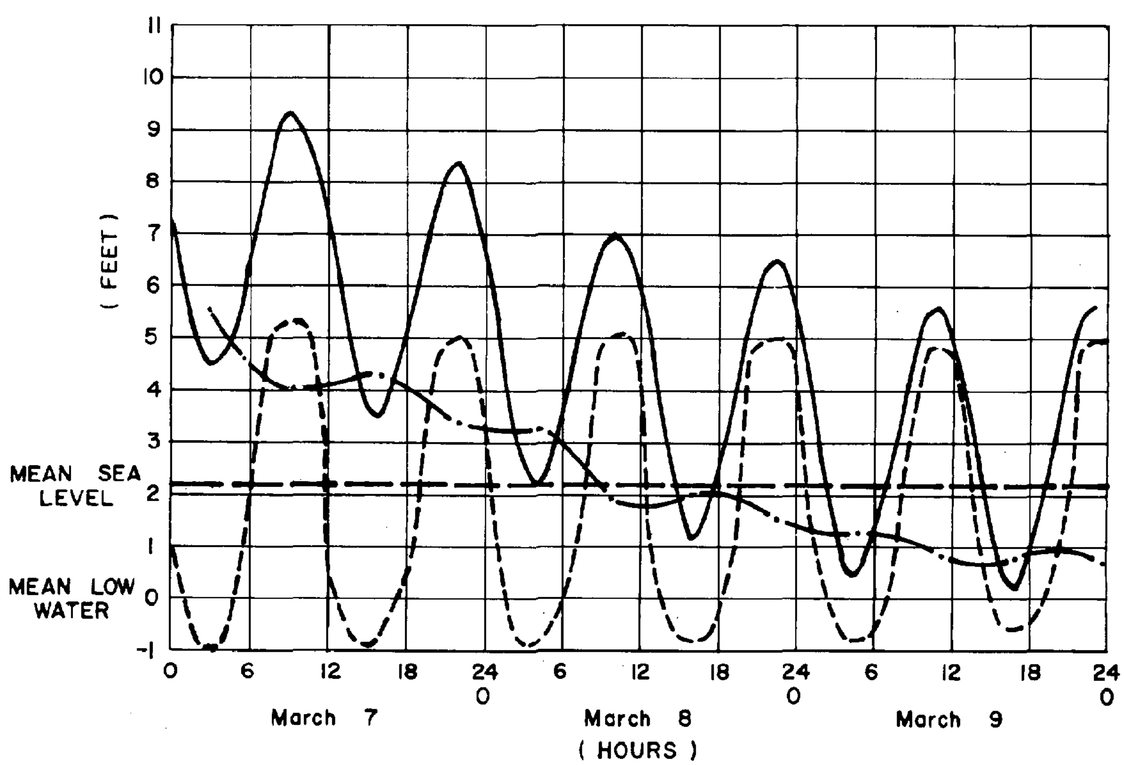
FIGURE D

Breakwater Harbor, LEWES, DELAWARE

March 4 - 6, 1962



March 7 - 9, 1962



STORM TIDE RECORDS FOR SELECTED

OBSERVATION POINTS AND TIMES

Reedy Point, Delaware

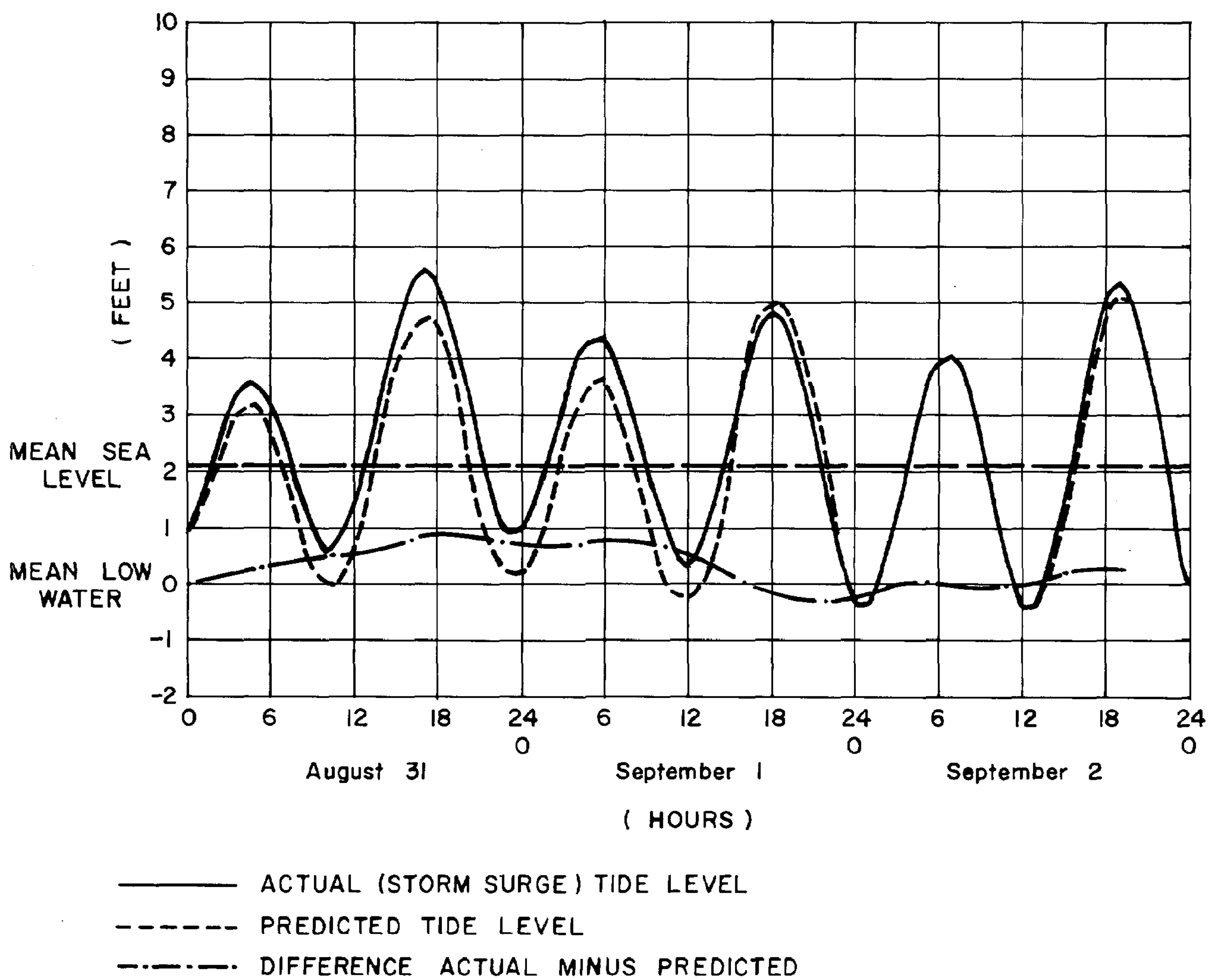
Breakwater Harbor, Lewes

Indian River Inlet, Coast Guard Station

Indian River Power Plant, Millsboro

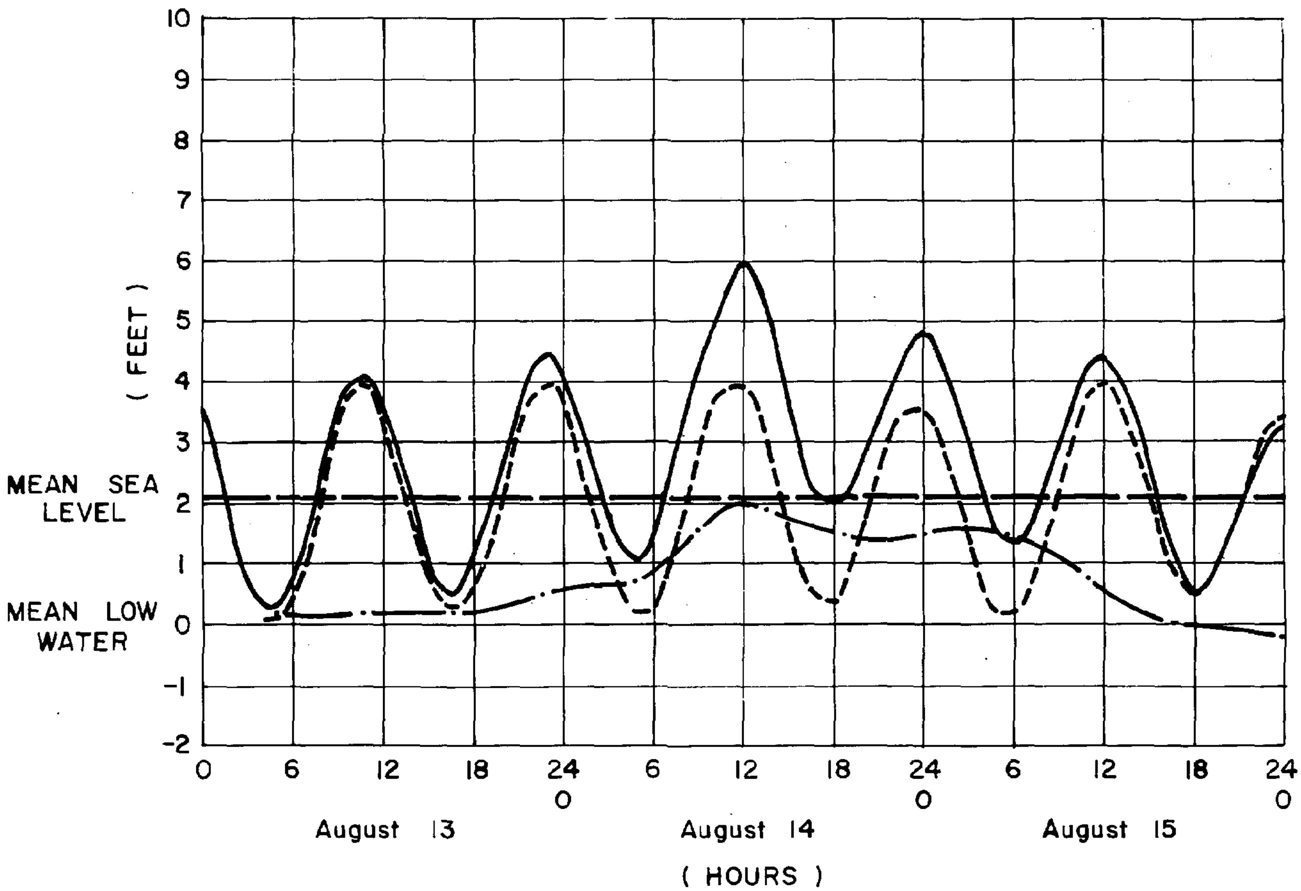
Breakwater Harbor

August 31 - September 2, 1952



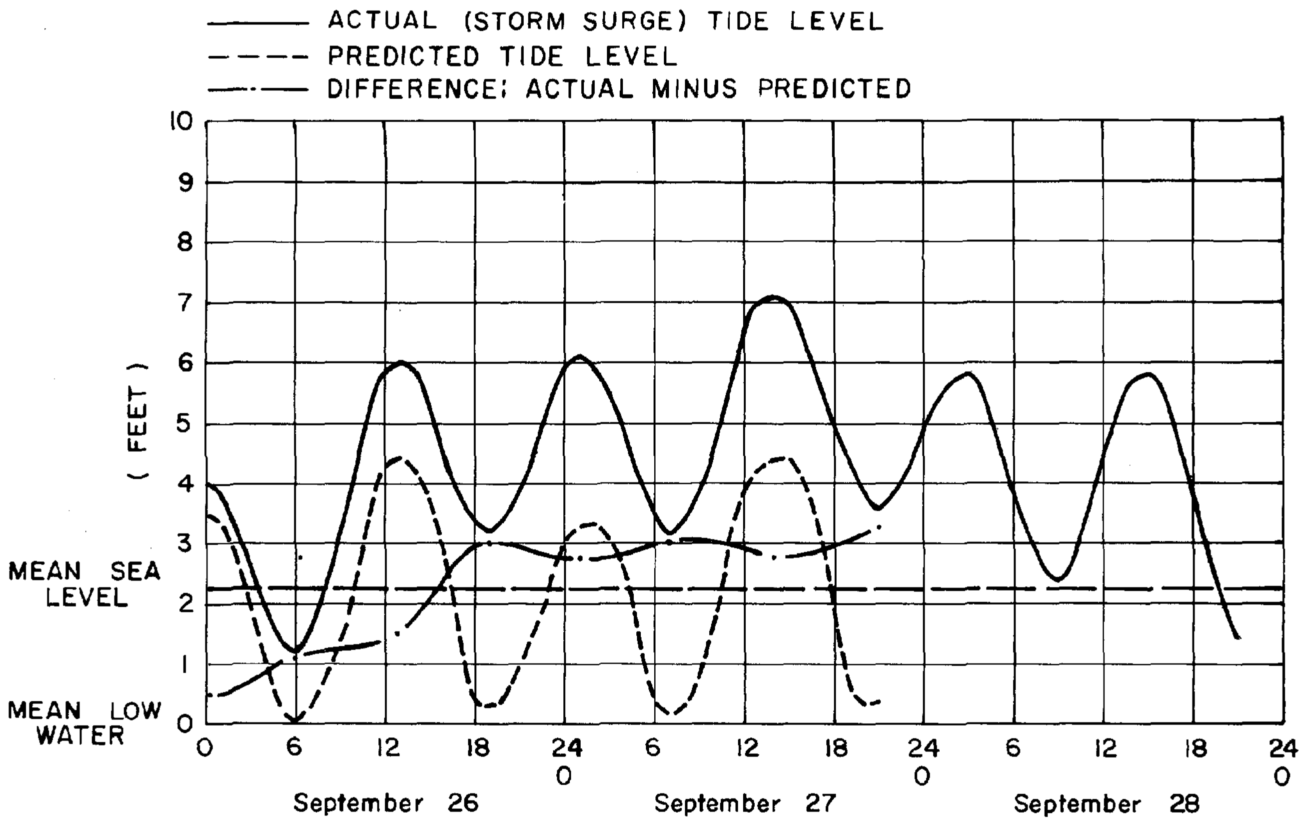
Breakwater Harbor

August 13 - 15, 1953



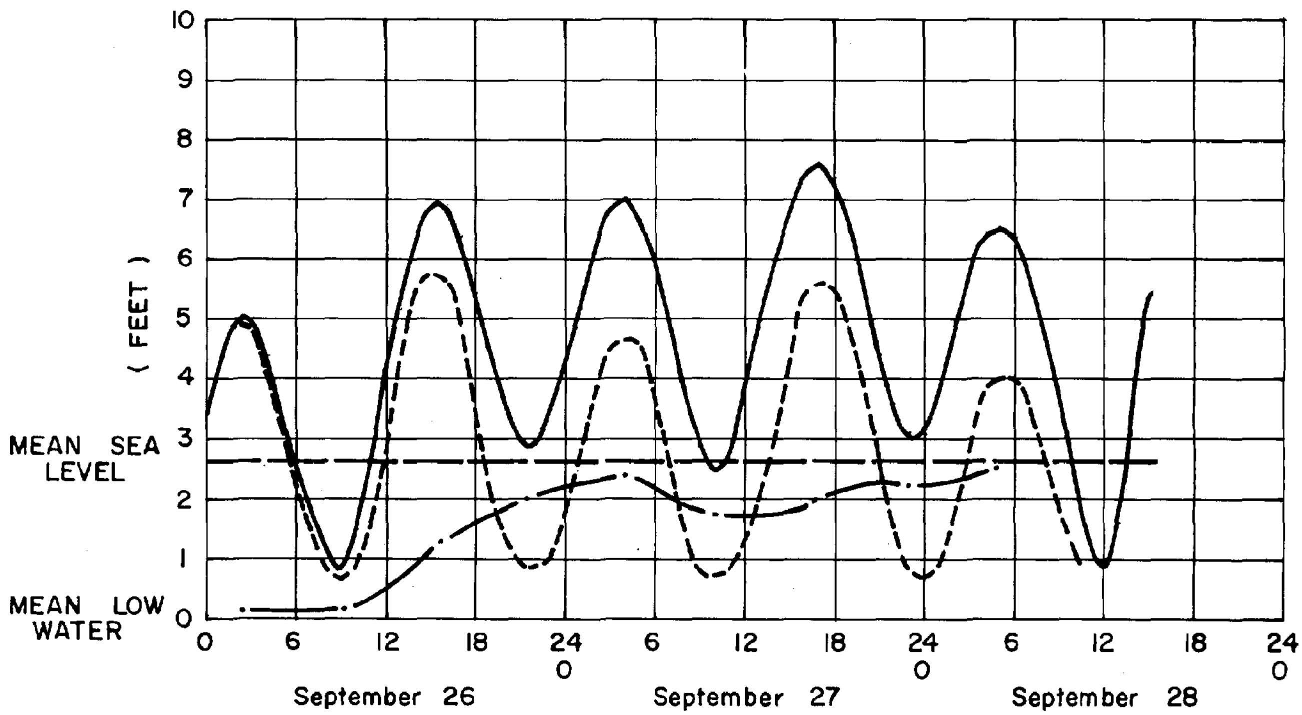
Breakwater Harbor

September 26 - 28, 1956



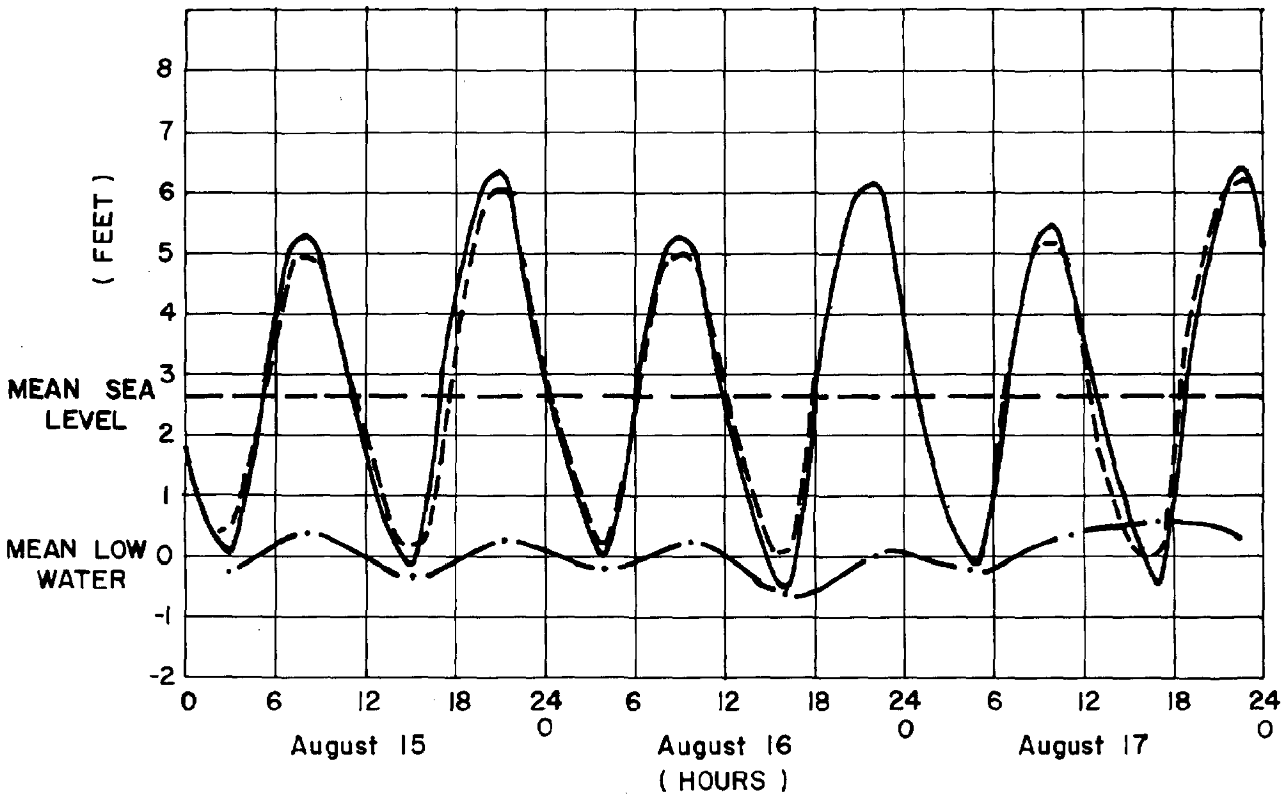
Reedy Point

September 26 - 28, 1956

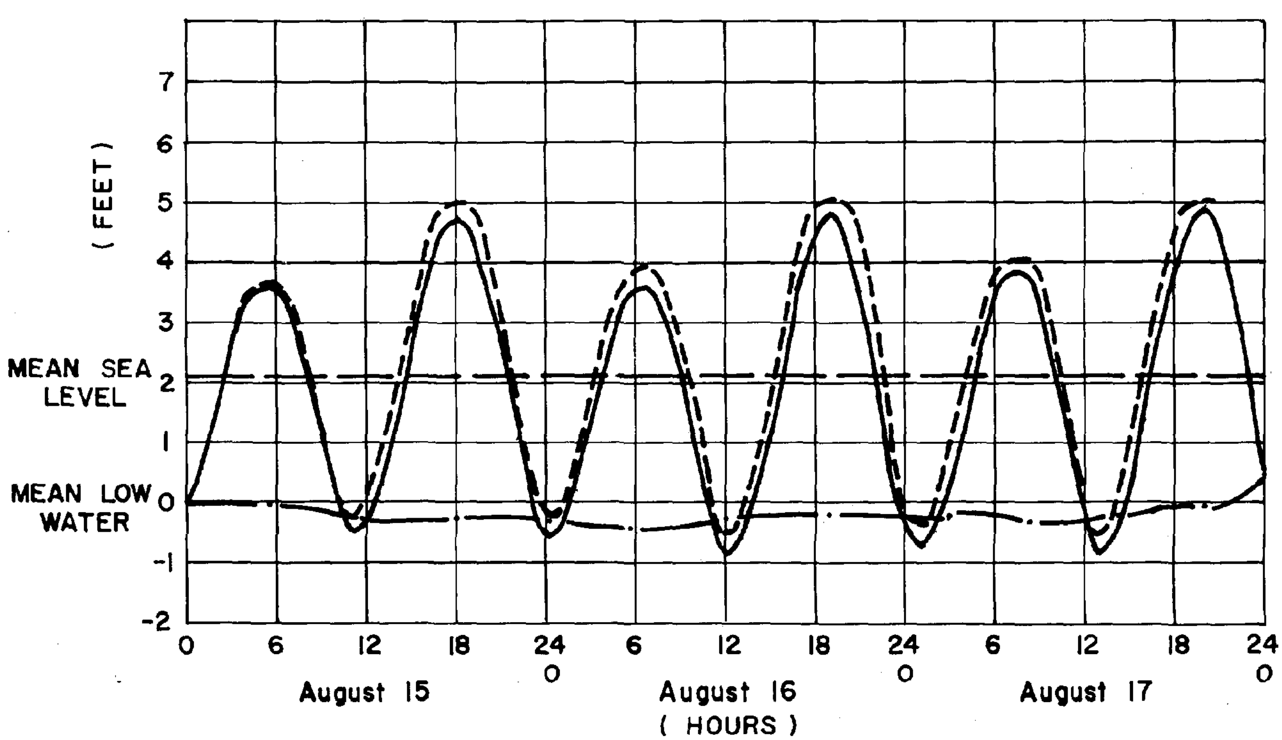


(HOURS)

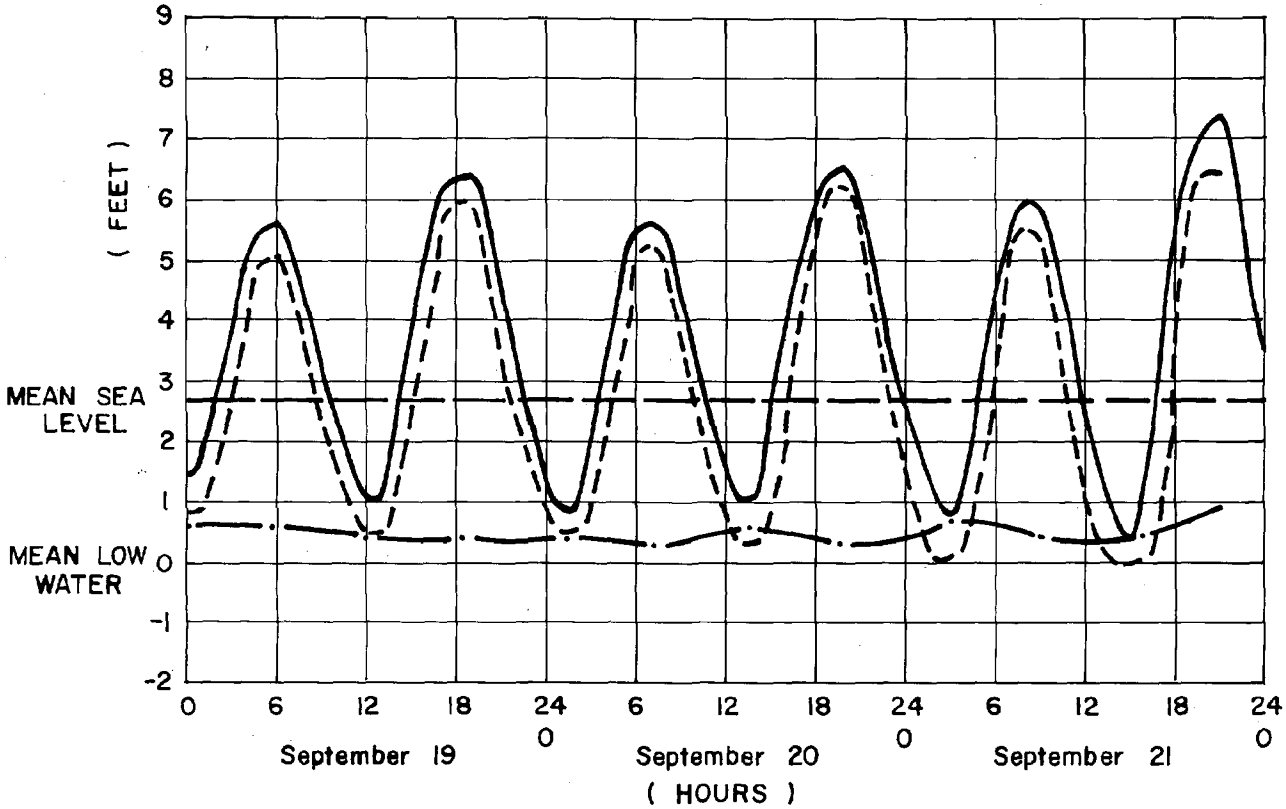
Reedy Point
August 15-17, 1959



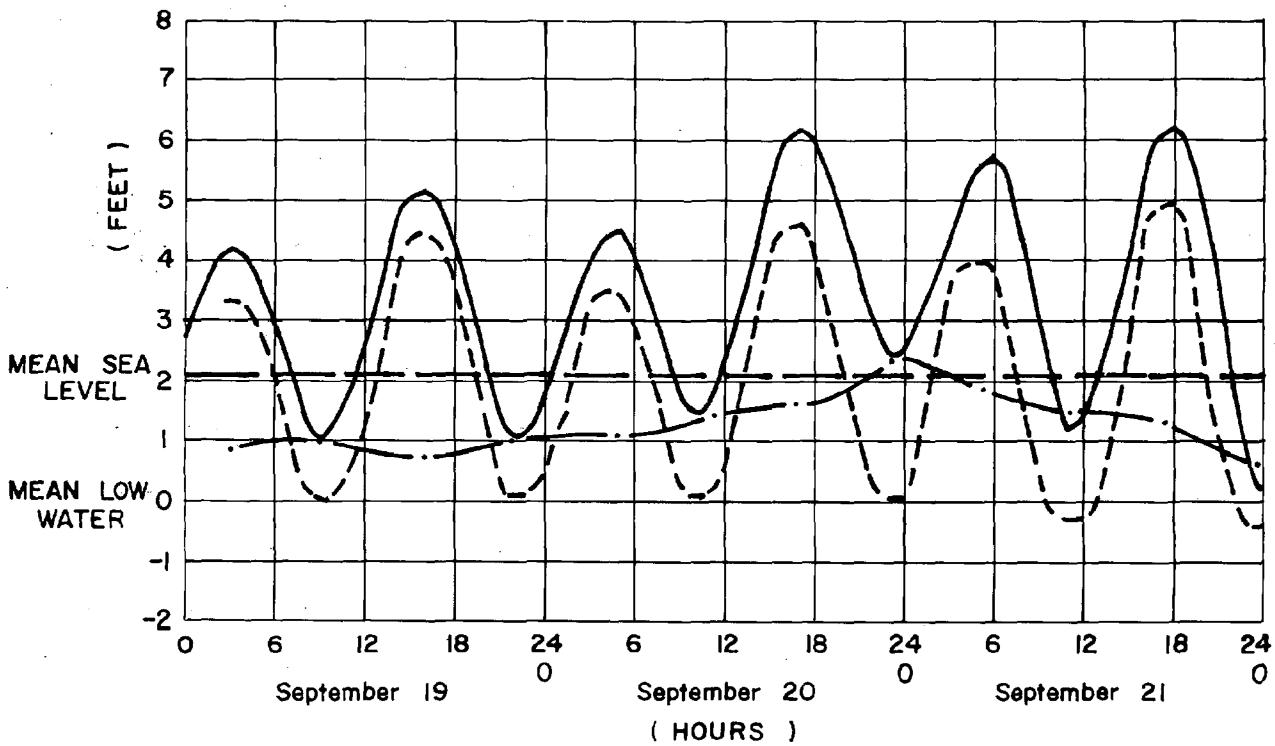
Breakwater Harbor
August 15-17, 1959



Reedy Point
September 19-21, 1961

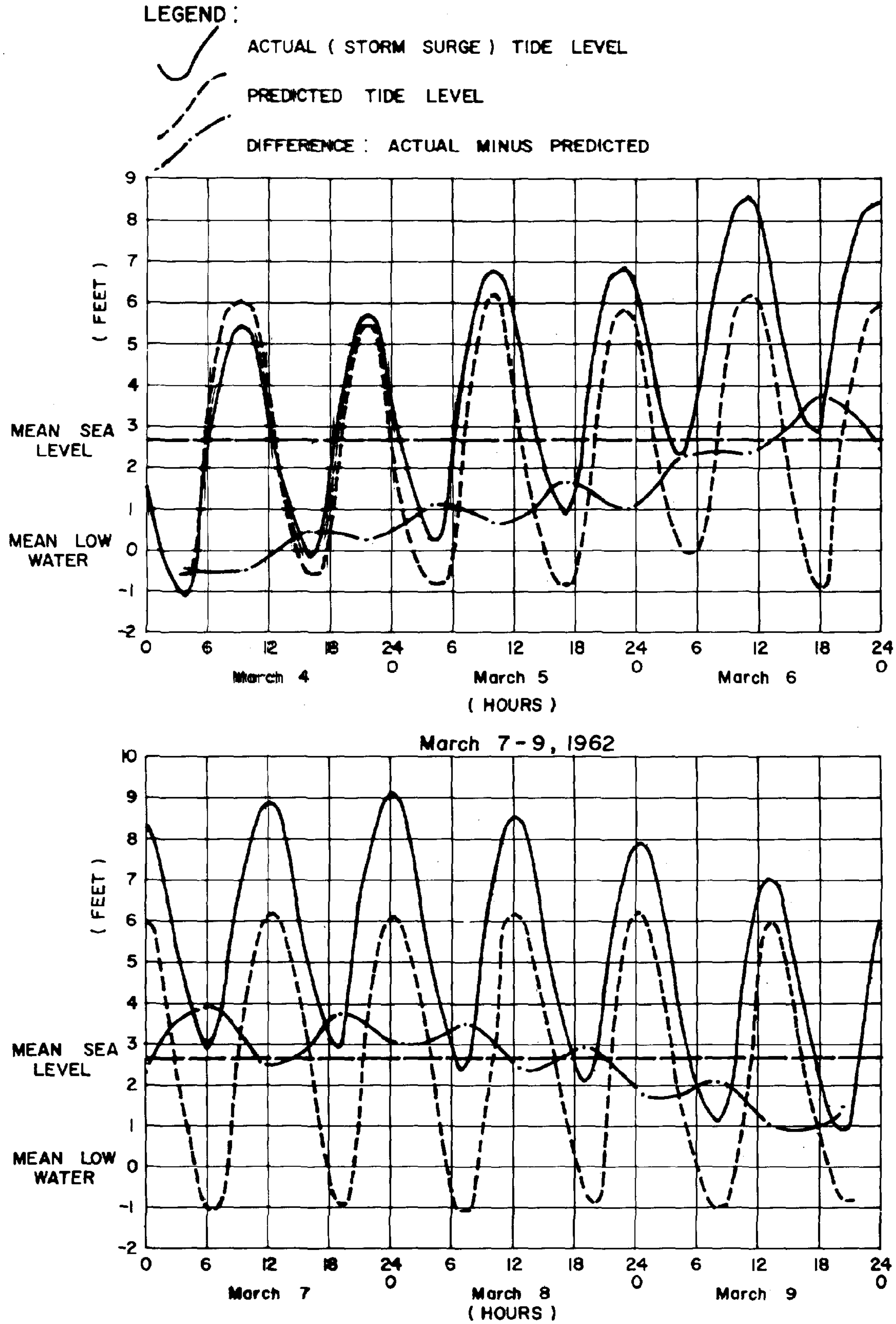


Breakwater Harbor
September 19-21, 1961



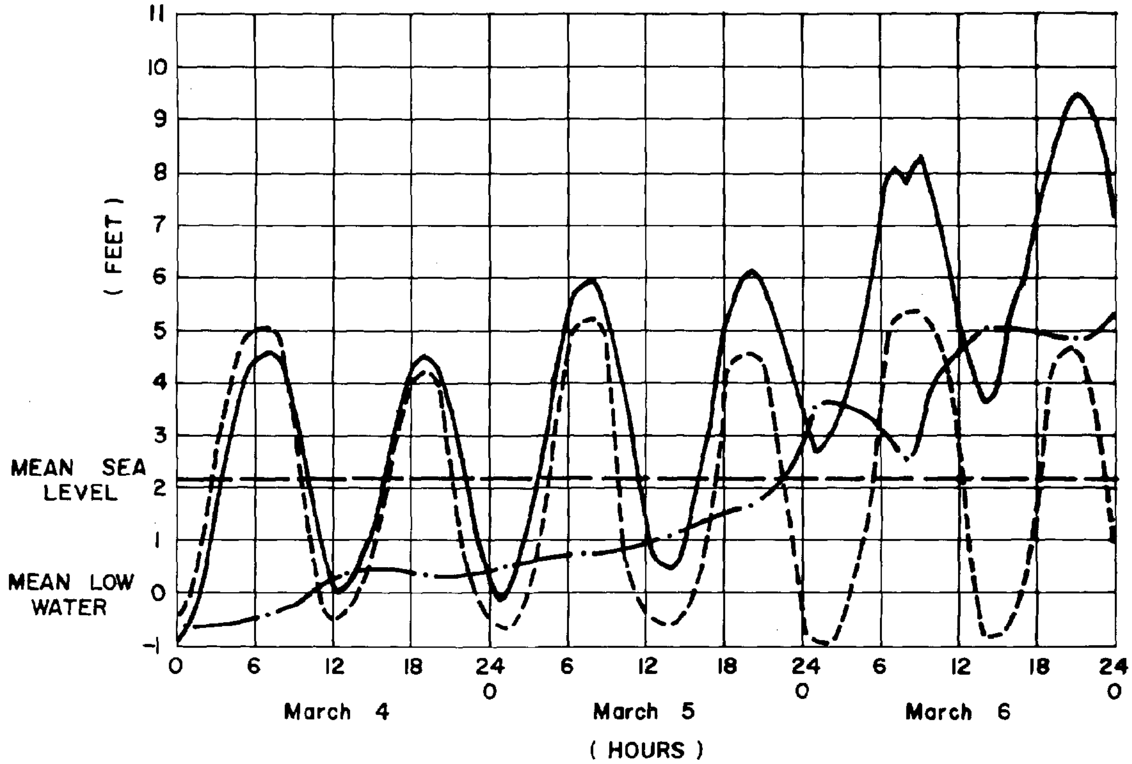
Reedy Point , DELAWARE

March 4 - 6 , 1962

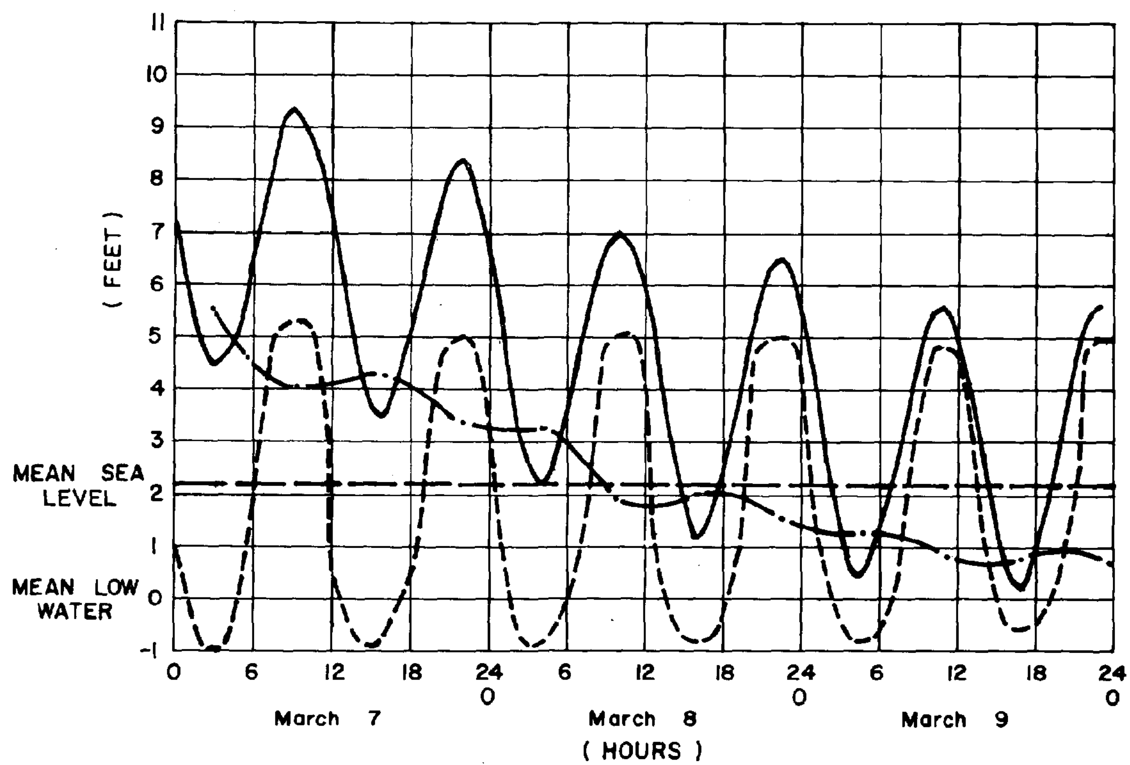


Breakwater Harbor, LEWES, DELAWARE

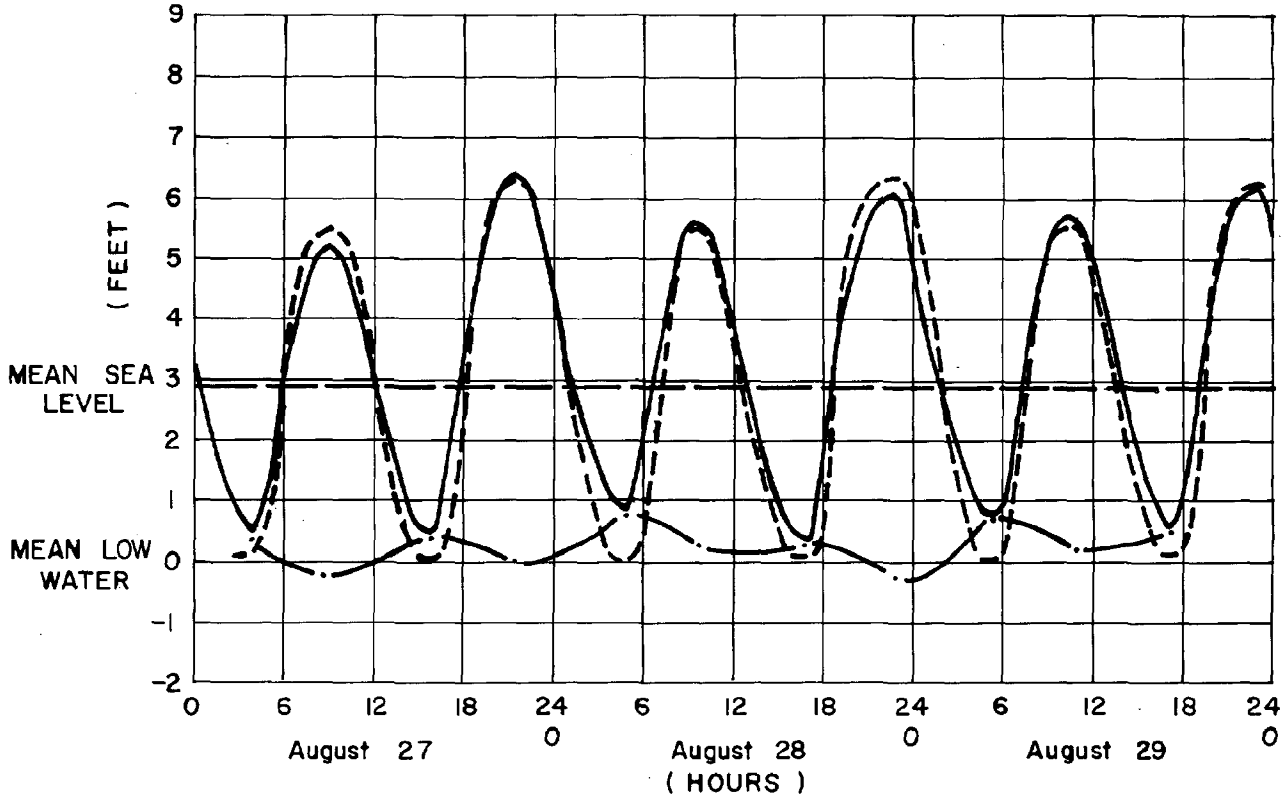
March 4 - 6, 1962



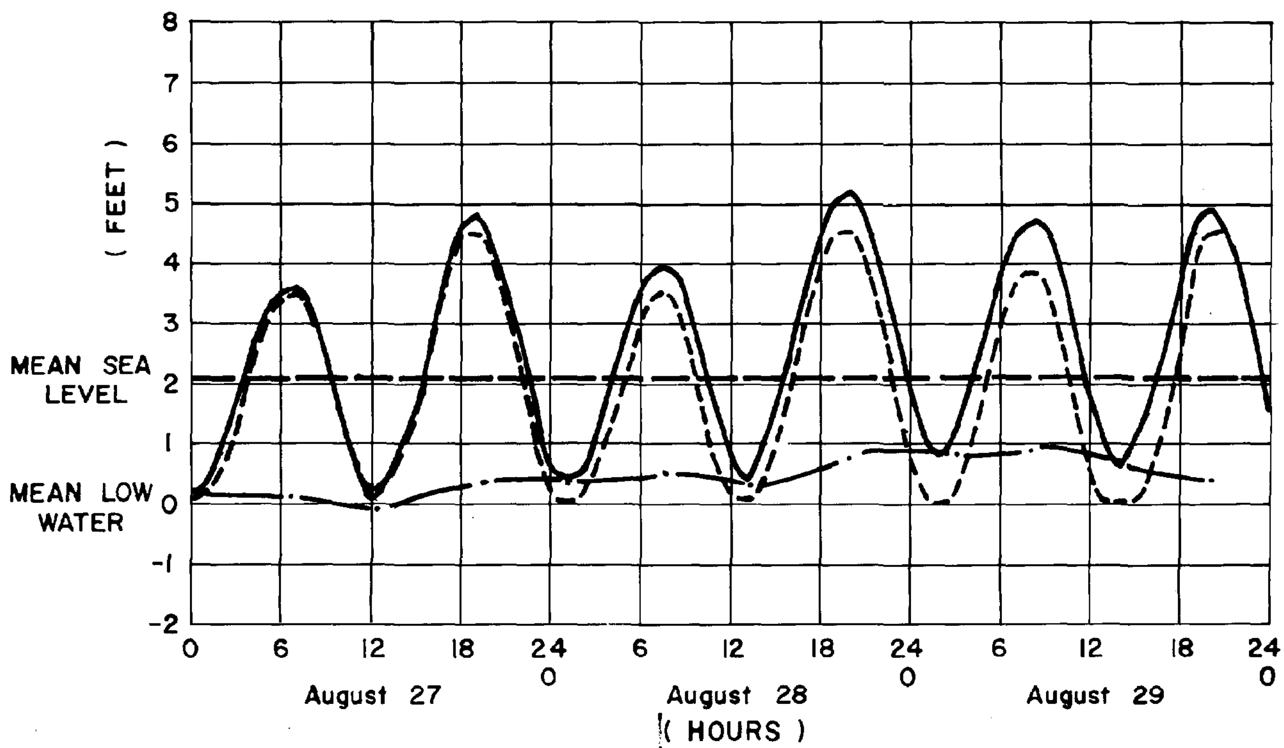
March 7 - 9, 1962



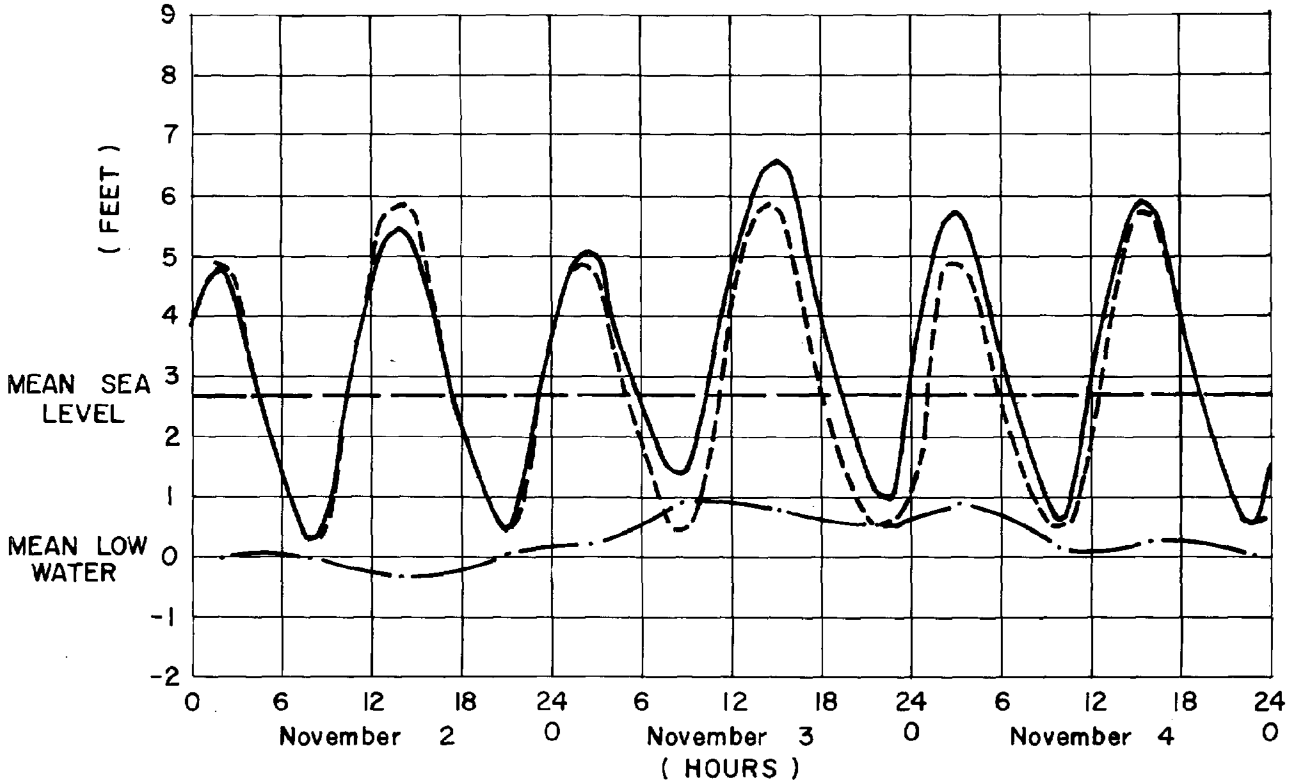
Reedy Point
August 27 - 29, 1962



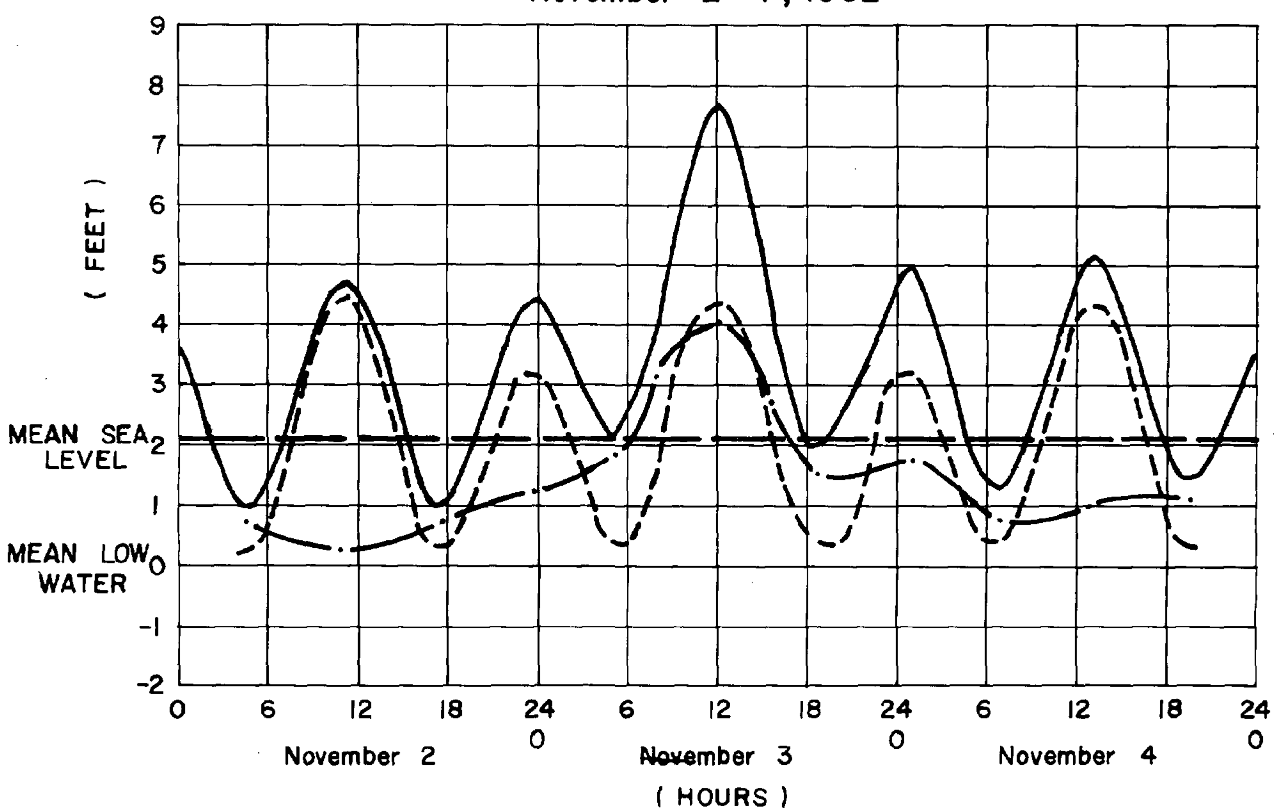
Breakwater Harbor
August 27 - 29, 1962



Reedy Point
November 2-4, 1962

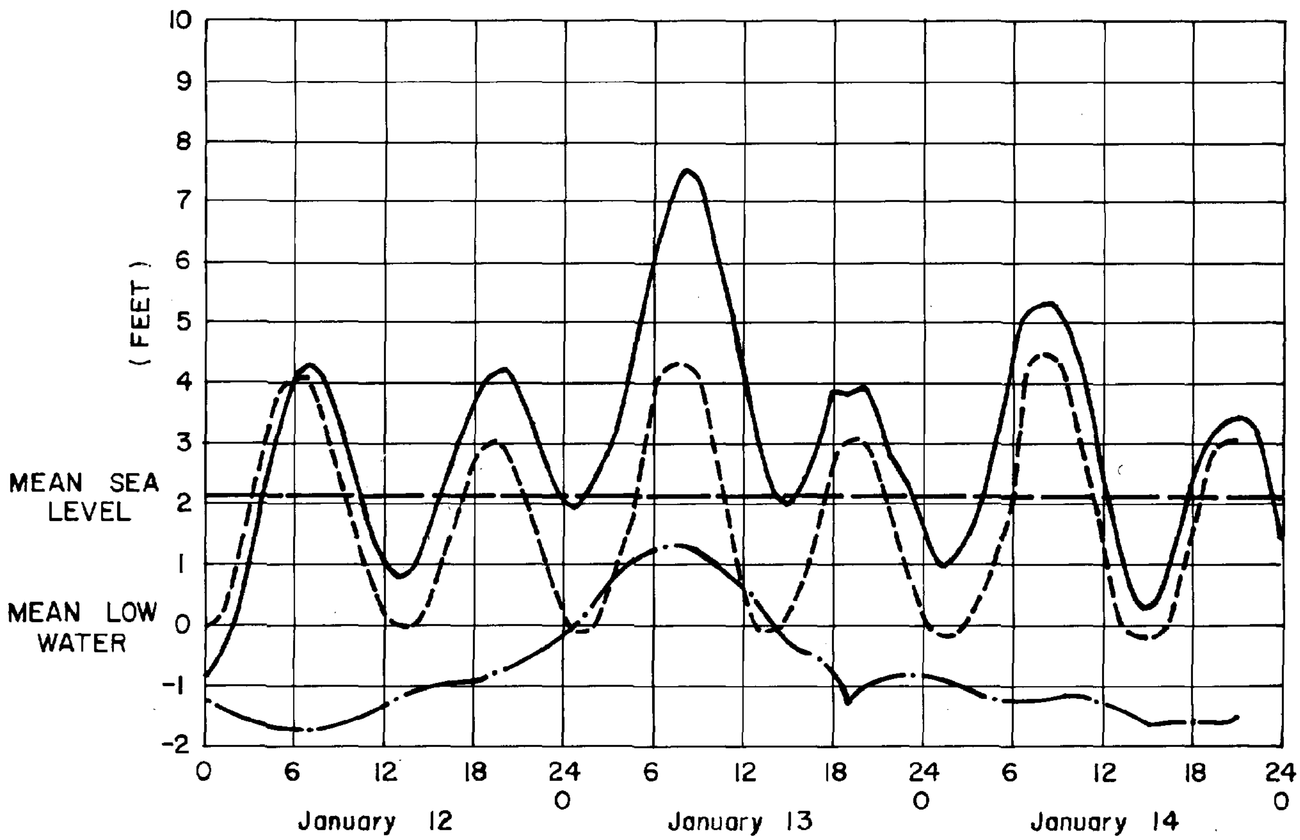


Breakwater Harbor
November 2-4, 1962



Breakwater Harbor

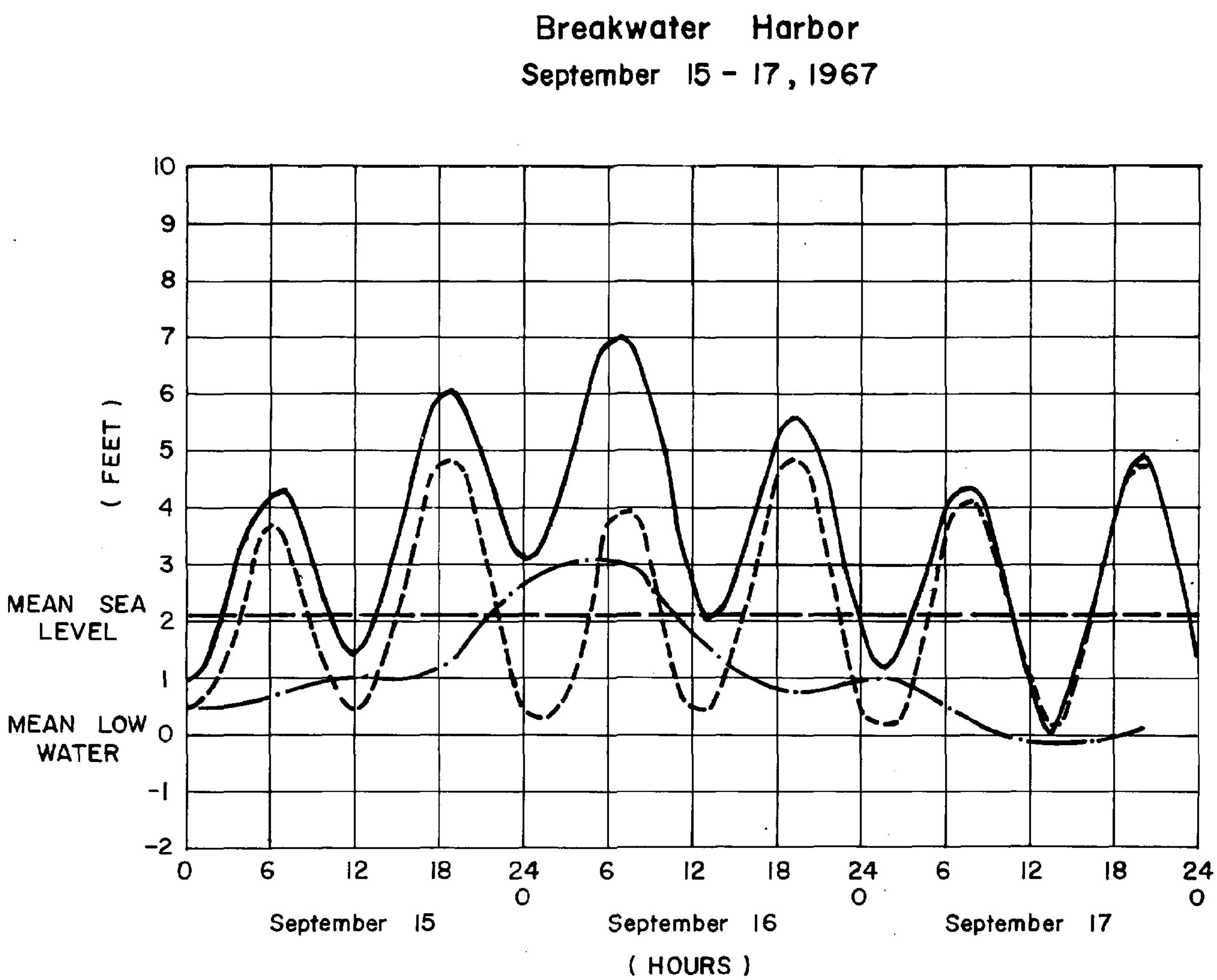
January 12 - 14, 1964



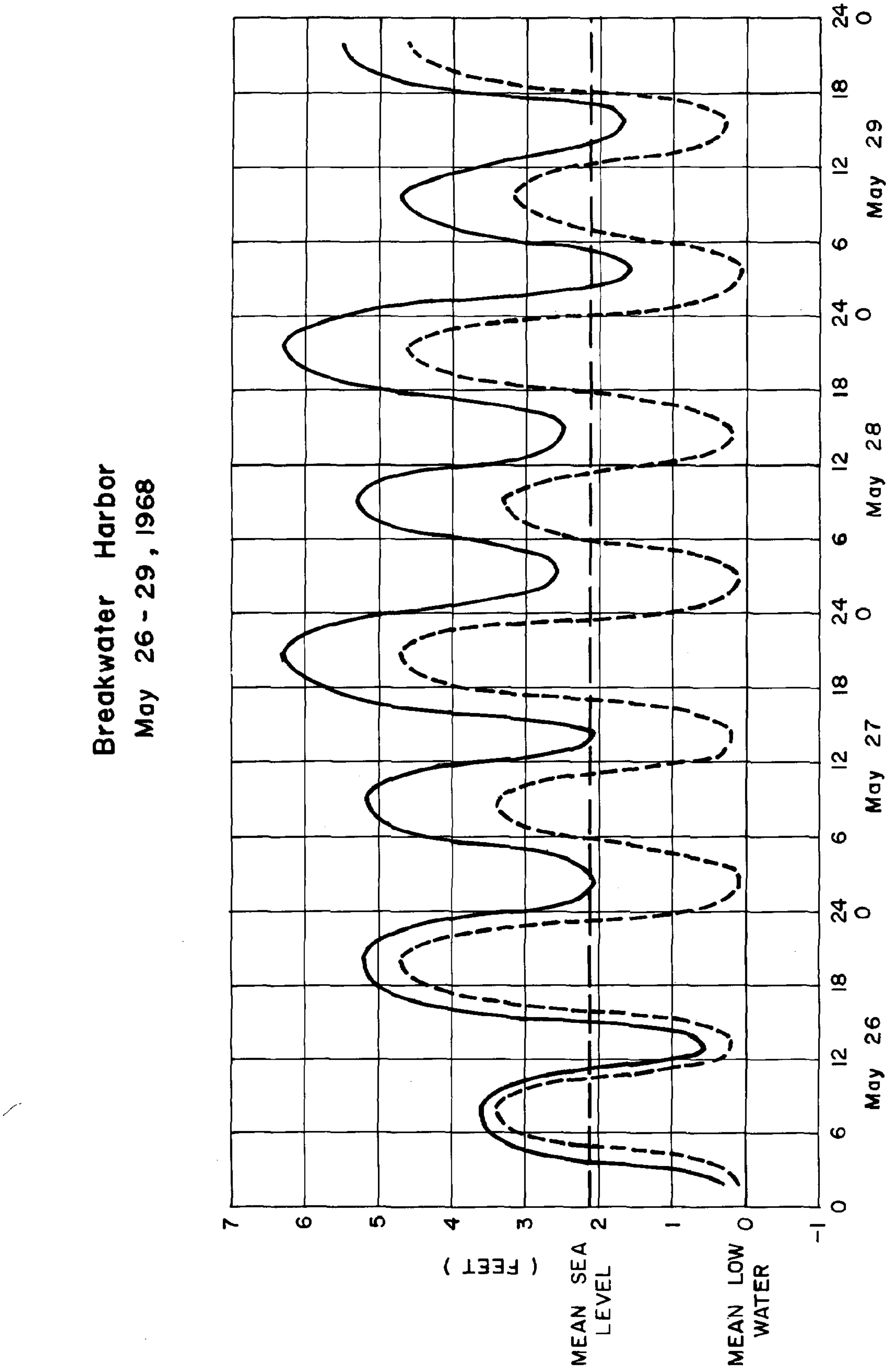
——— ACTUAL (STORM SURGE) TIDE LEVEL

– – – – – PREDICTED TIDE LEVEL

—·—·— DIFFERENCE: ACTUAL MINUS PREDICTED



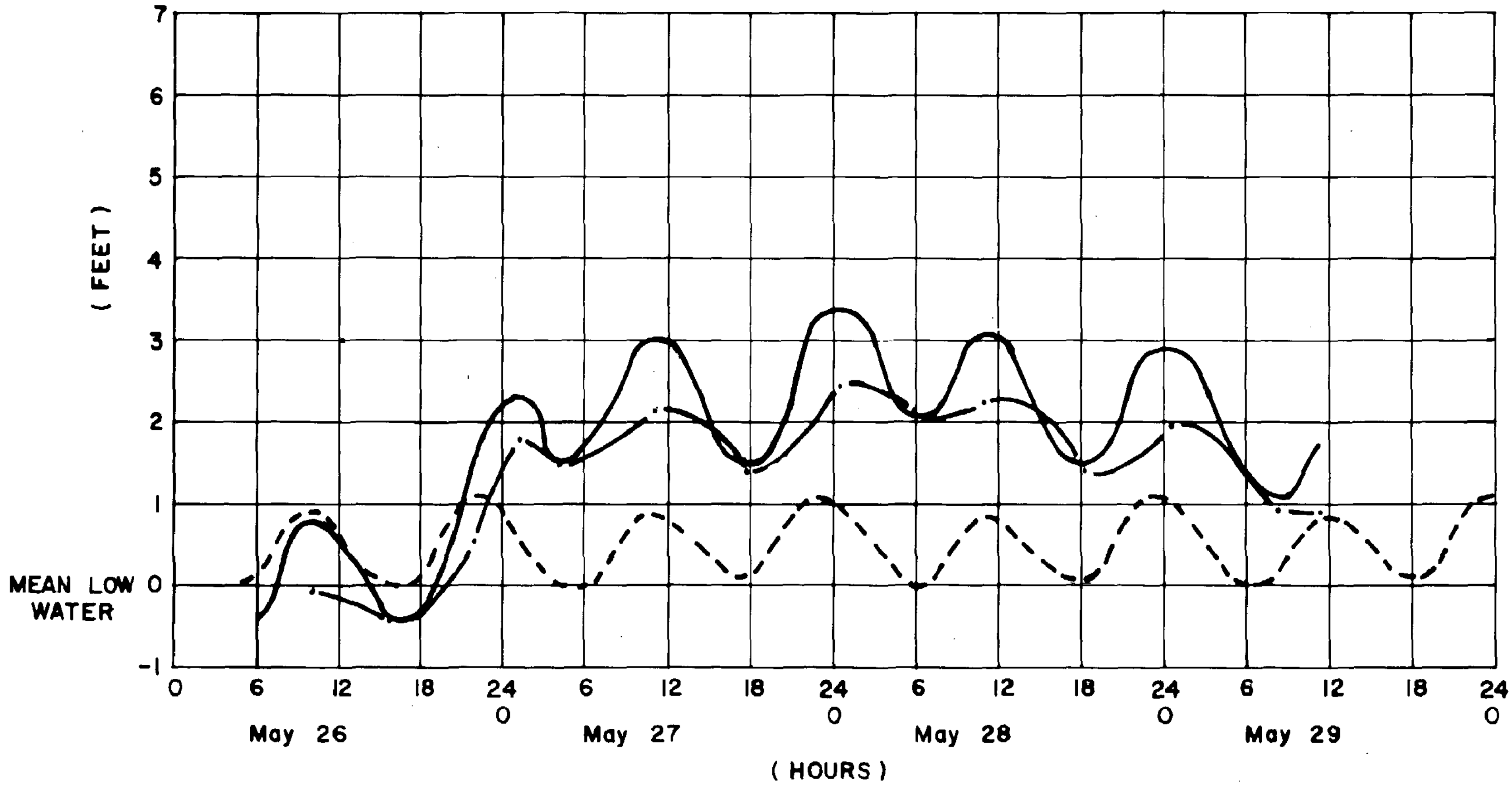
Breakwater Harbor
September 15 - 17, 1967
10
9
8
7
6
5
4
3
2
1
0
-1
-2
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
0
6
12
18
24
0
6
12
18
24
0
6
12
18
24
0
September 15
September 16
September 17
(HOURS)


Breakwater Harbor
May 26 - 29, 1968
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
7
6
5
4
3
2
1
0
-1
0 6 12 18 24
0 6 12 18 24
0 6 12 18 24
0 6 12 18 24
May 26
May 27
May 28
May 29
(HOURS)

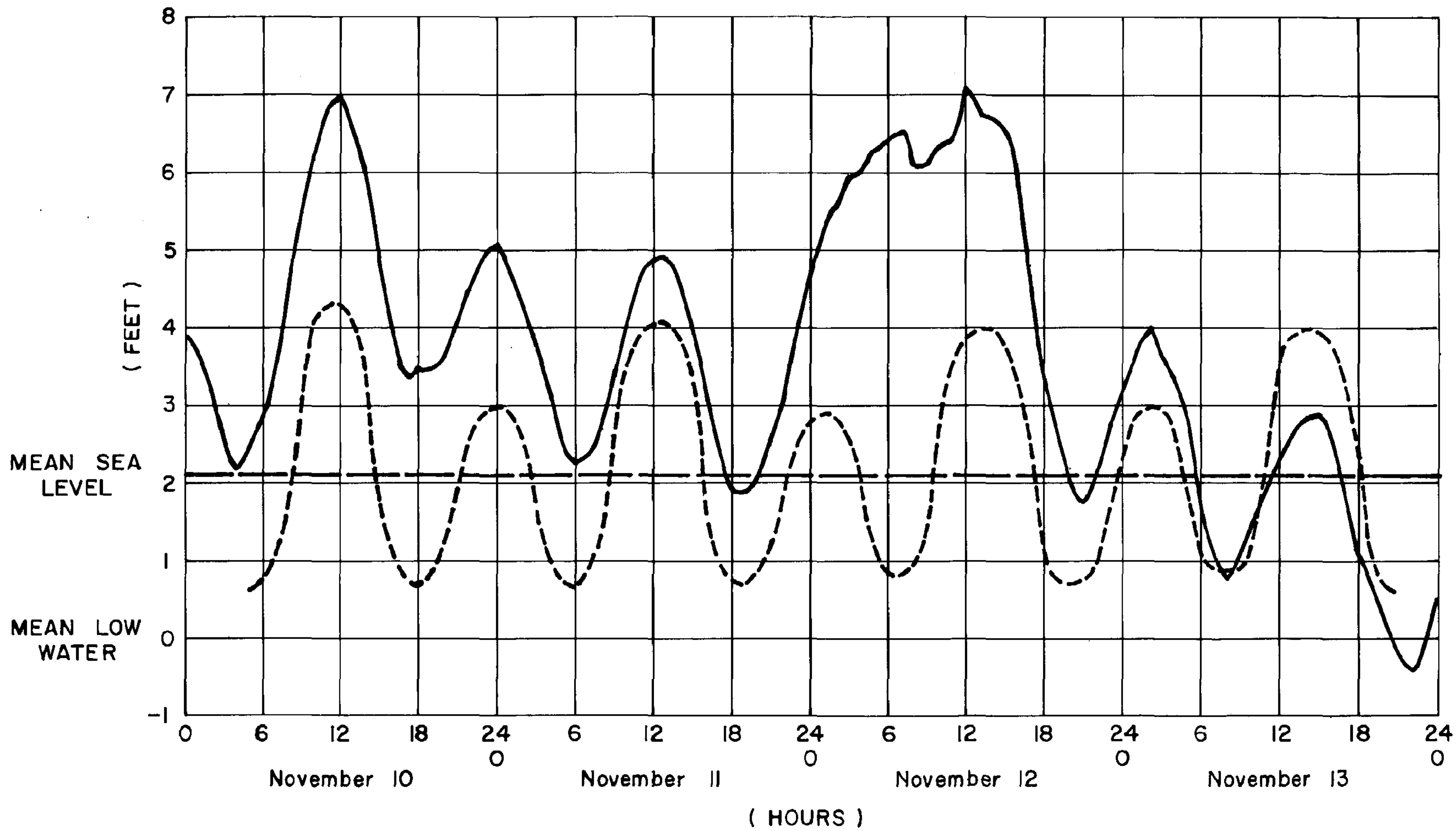
Indian River Power Plant, INDIAN RIVER, DE.

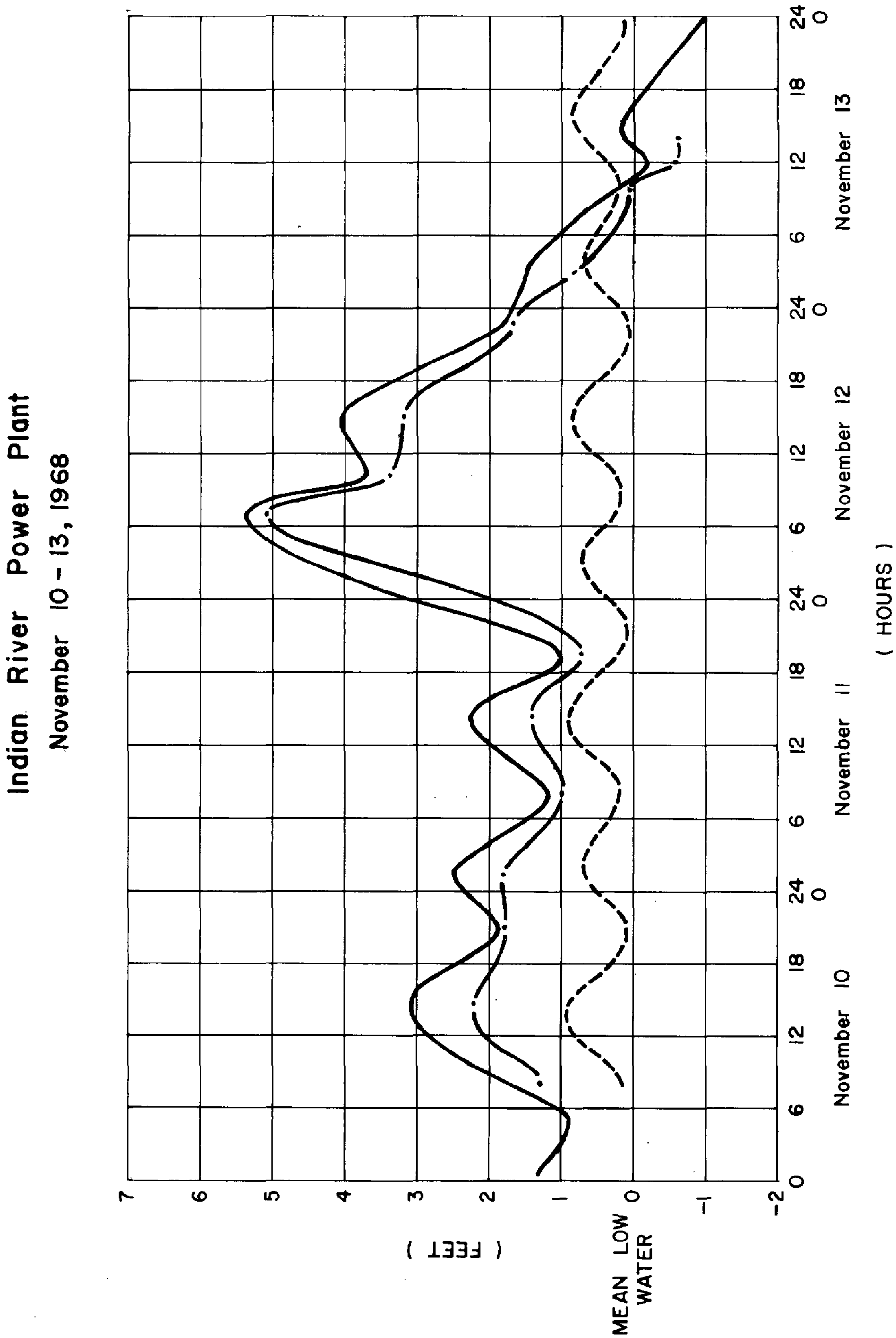
May 26 - 29, 1968

LEGEND: SEE FIGURE A

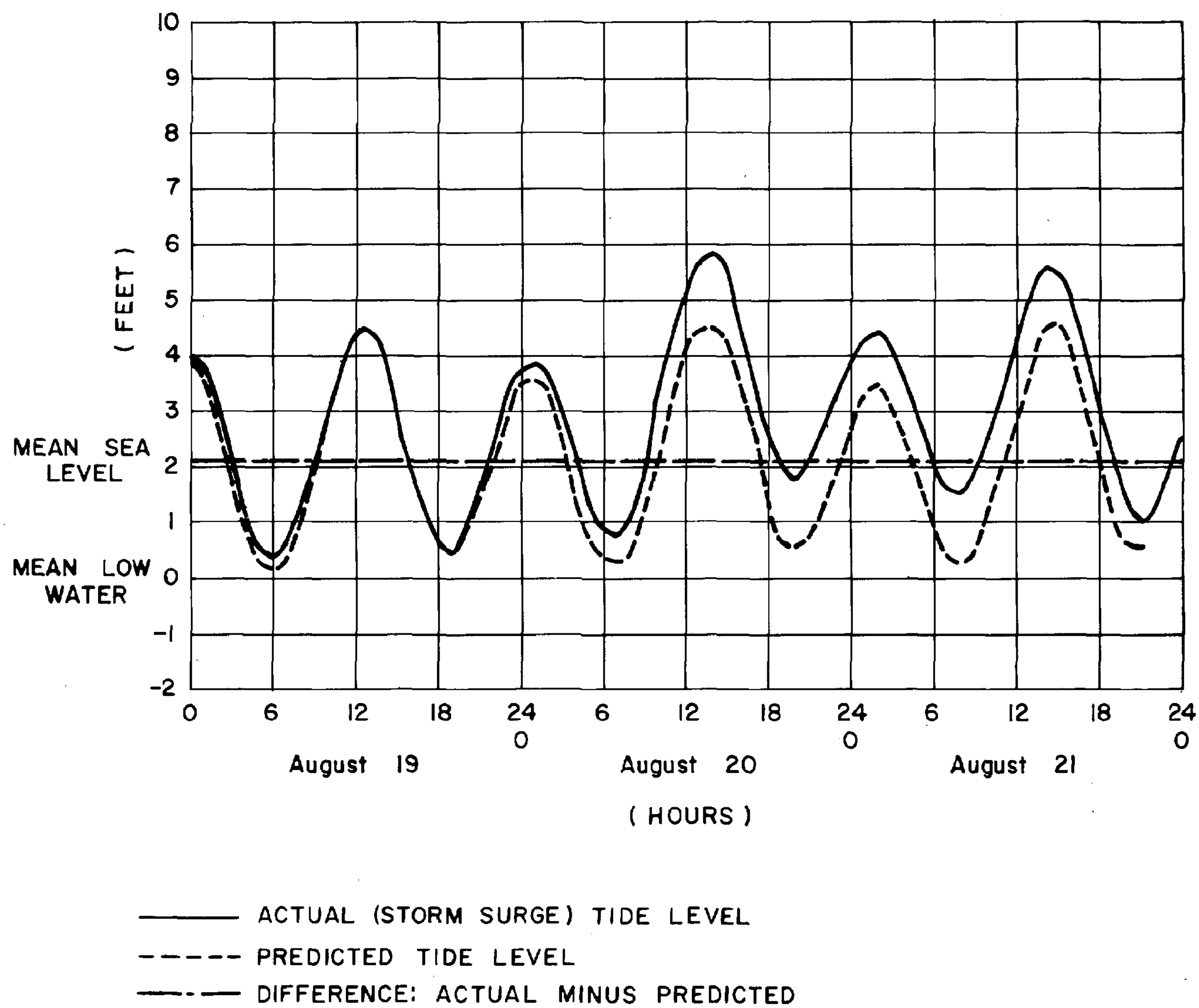


Breakwater Harbor
November 10 - 13, 1968



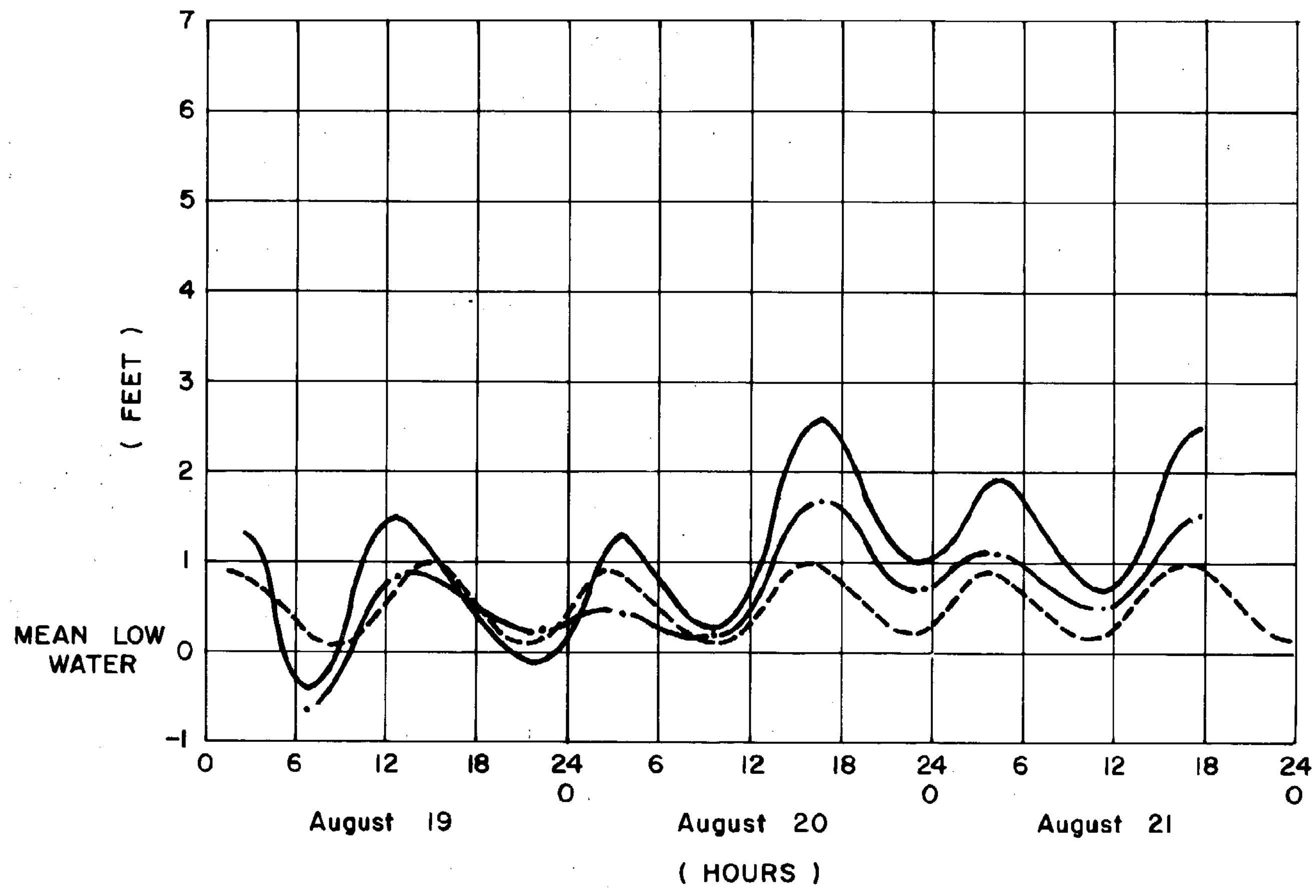

Indian River Power Plant
November 10 - 13, 1968
(FEET)
MEAN LOW WATER
7
6
5
4
3
2
1
0
-1
-2
0
6
12
18
24
0
November 10
November 11
November 12
November 13
(HOURS)

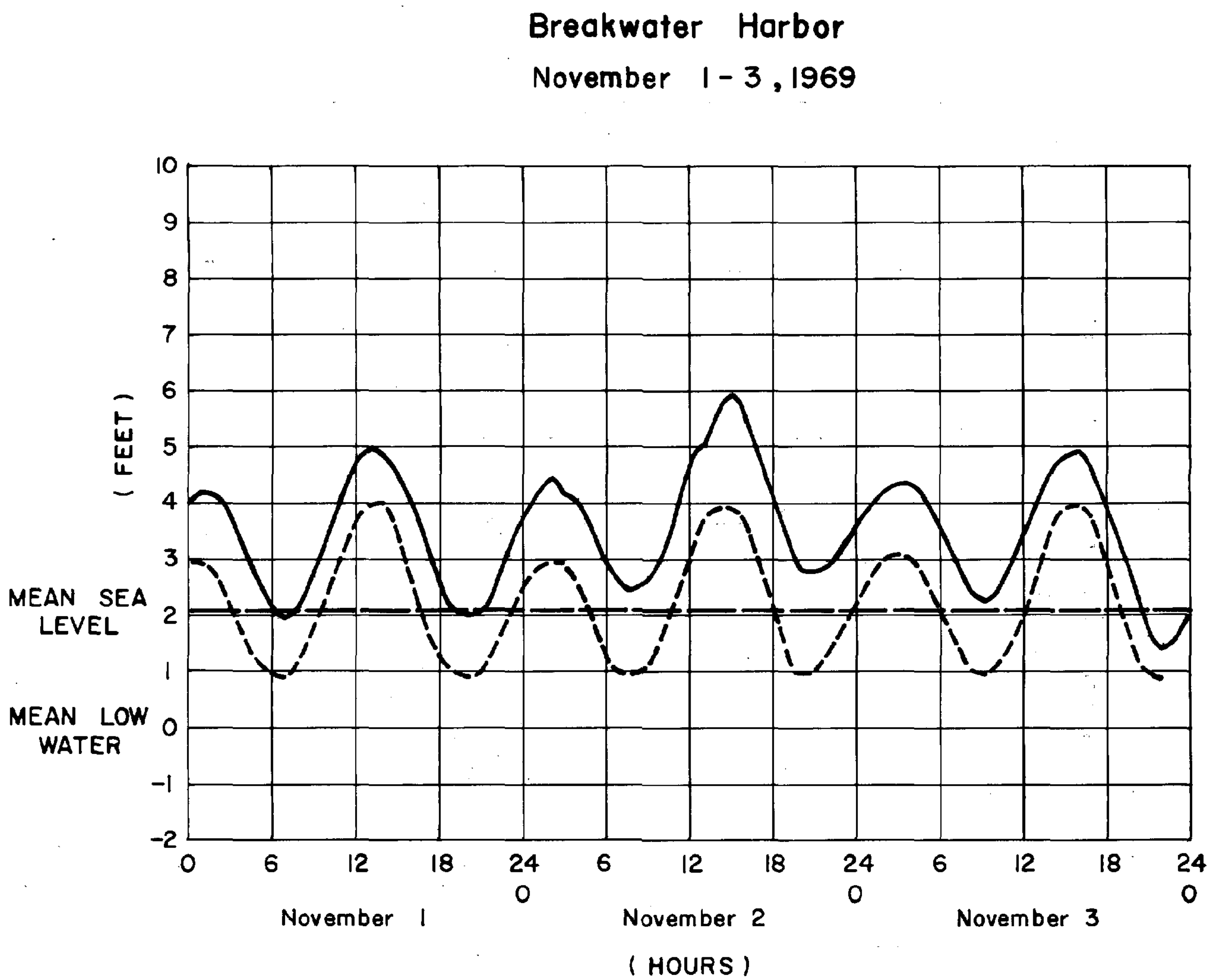
Breakwater Harbor
August 19 - 21, 1969



Indian River Power Plant

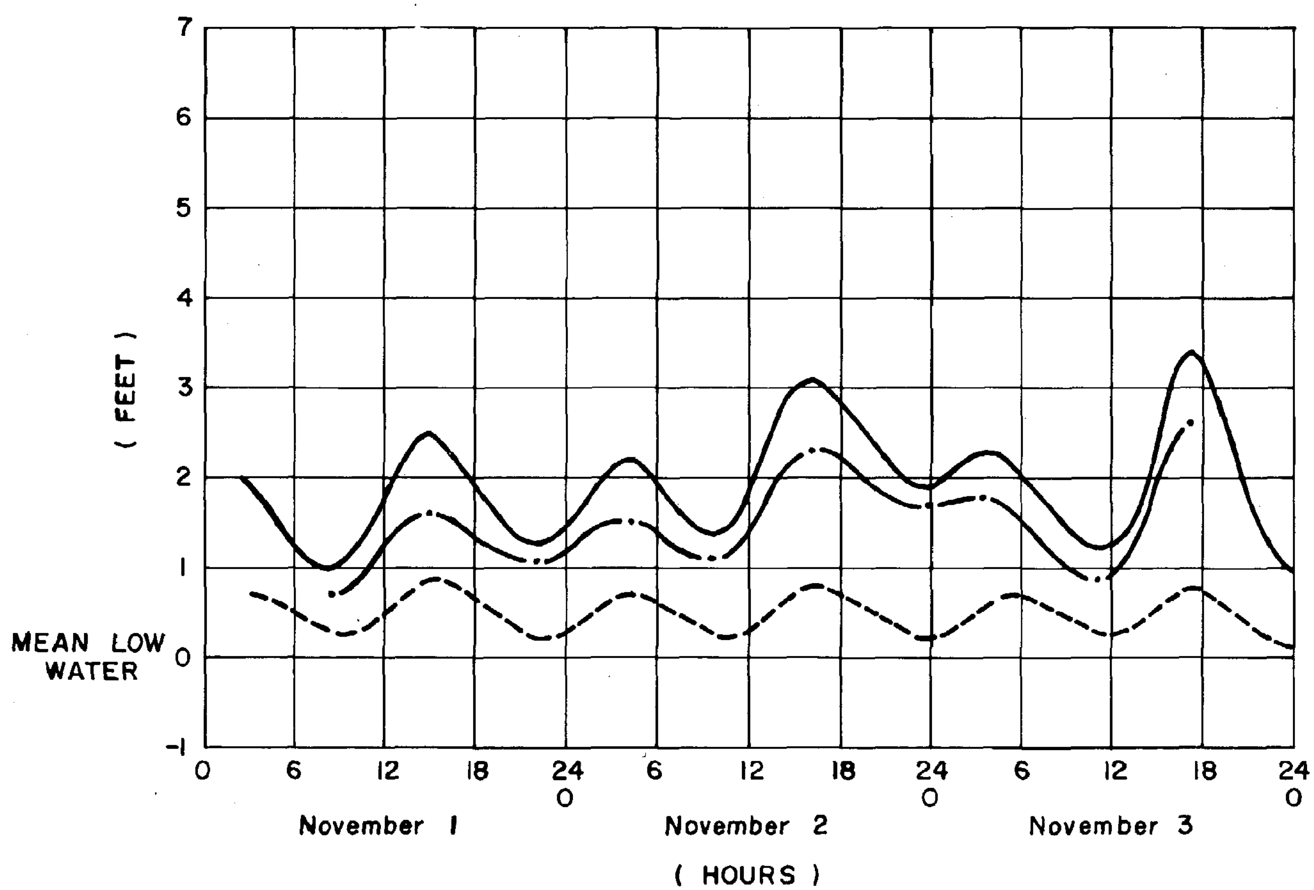
August 19-21, 1969



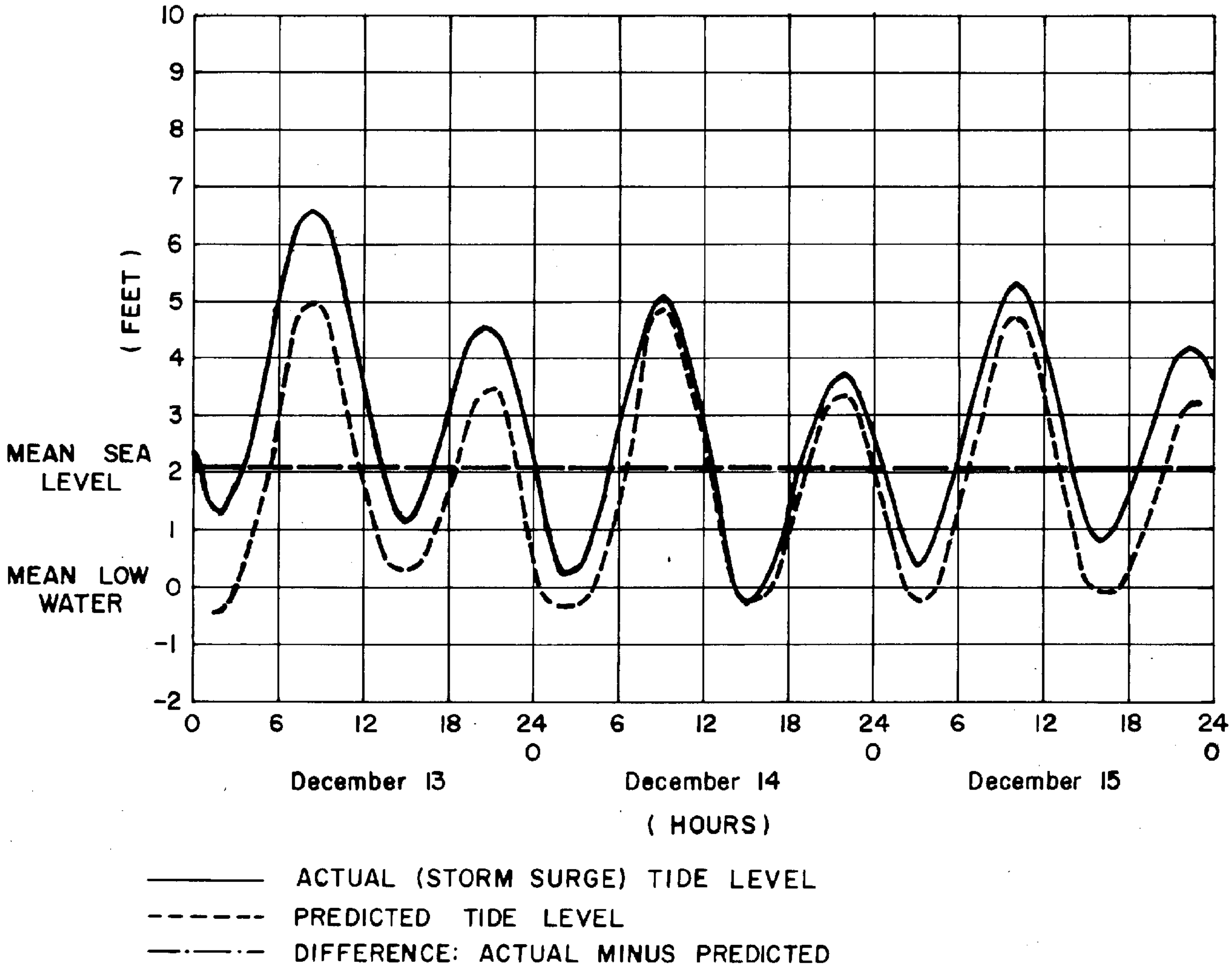

Breakwater Harbor
November 1 - 3, 1969
10
9
8
7
6
5
4
3
2
1
0
-1
-2
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
0
6
12
18
24
0
6
12
18
24
0
6
12
18
24
0
November 1
November 2
November 3
(HOURS)

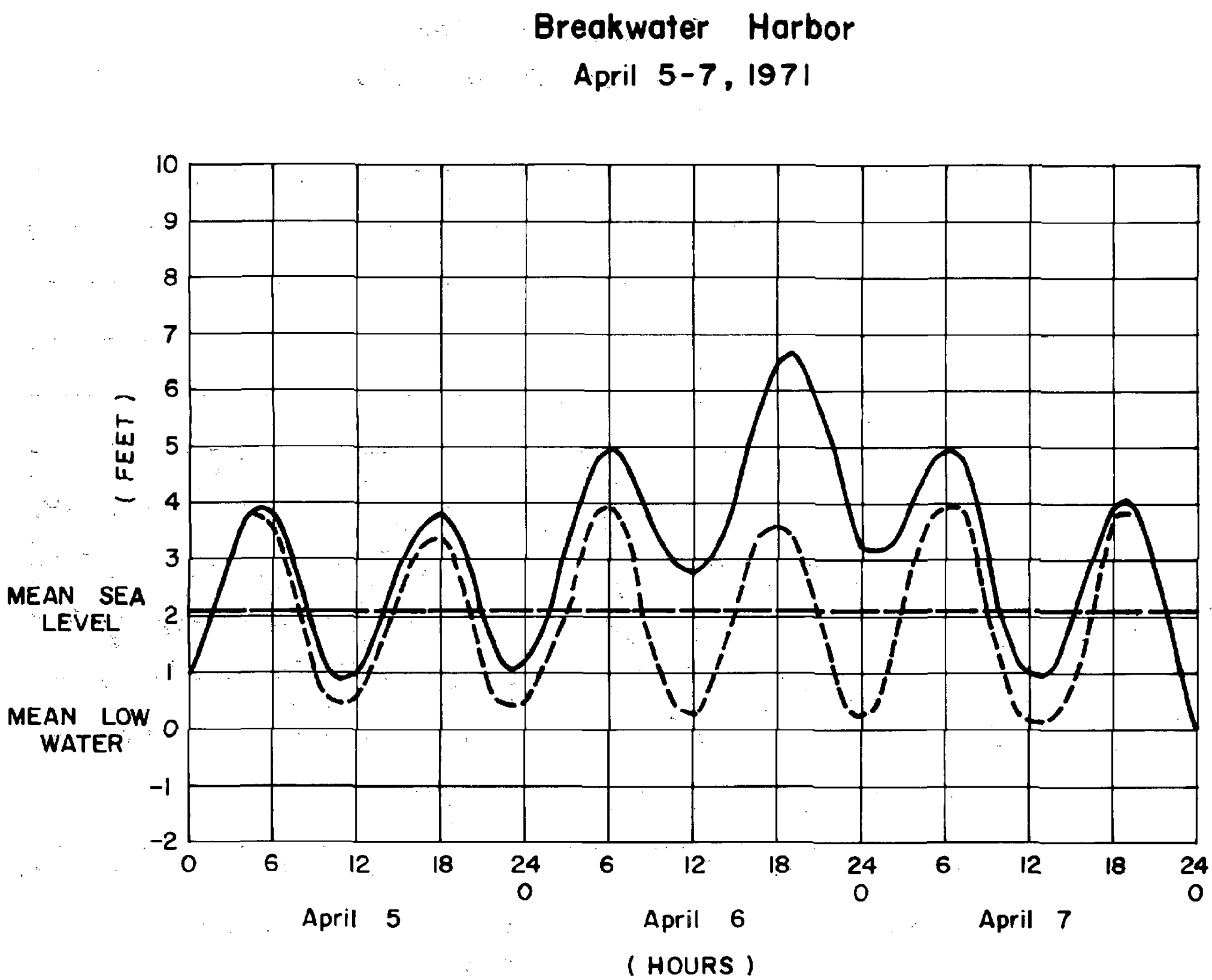
Indian River Power Plant

November 1 - 3, 1969



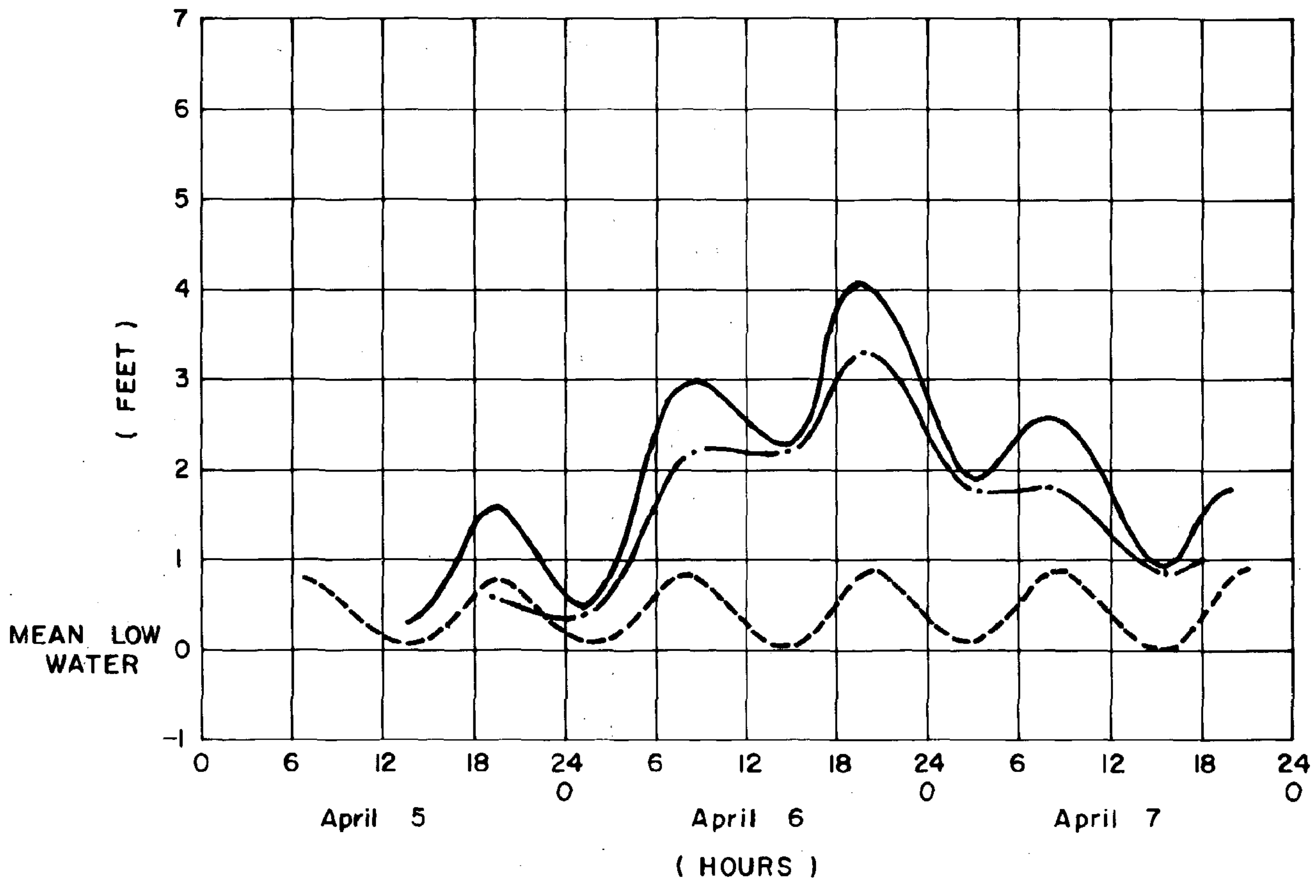
Breakwater Harbor
December 13 - 15, 1970




Breakwater Harbor
April 5-7, 1971
10
9
8
7
6
5
4
3
2
1
0
-1
-2
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
0
6
12
18
24
0
6
12
18
24
0
6
12
18
24
0
April 5
April 6
April 7
(HOURS)

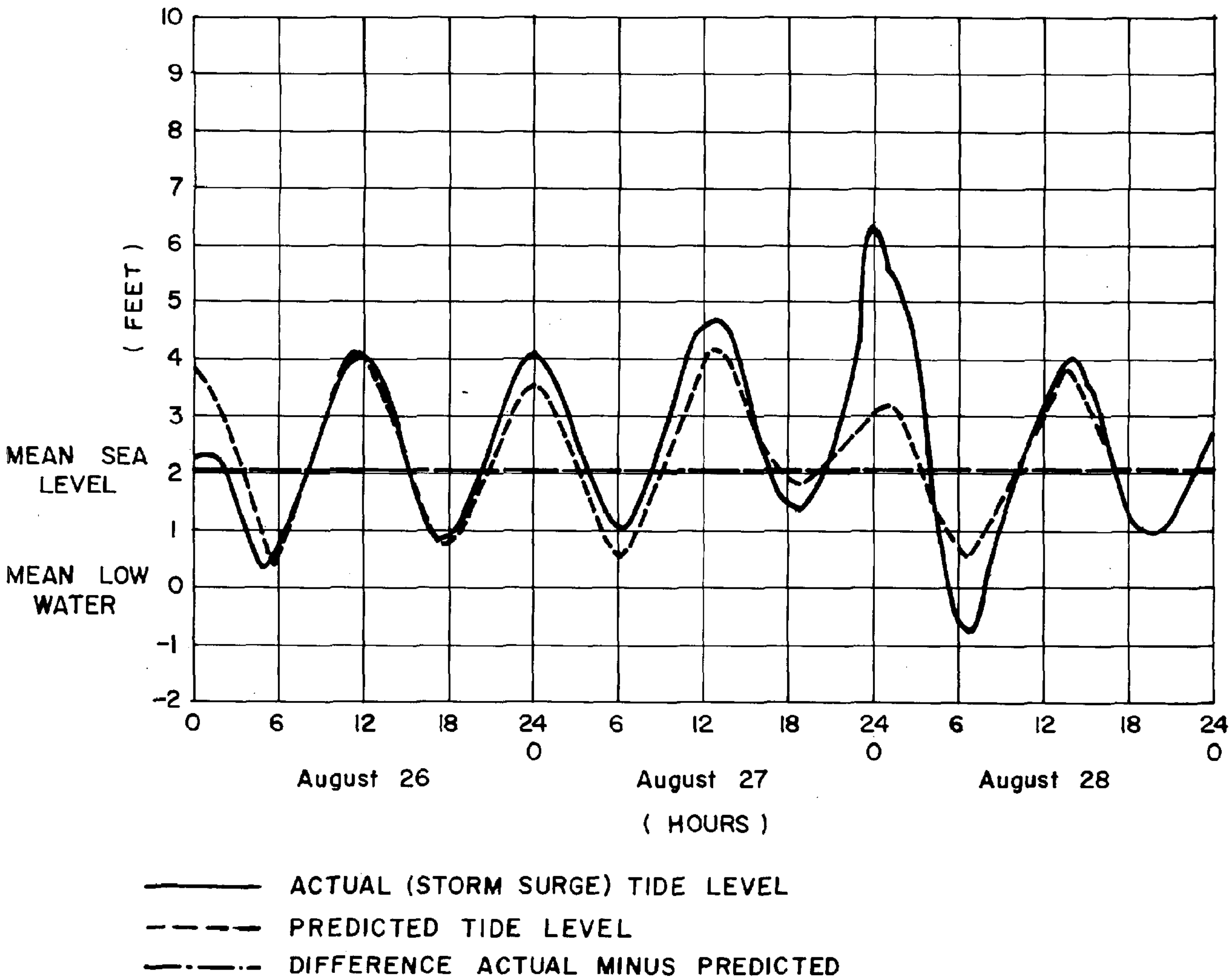
Indian River Power Plant

April 5 - 7, 1971



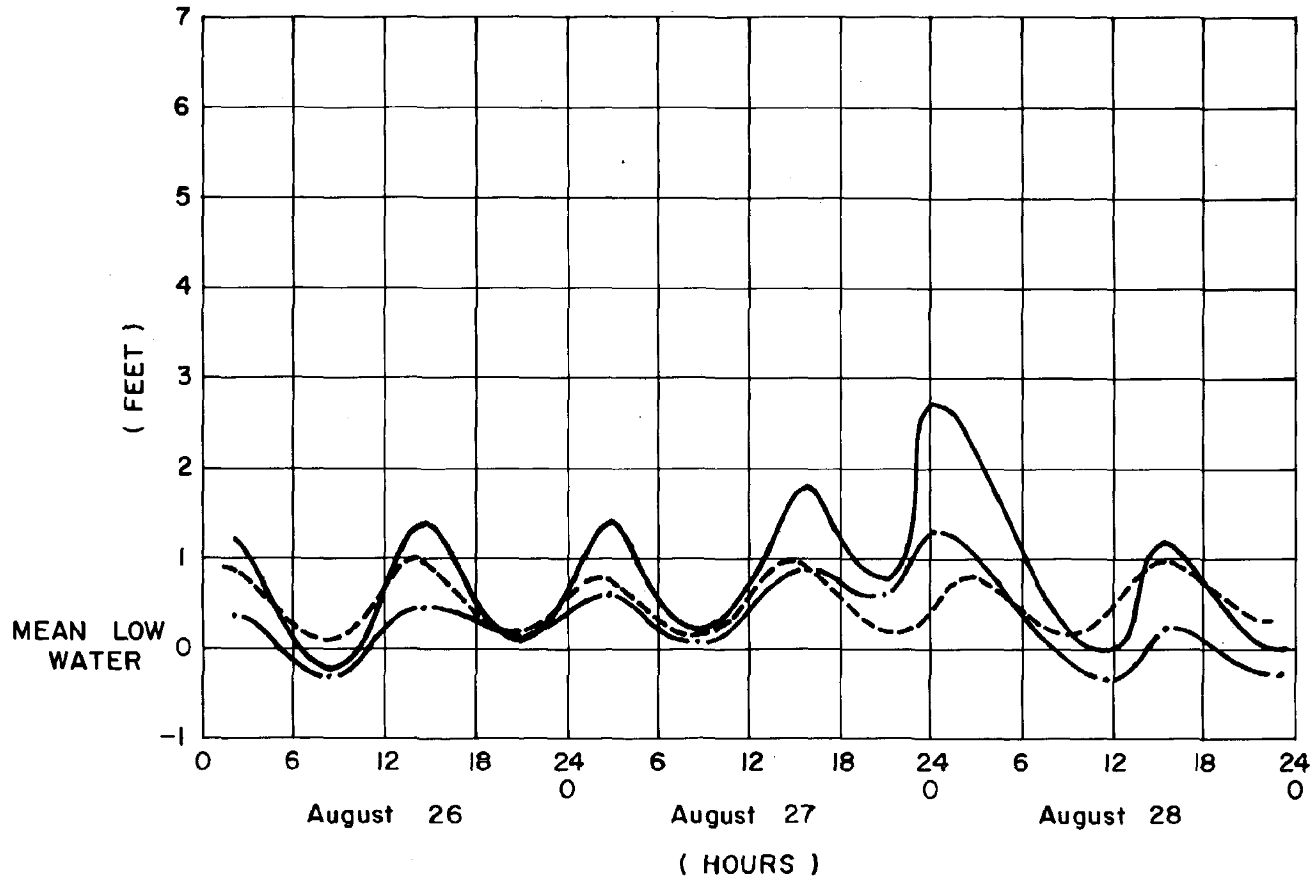
Breakwater Harbor

August 26 – 28, 1971



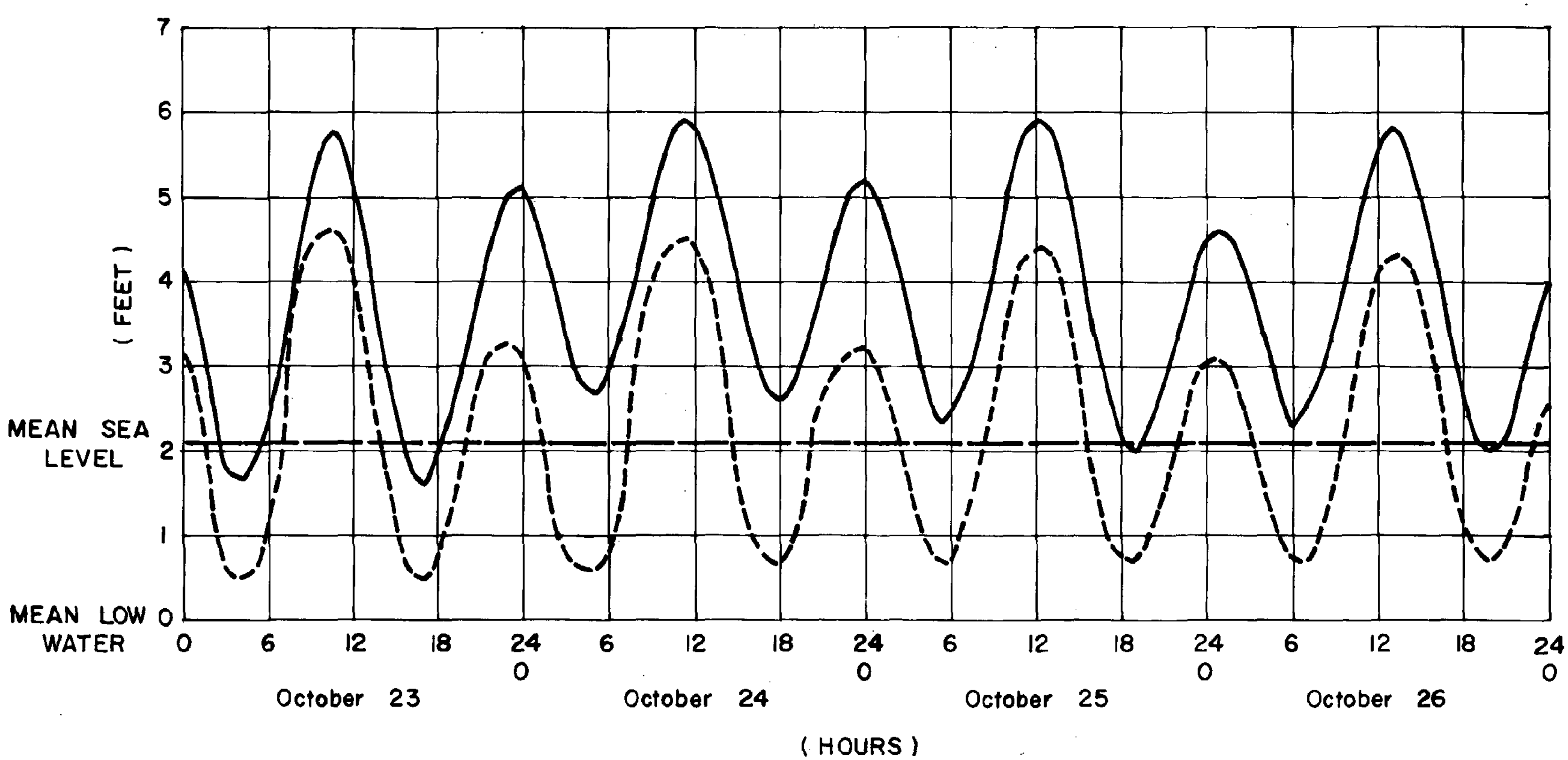
Indian River Power Plant

August 26 - 28, 1971

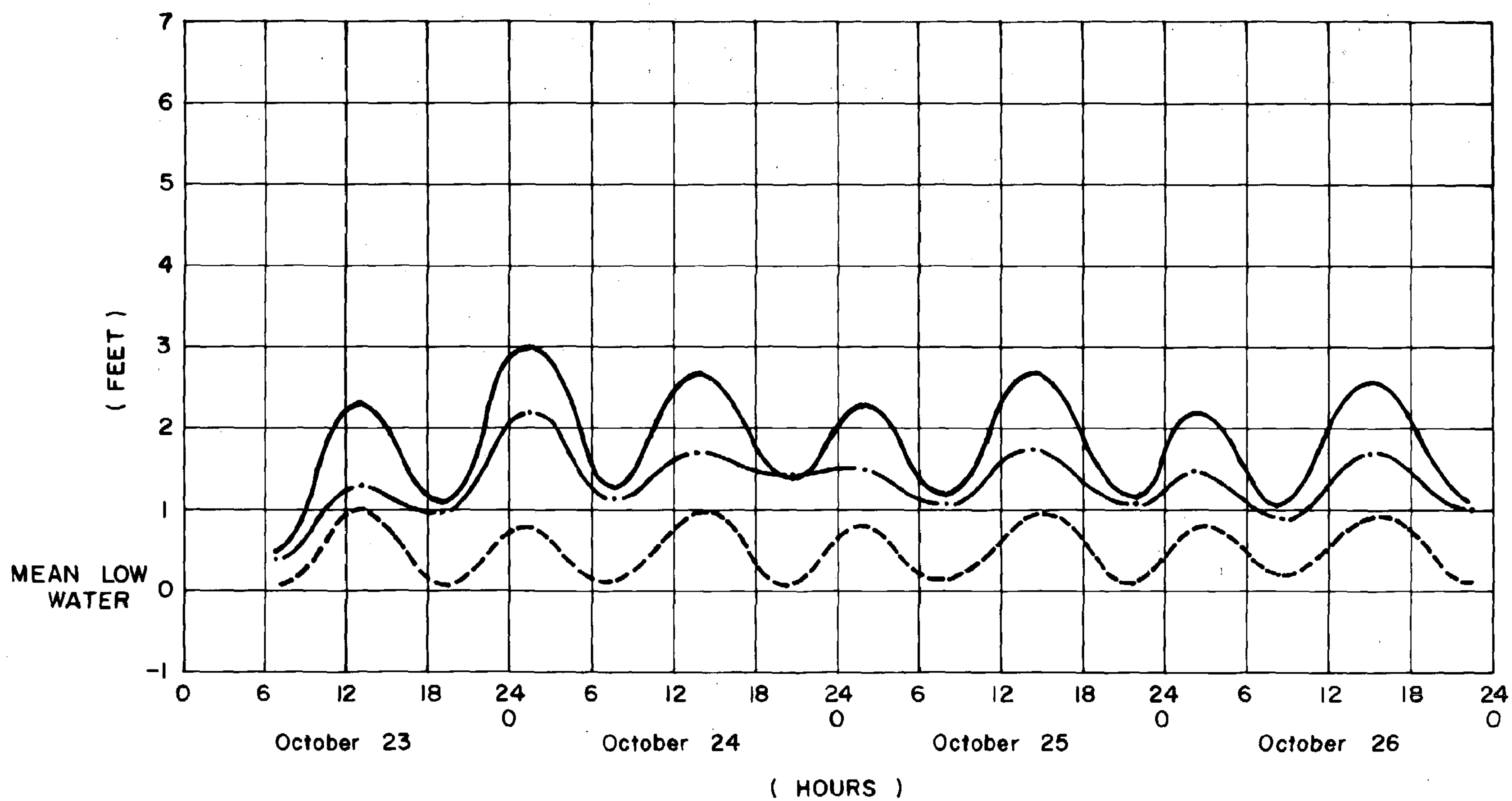


Breakwater Harbor

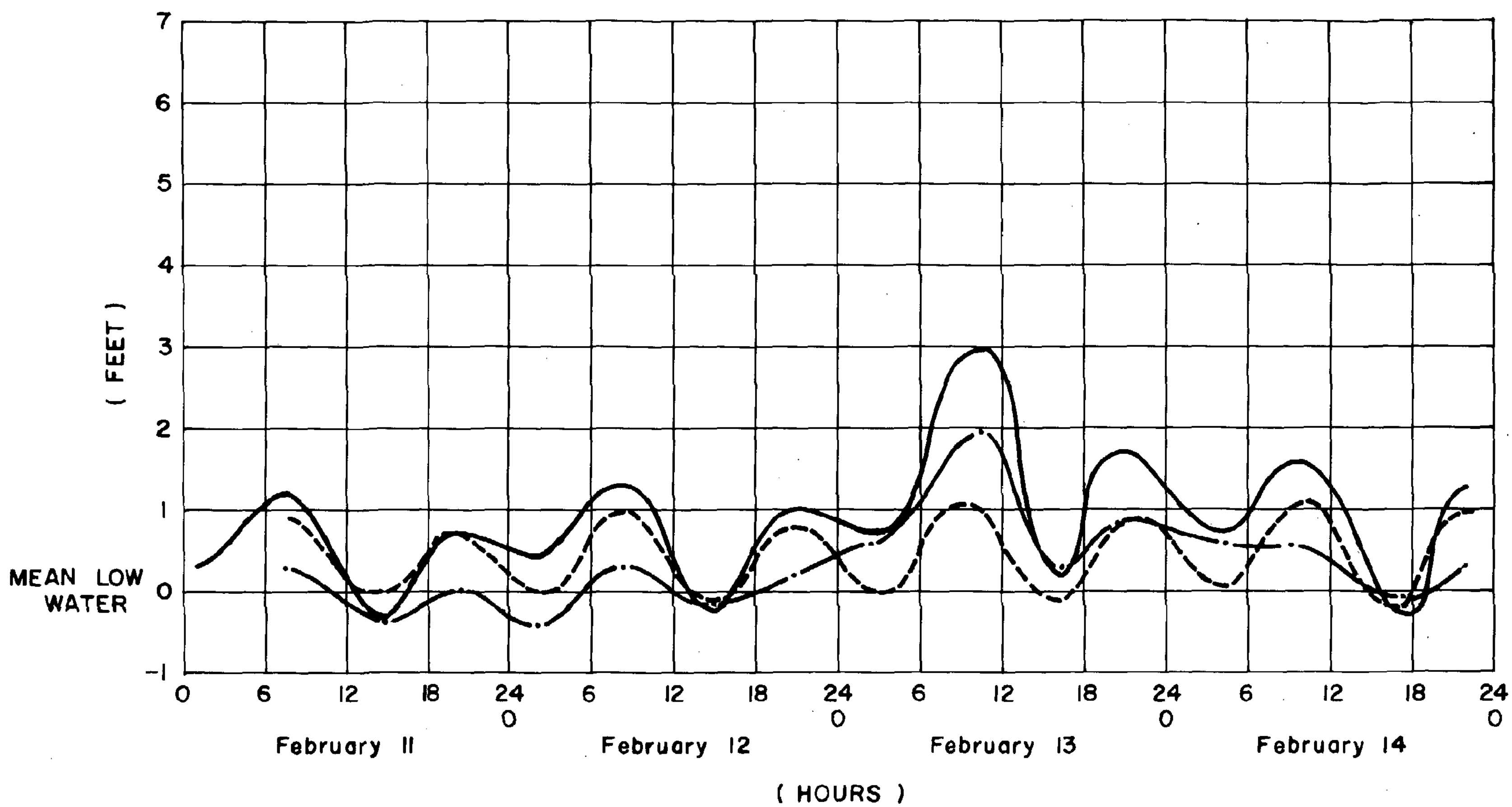
October 23 - 26, 1971



Indian River Power Plant
October 23-26, 1971

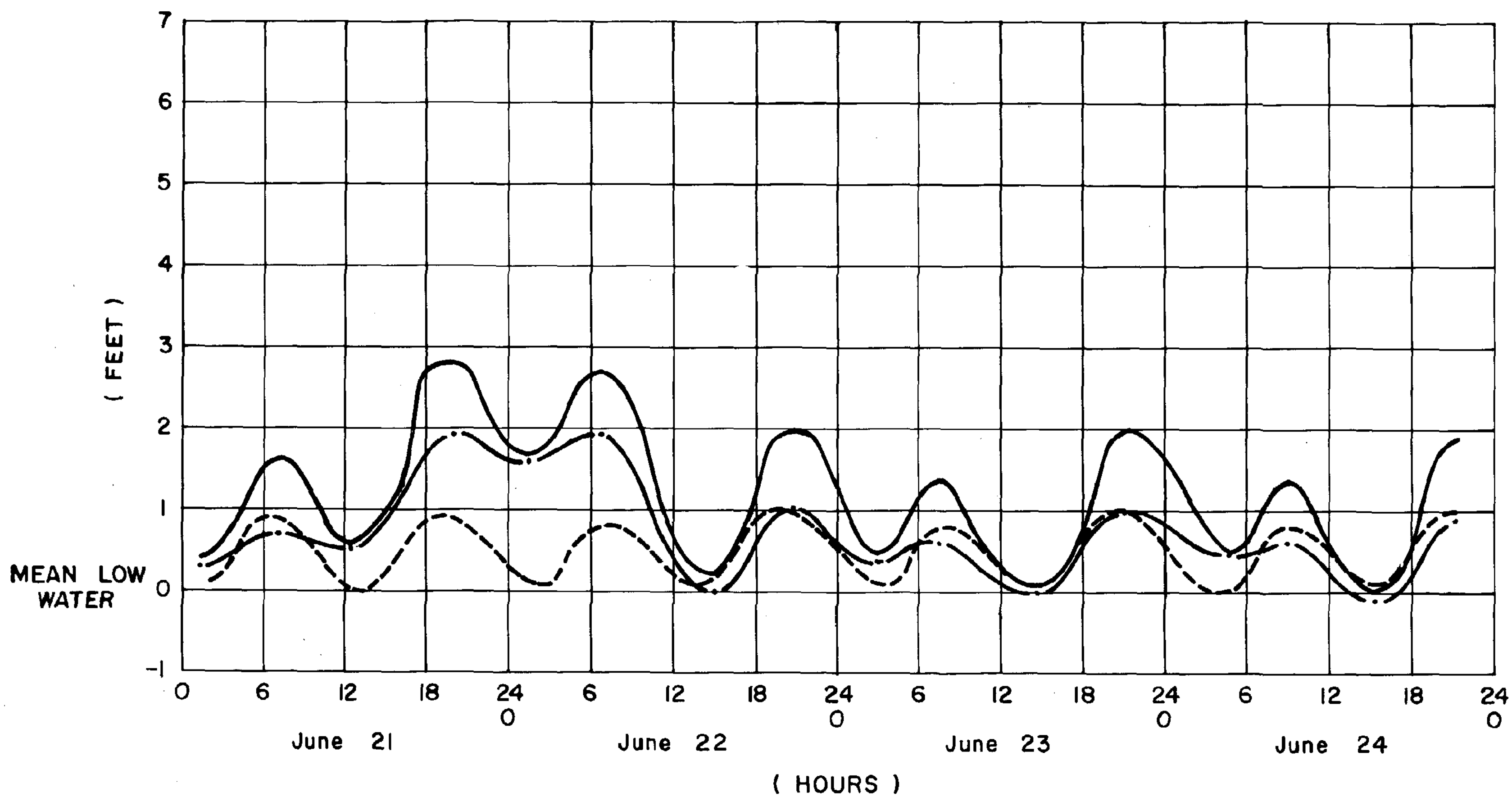


Indian River Power Plant
February 11 - 14, 1972

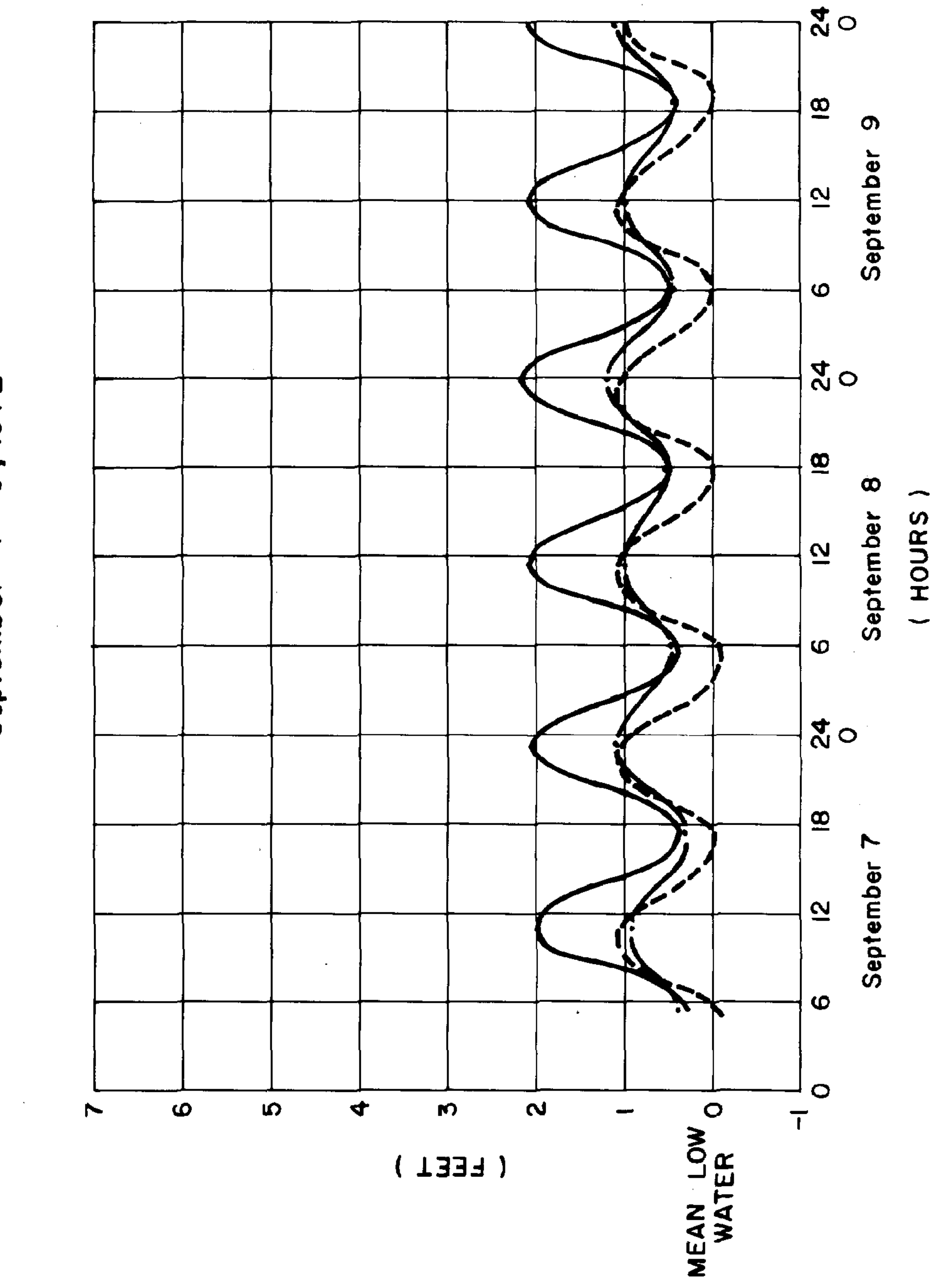


Indian River Power Plant

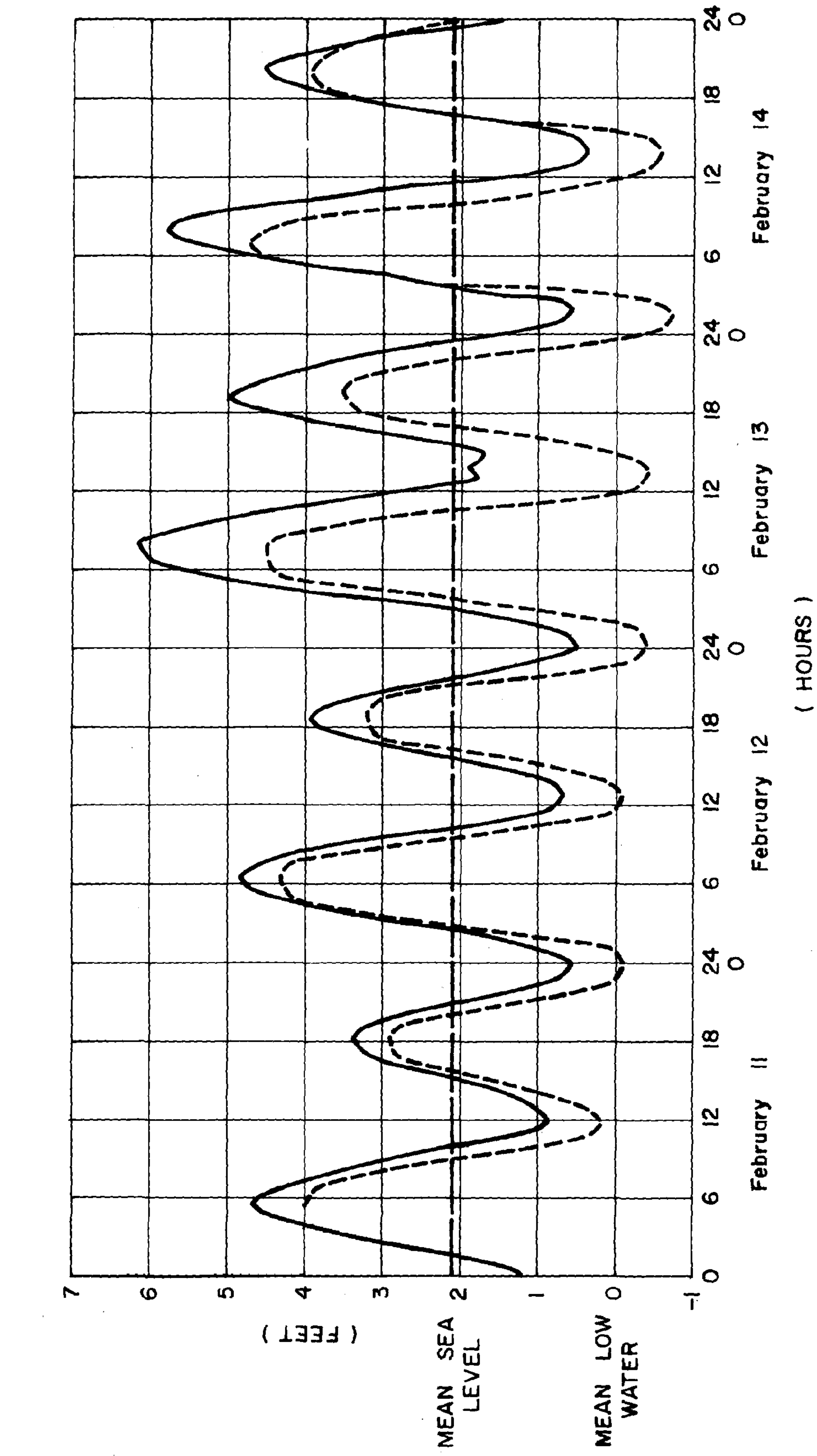
June 21 - 24, 1972



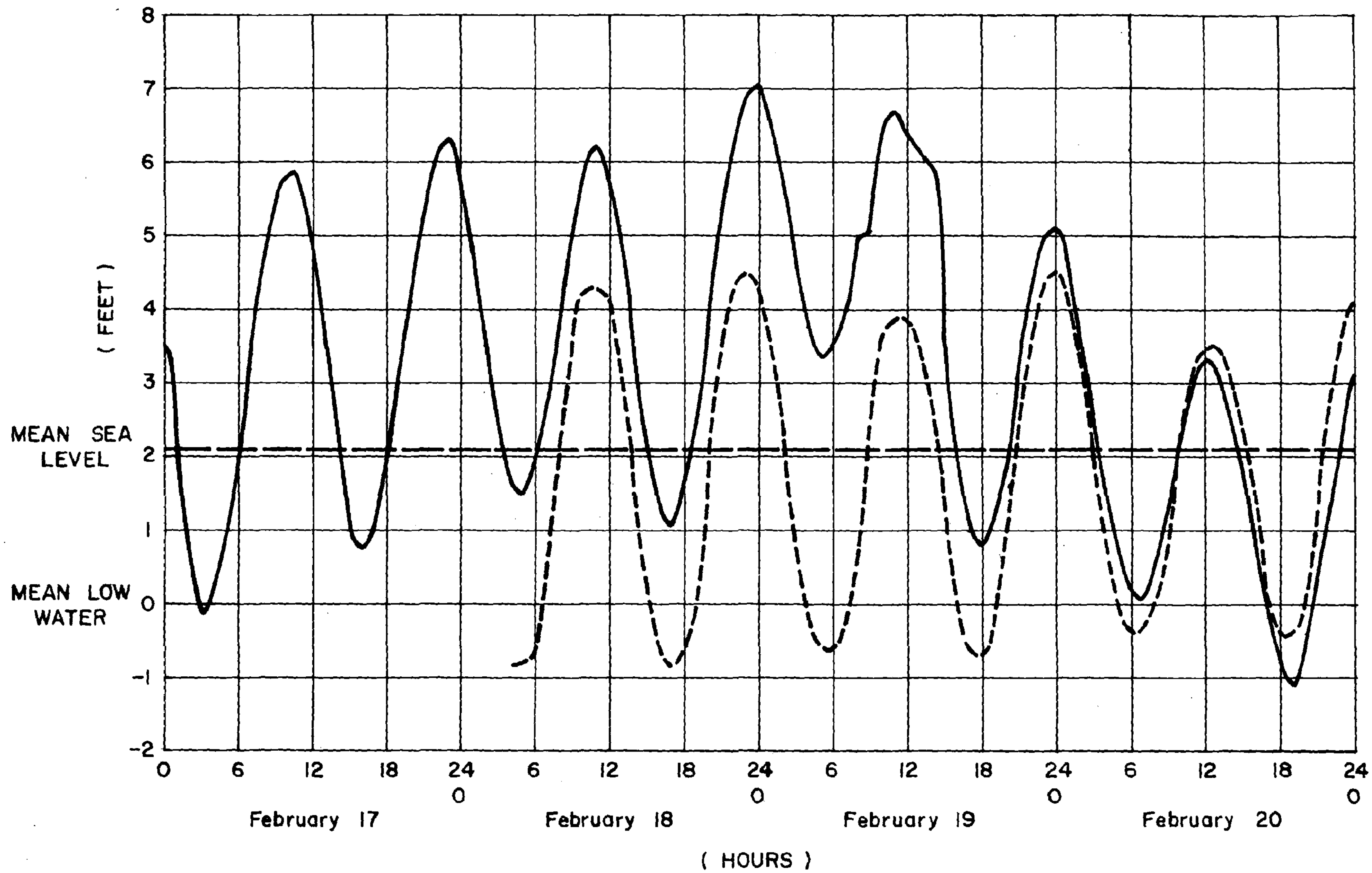
Indian River Power Plant
September 7 - 9, 1972



Breakwater Harbor
February 11 - 14, 1972

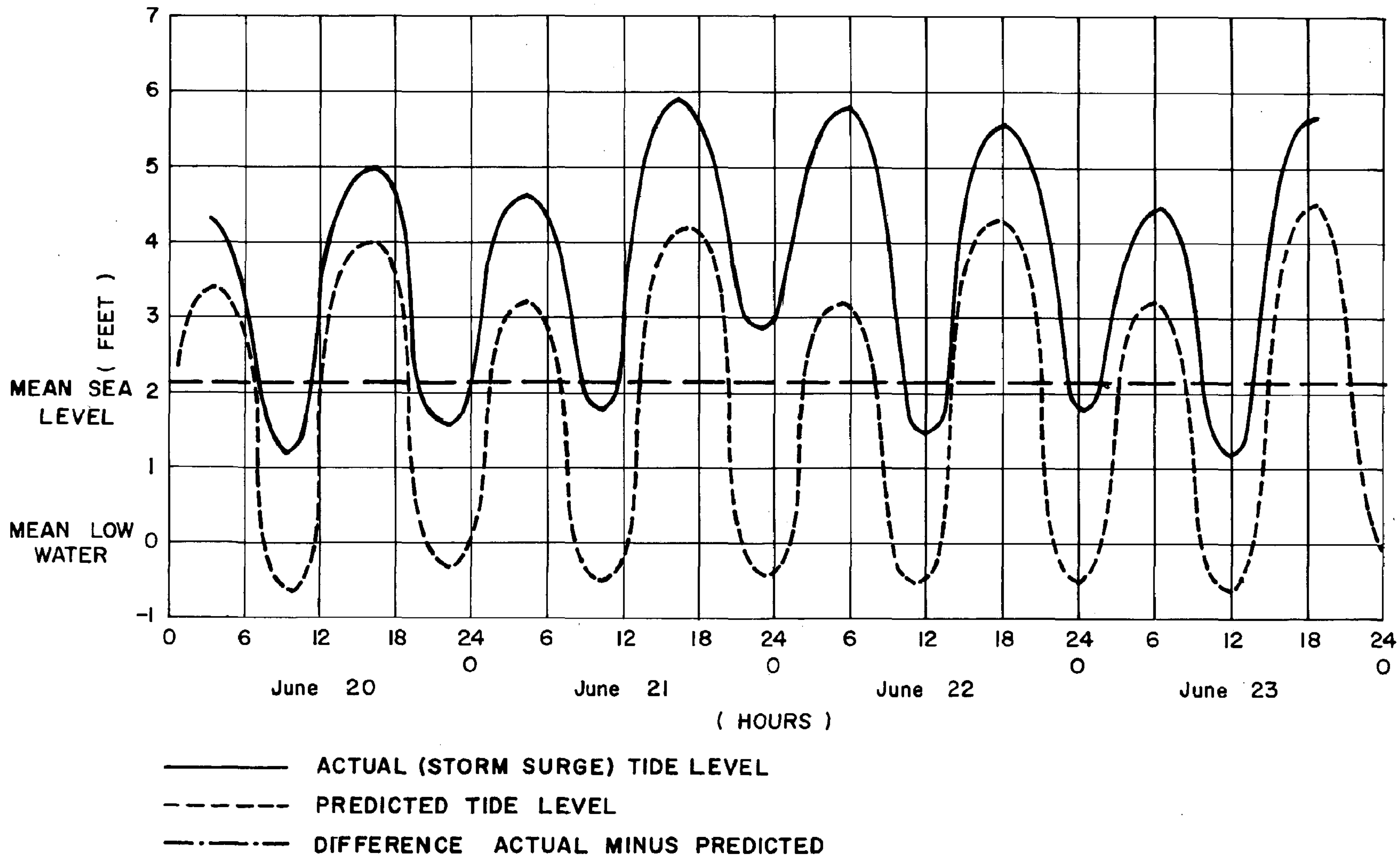


Breakwater Harbor
February 17 - 20, 1972



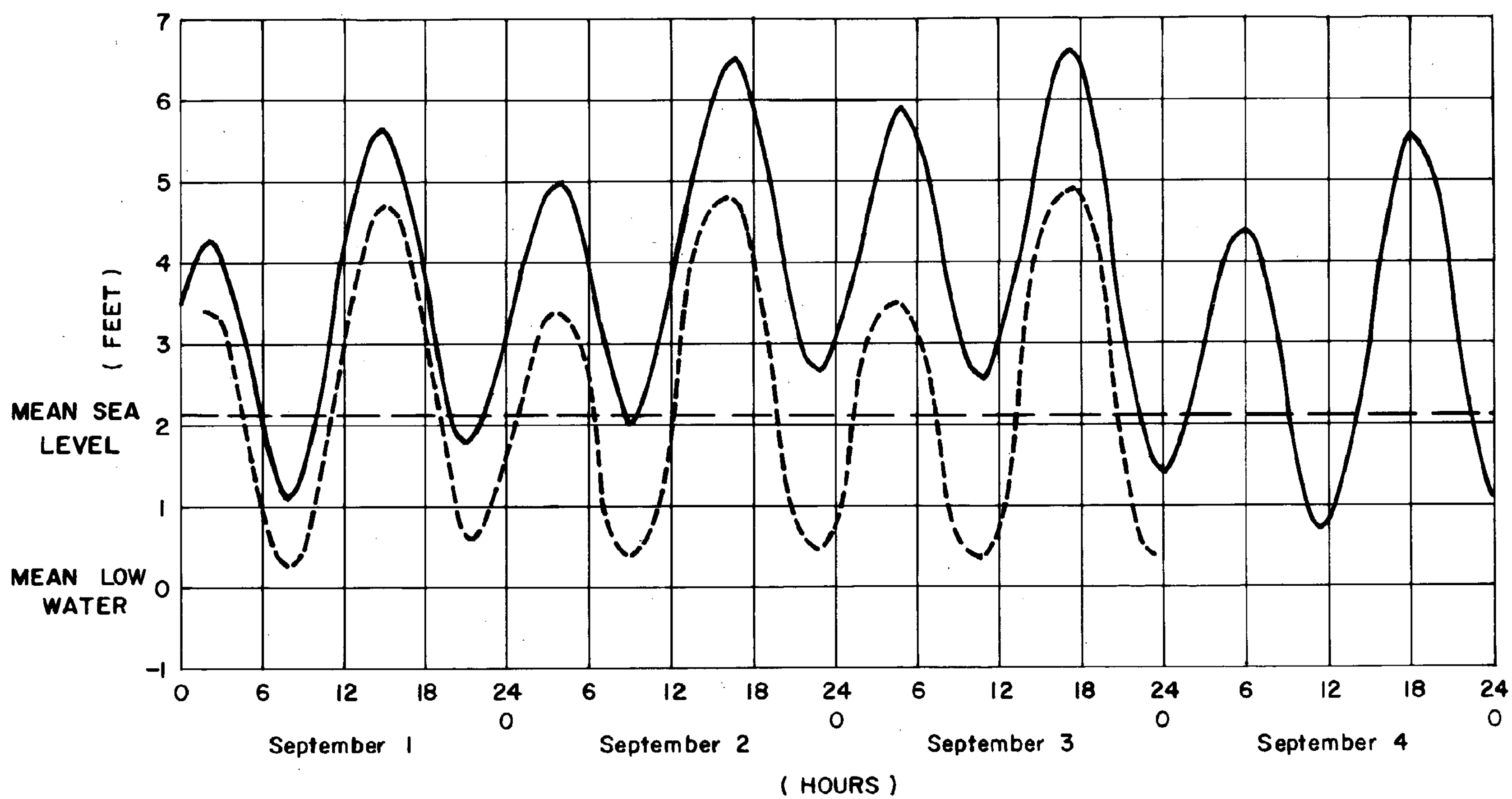
Breakwater Harbor

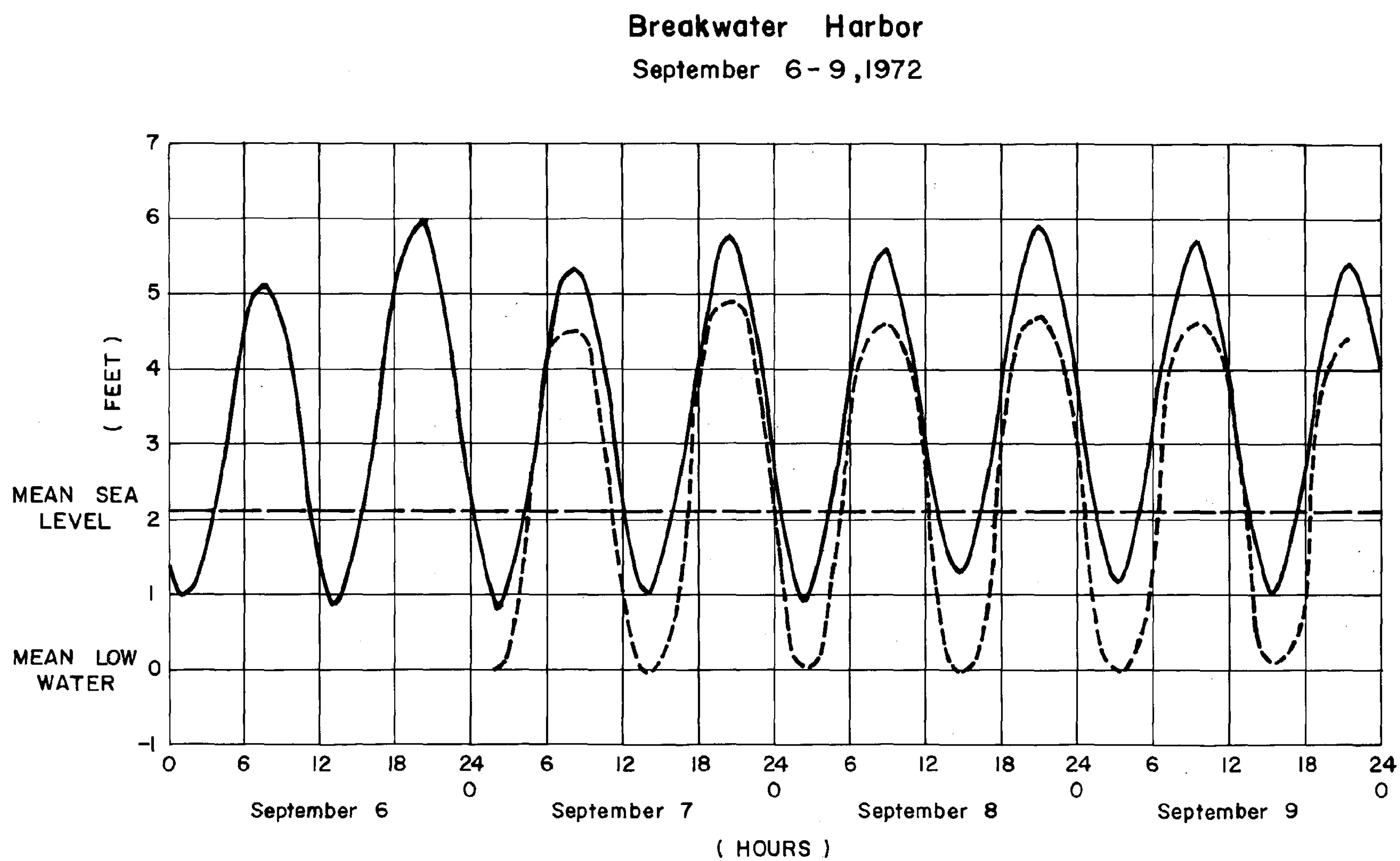
June 20 - 23, 1972



Breakwater Harbor

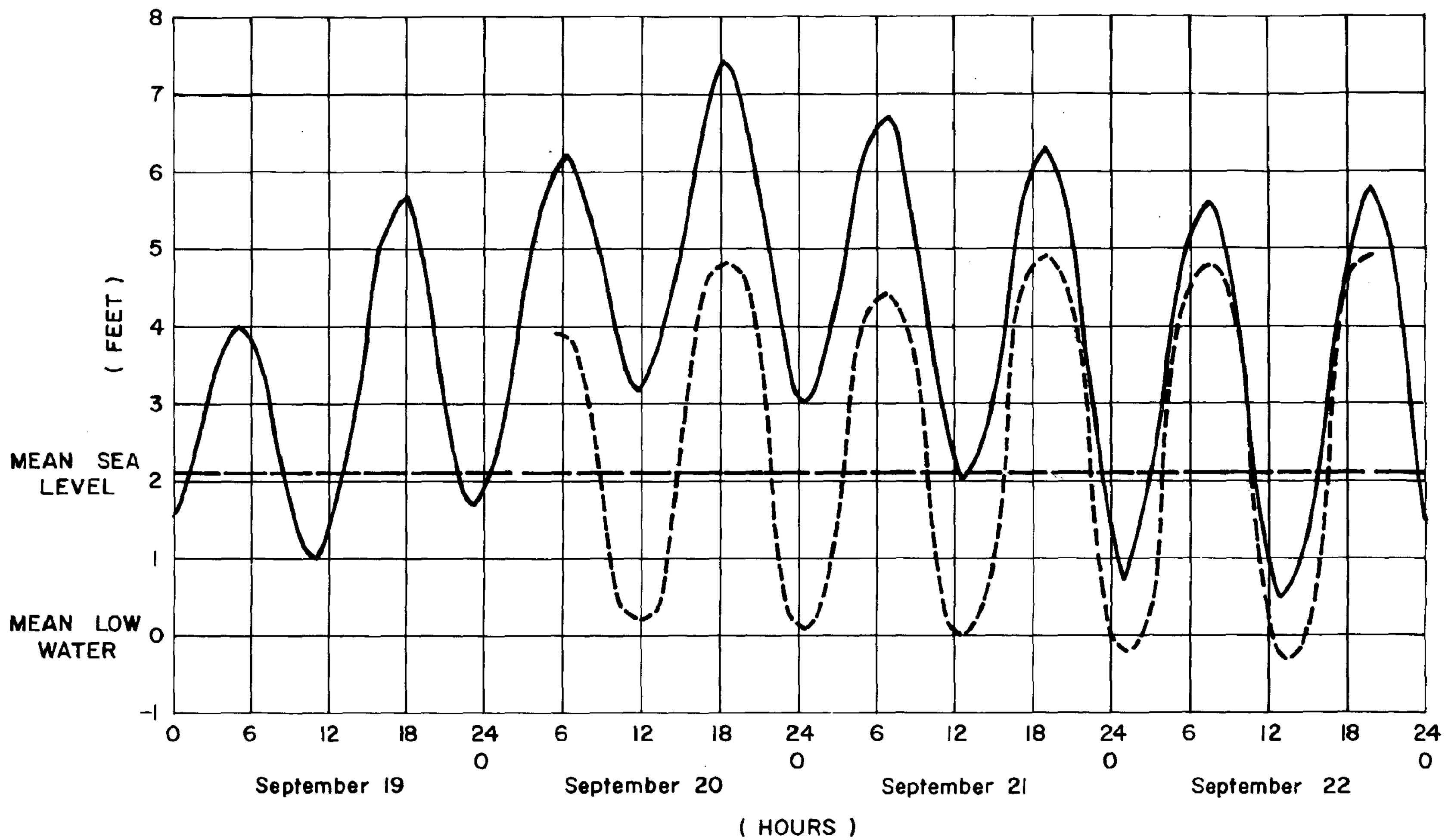
September 1 - 4, 1972

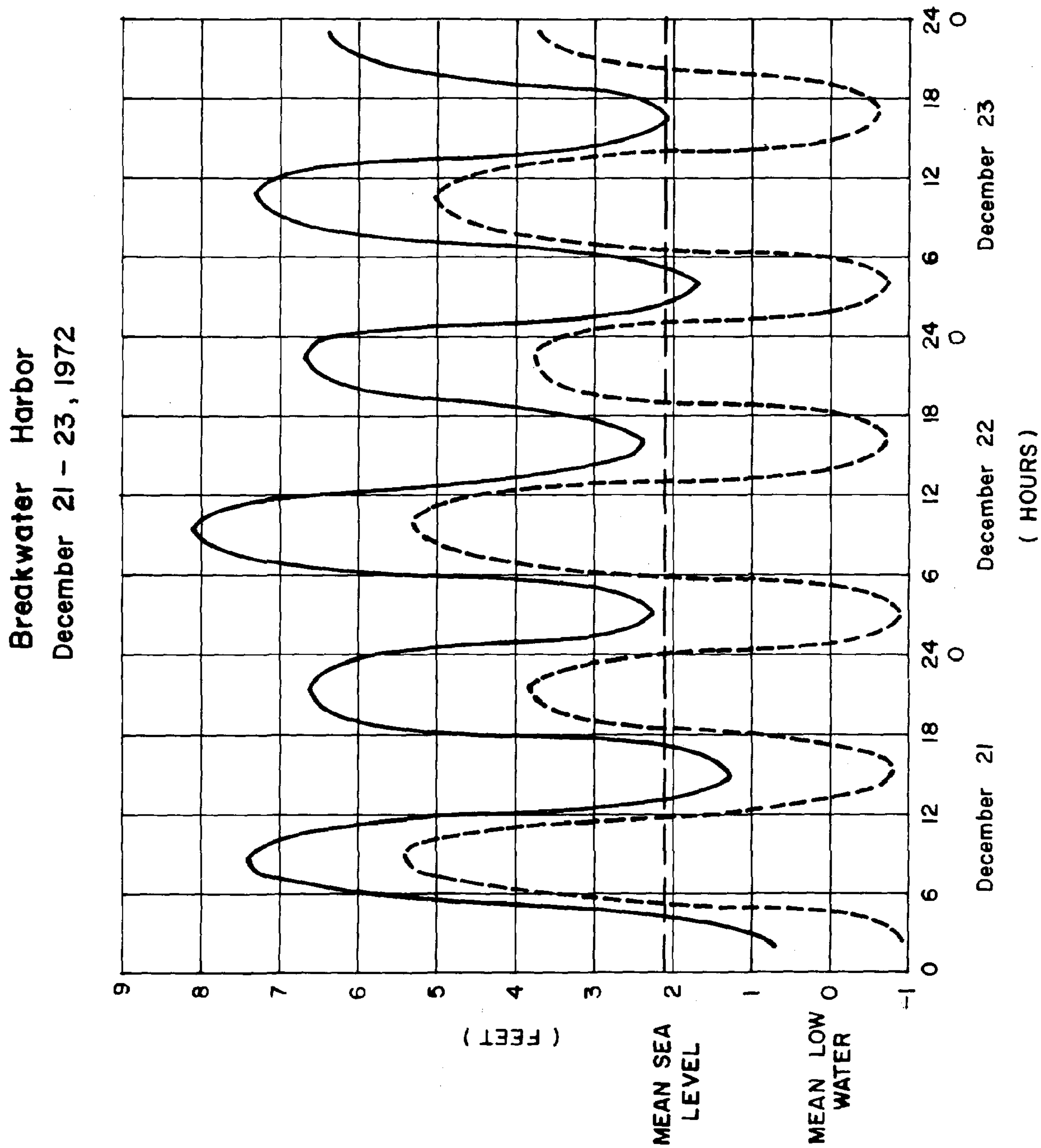




Breakwater Harbor
September 6-9, 1972
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
7
6
5
4
3
2
1
0
-1
0 6 12 18 24 0 6 12 18 24 0 6 12 18 24 0 6 12 18 24 0
September 6
September 7
September 8
September 9
(HOURS)

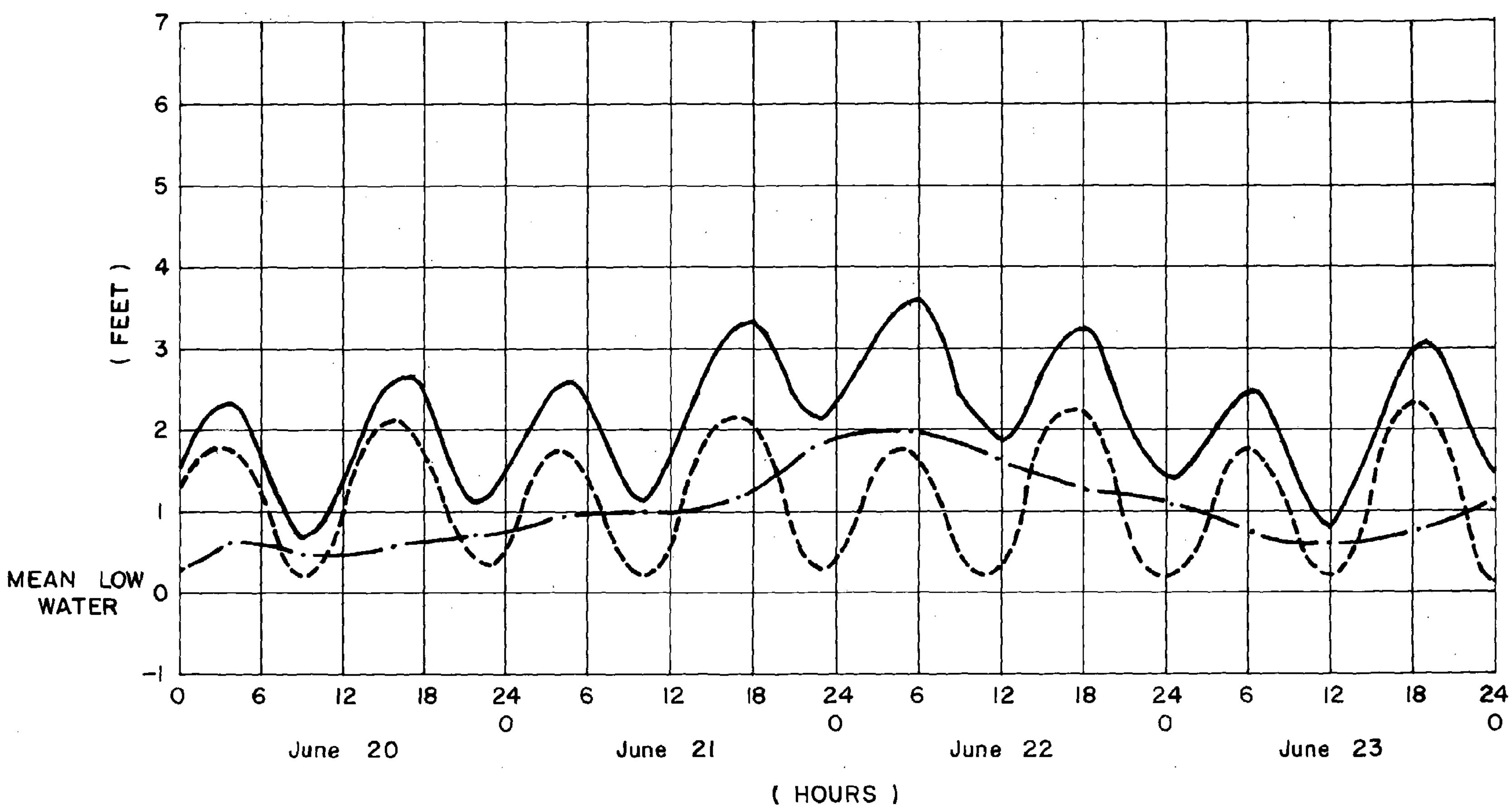
Breakwater Harbor
September 19 - 22, 1972




Breakwater Harbor
December 21 - 23, 1972
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
9
8
7
6
5
4
3
2
1
0
-1
0
6
12
18
24
0
6
12
18
24
0
6
12
18
24
0
December 21
December 22
December 23
(HOURS)

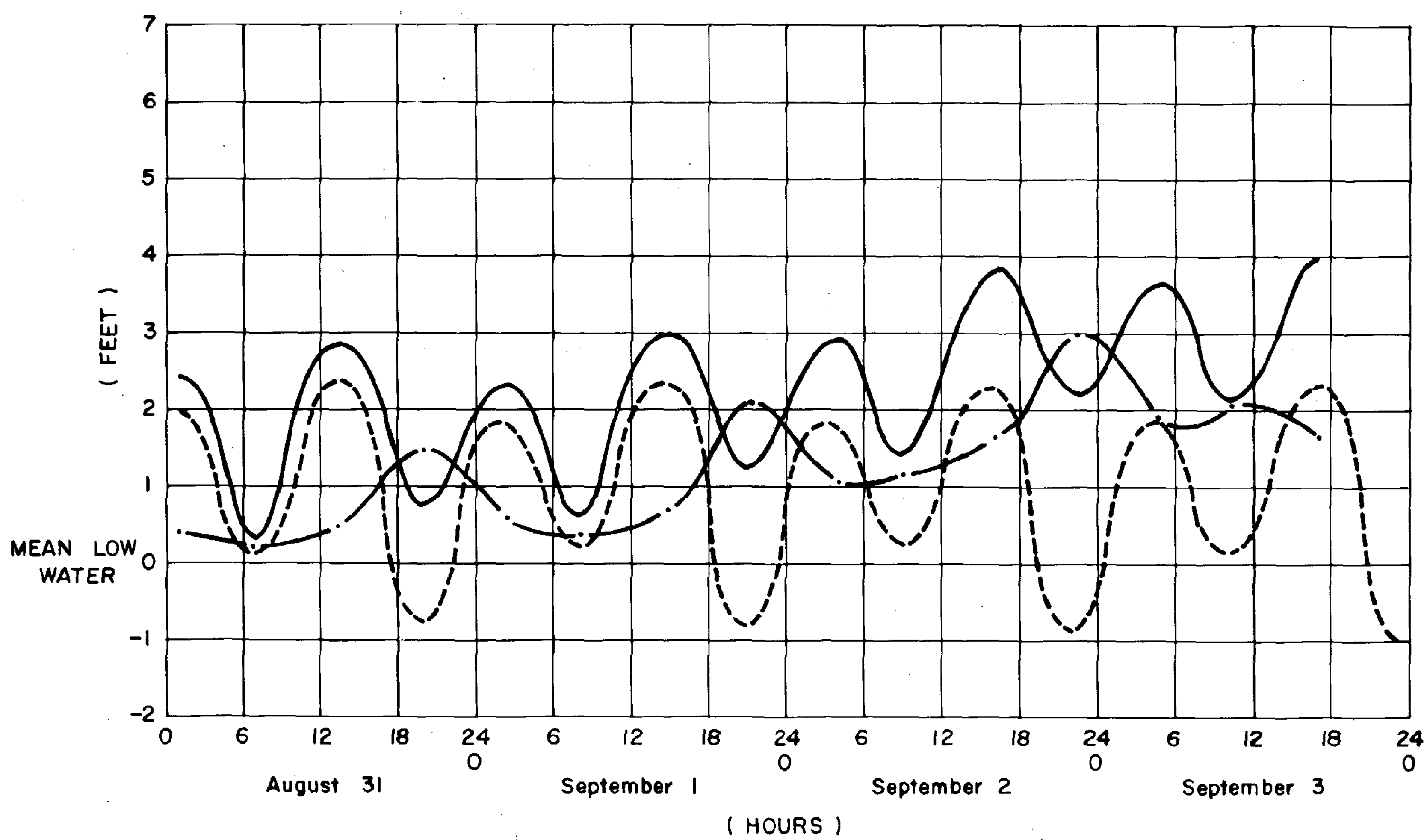
Indian River Coast Guard Station

June 20 - 23, 1972

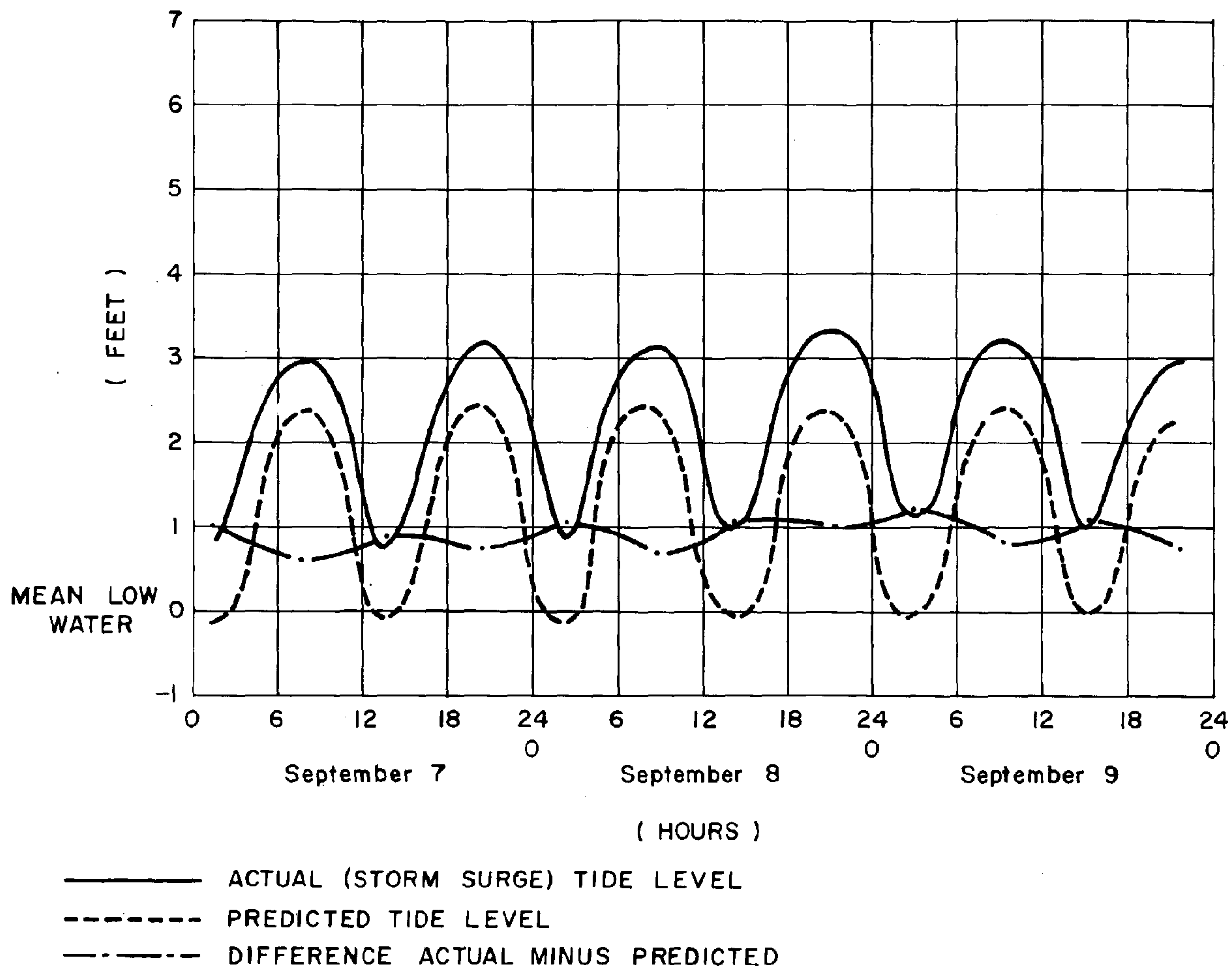


Indian River Coast Guard Station

August 31 - September 3, 1972

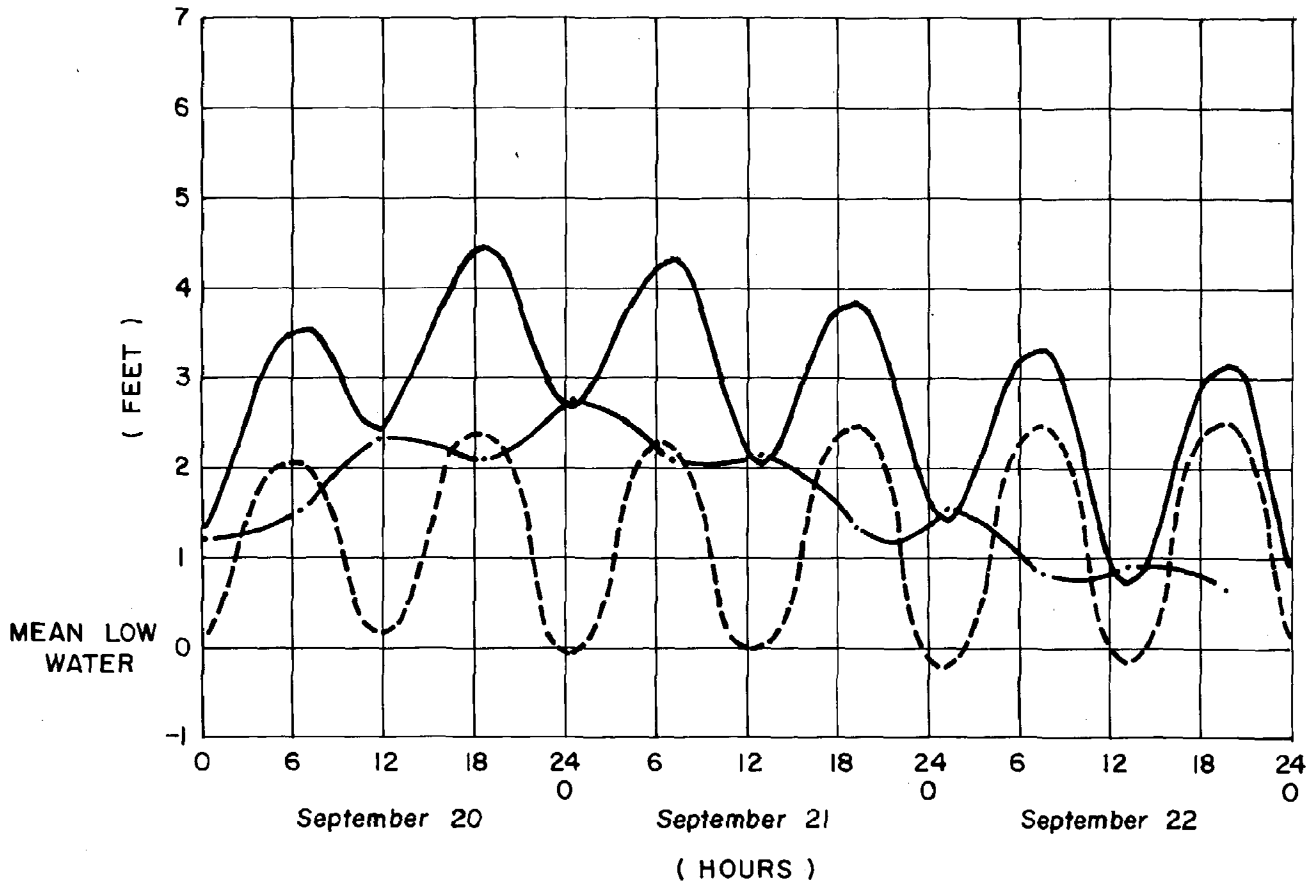


Indian River Coast Guard Station
September 7-9, 1972



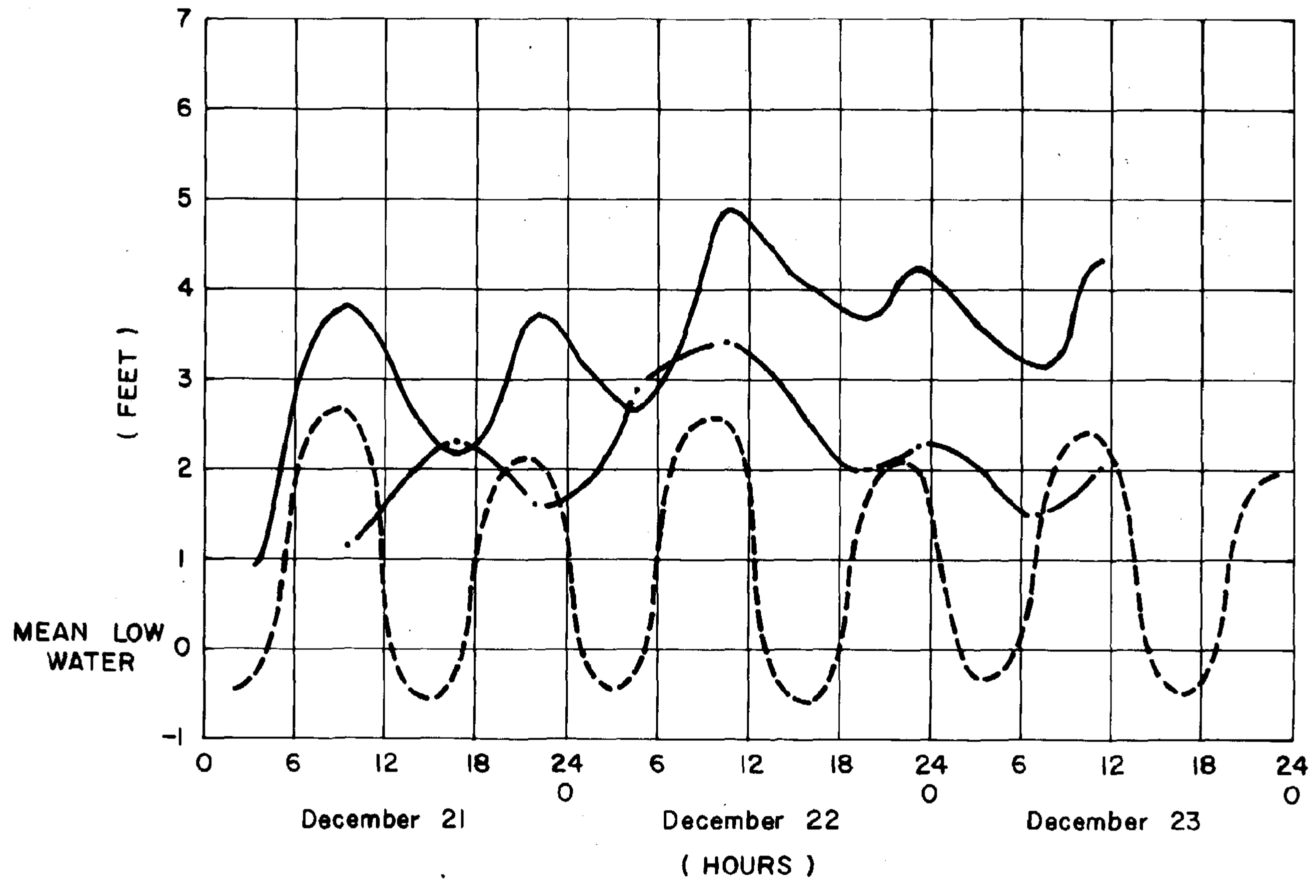
Indian River Coast Guard Station

September 20 - 22, 1972

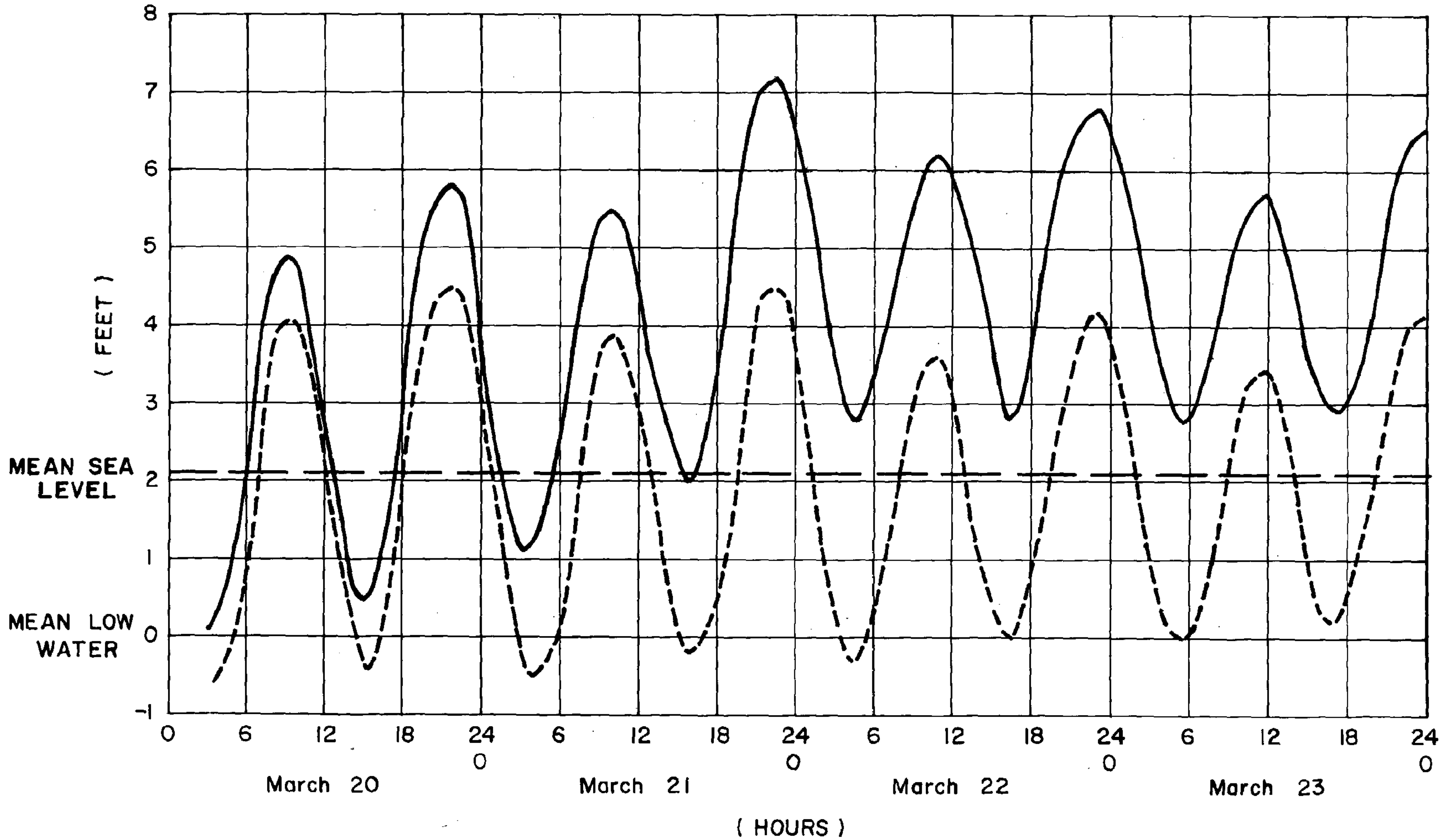


Indian River Coast Guard Station

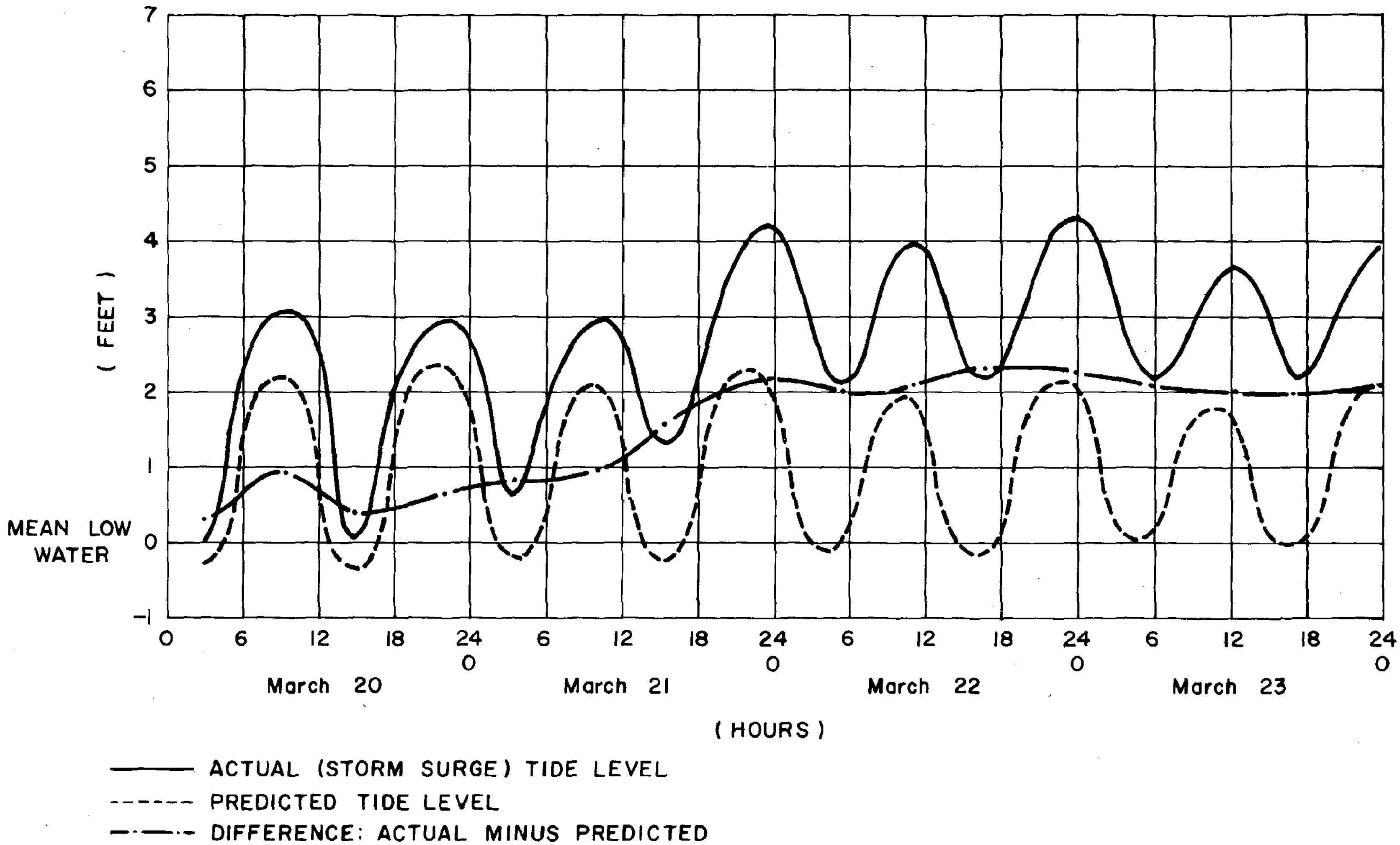
December 21 - 23, 1972

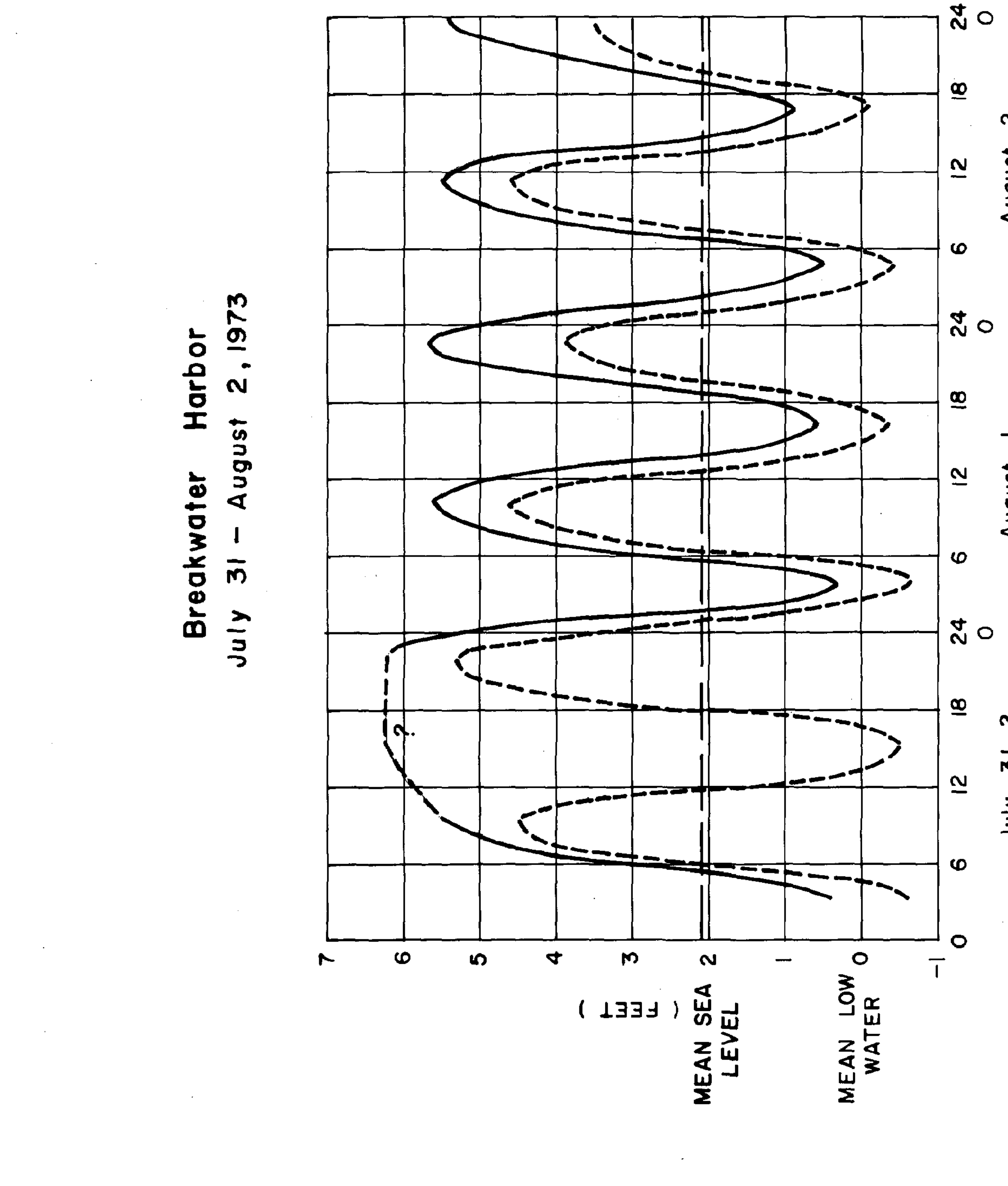


Breakwater Harbor
March 20-23, 1973

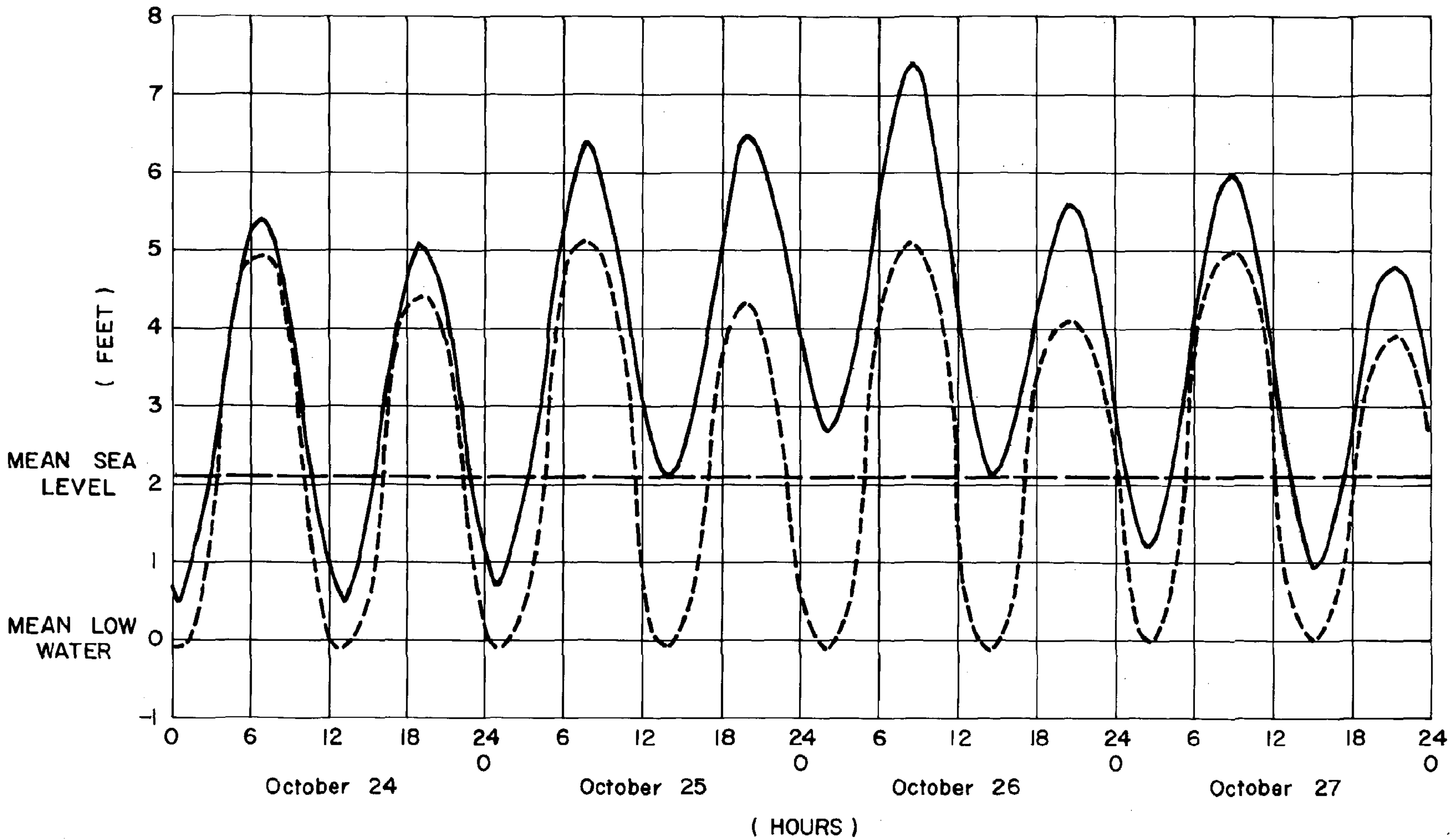


Indian River Coast Guard Station
March 20 - 23, 1973

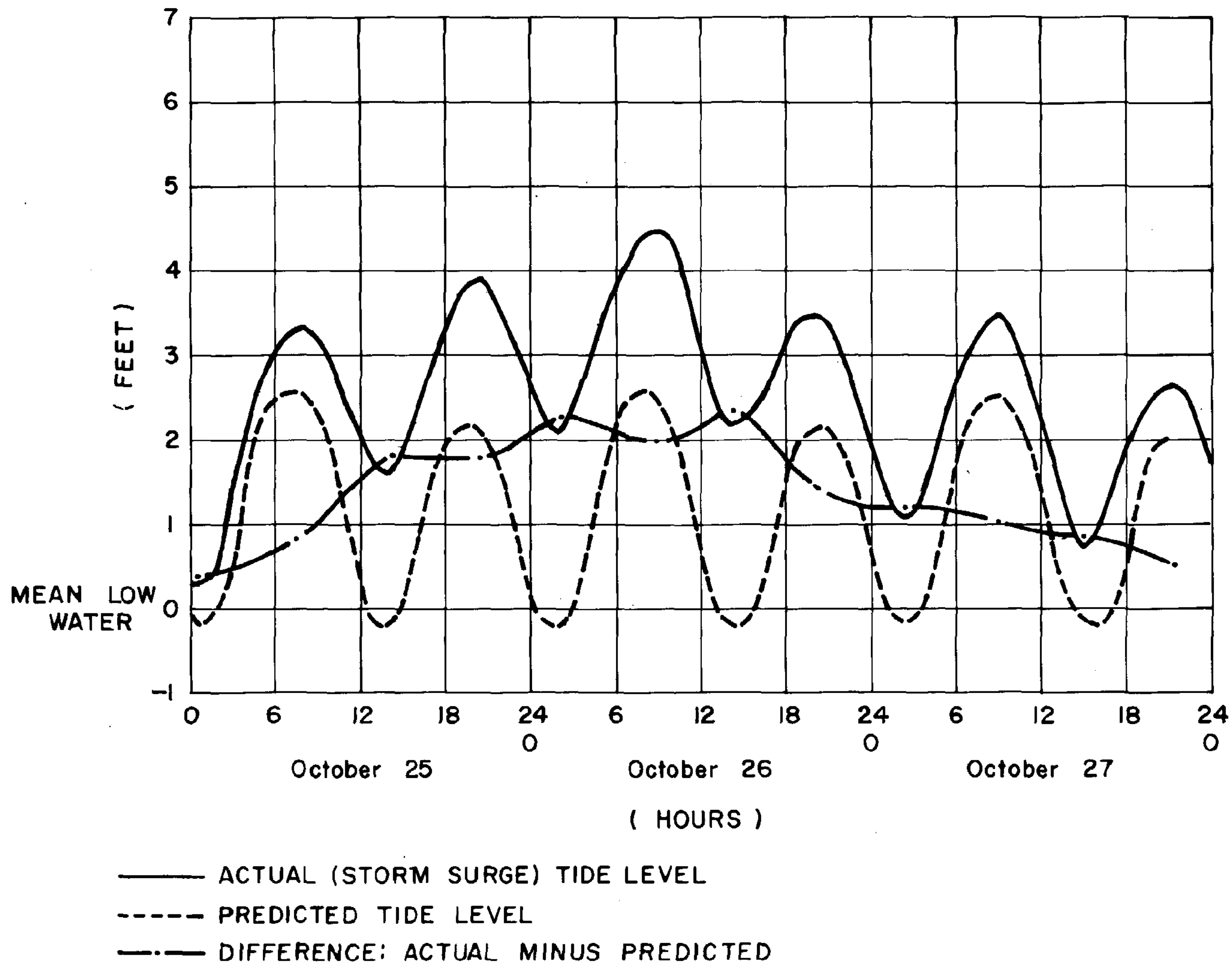



Breakwater Harbor
July 31 – August 2, 1973
(FEET)
MEAN SEA LEVEL
MEAN LOW WATER
7
6
5
4
3
2
1
0
−1
0
6
12
18
24
0
6
12
18
24
0
6
12
18
24
0
July 31 ?
August 1
August 2
(HOURS)
?

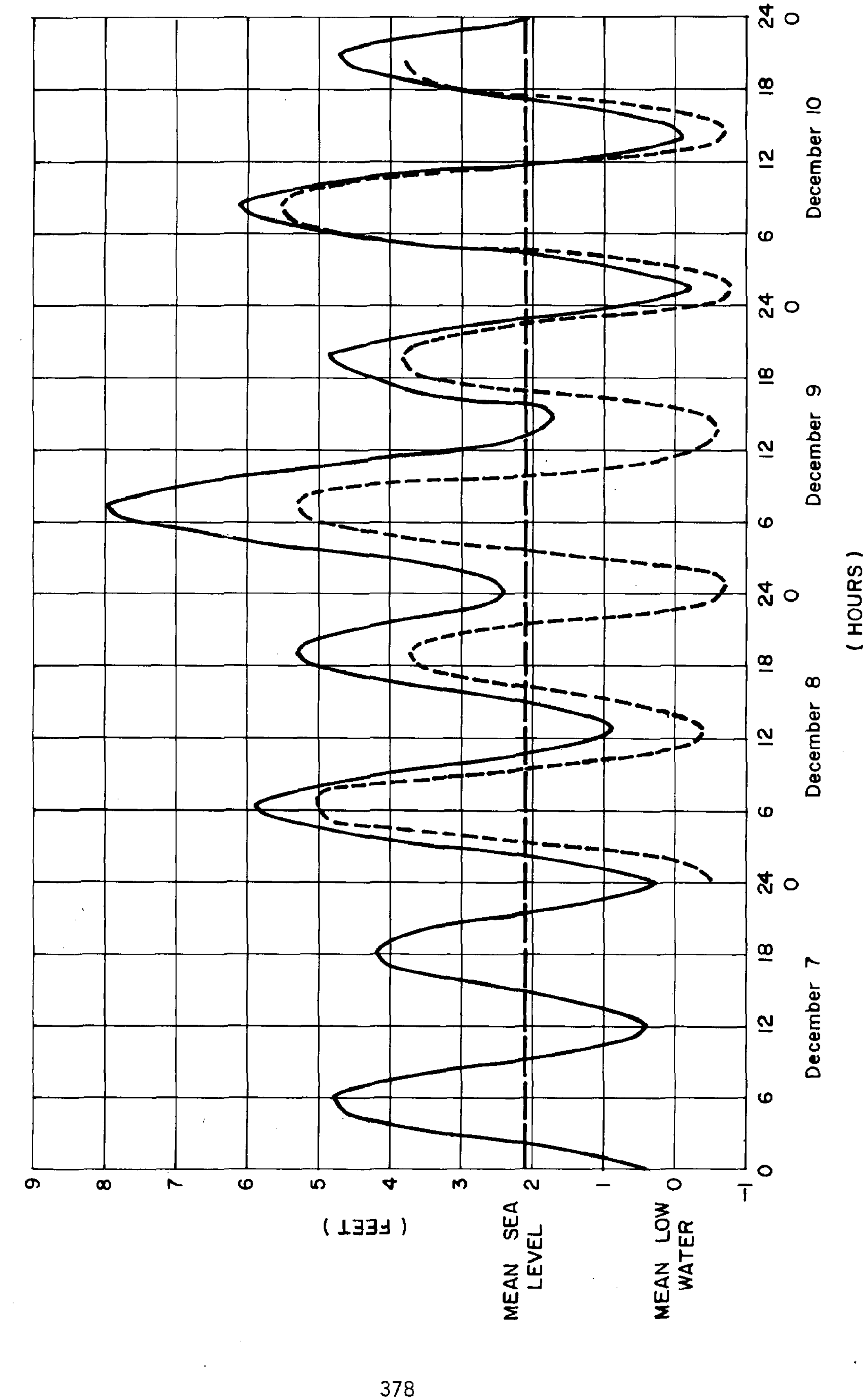
Breakwater Harbor
October 24 - 27, 1973



Indian River Coast Guard Station
October 25 - 27, 1973

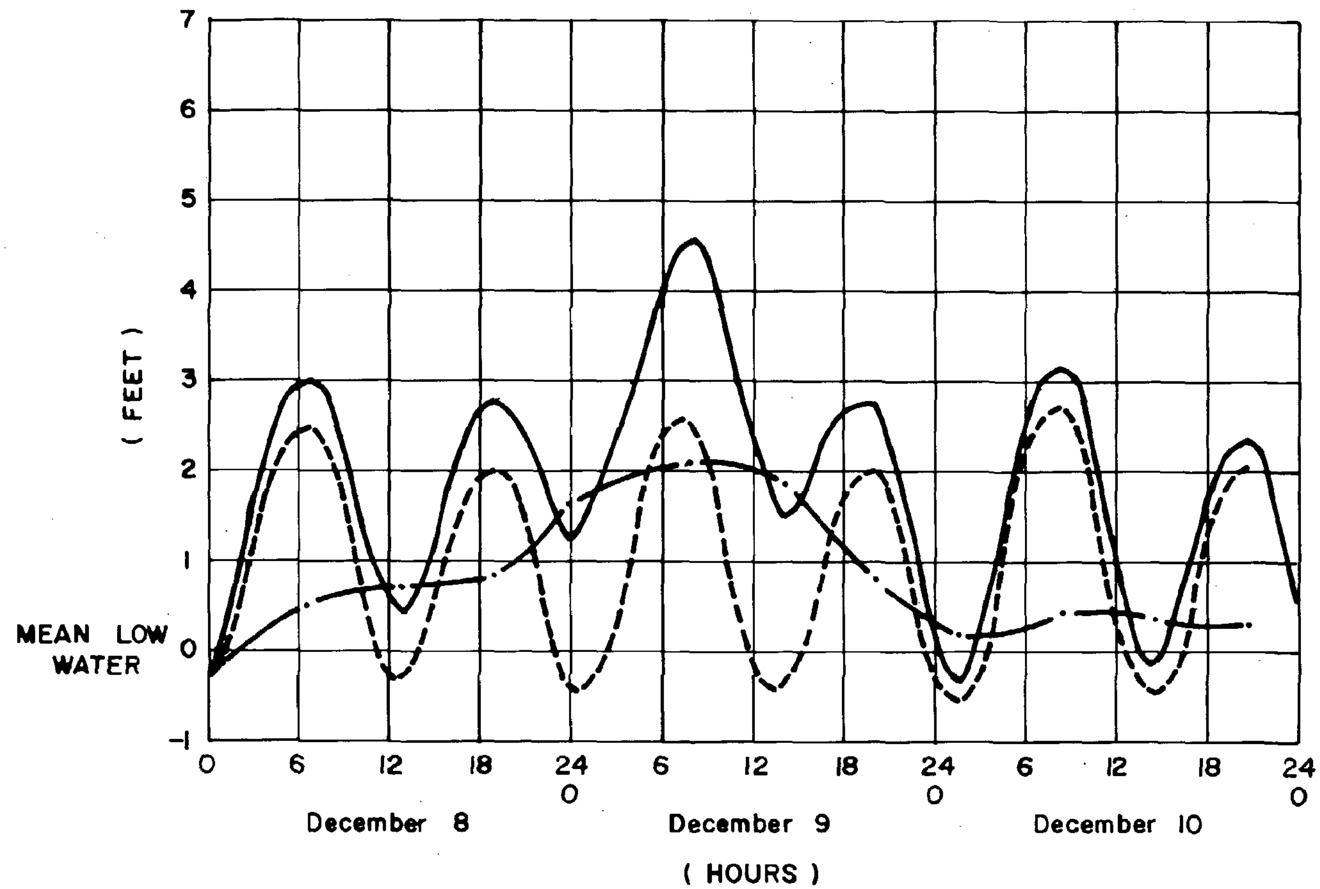


Breakwater Harbor
December 7 - 10, 1973



Indian River Coast Guard Station

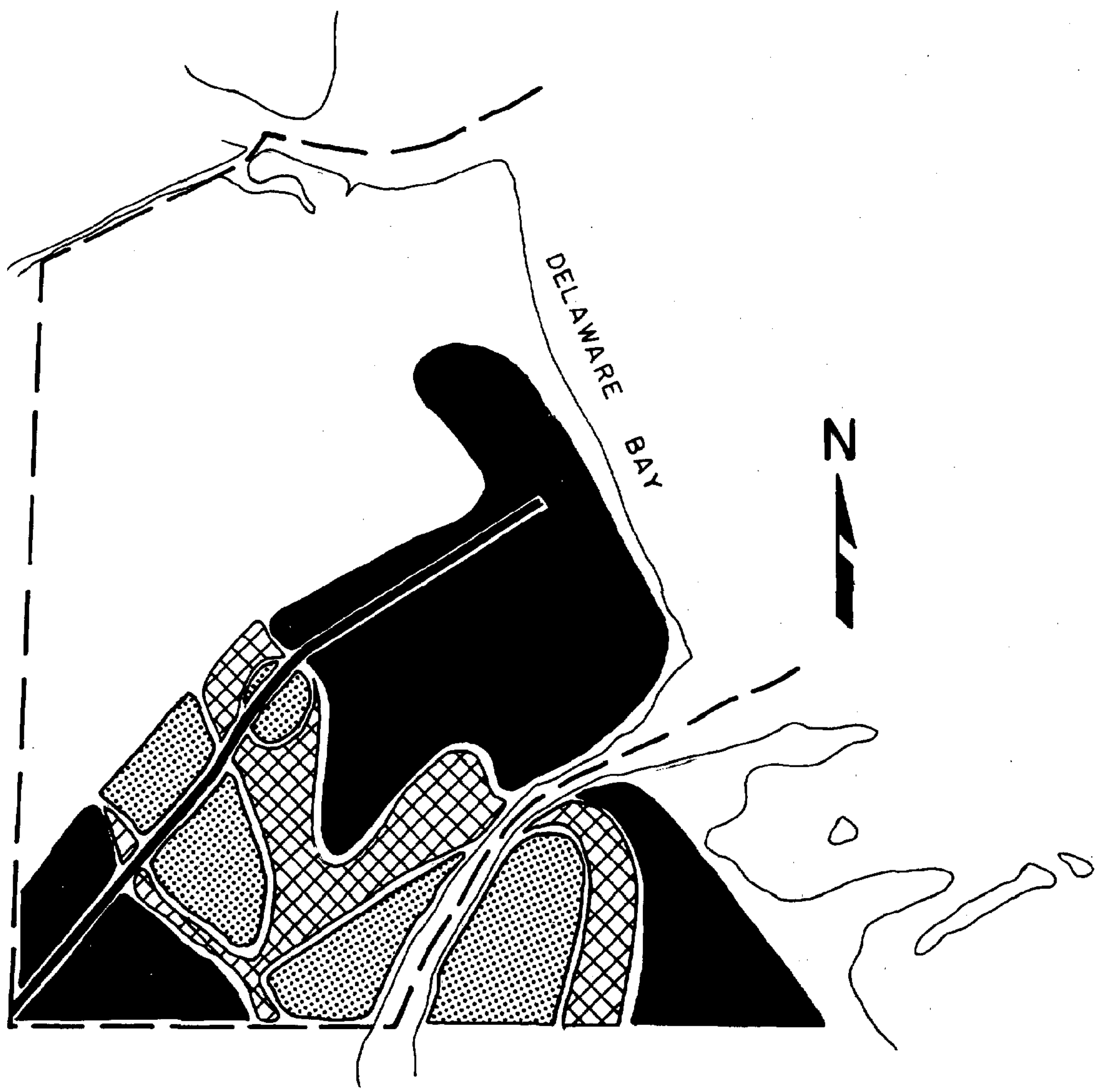
December 8 - 10, 1973



APPENDIX V

The purpose of the SYMAP computer-drawn maps presented in this Appendix is to determine whether the distribution or pattern of responses to selected questions on the questionnaire offers further insight into a community's perception of coastal flooding and their reaction to this natural hazard. While each mapped response does not always display or produce an obvious and explainable pattern, it is hypothesized that the geographical location of replies might be in general accord with the localized patterns of the flood hazard. These maps should be only used as an indicator of perception, not as definitive measures of coastal flooding experience.

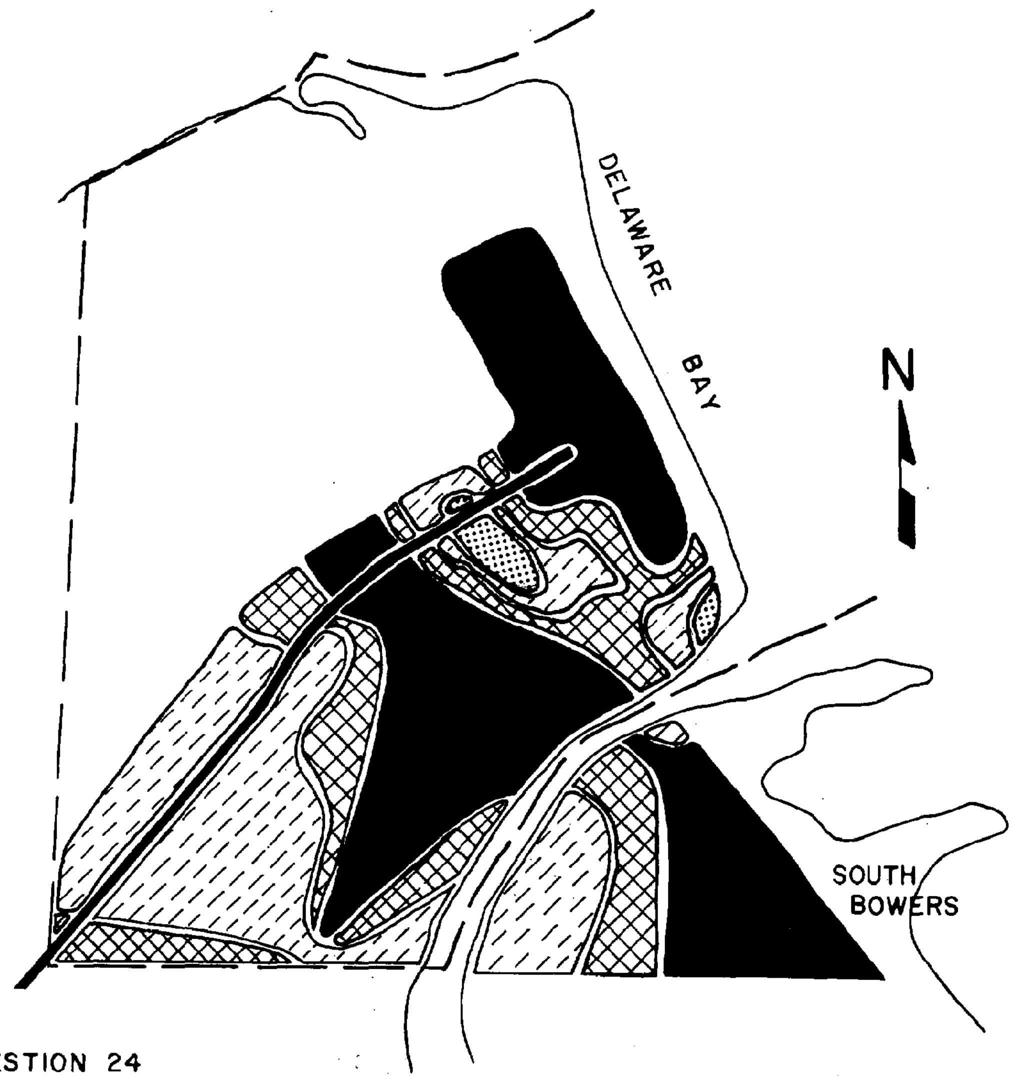
BOWERS



QUESTION 11
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS 26

■	YES	▨	NO
░	NO OPINION	□	NO INTERVIEWS

BOWERS



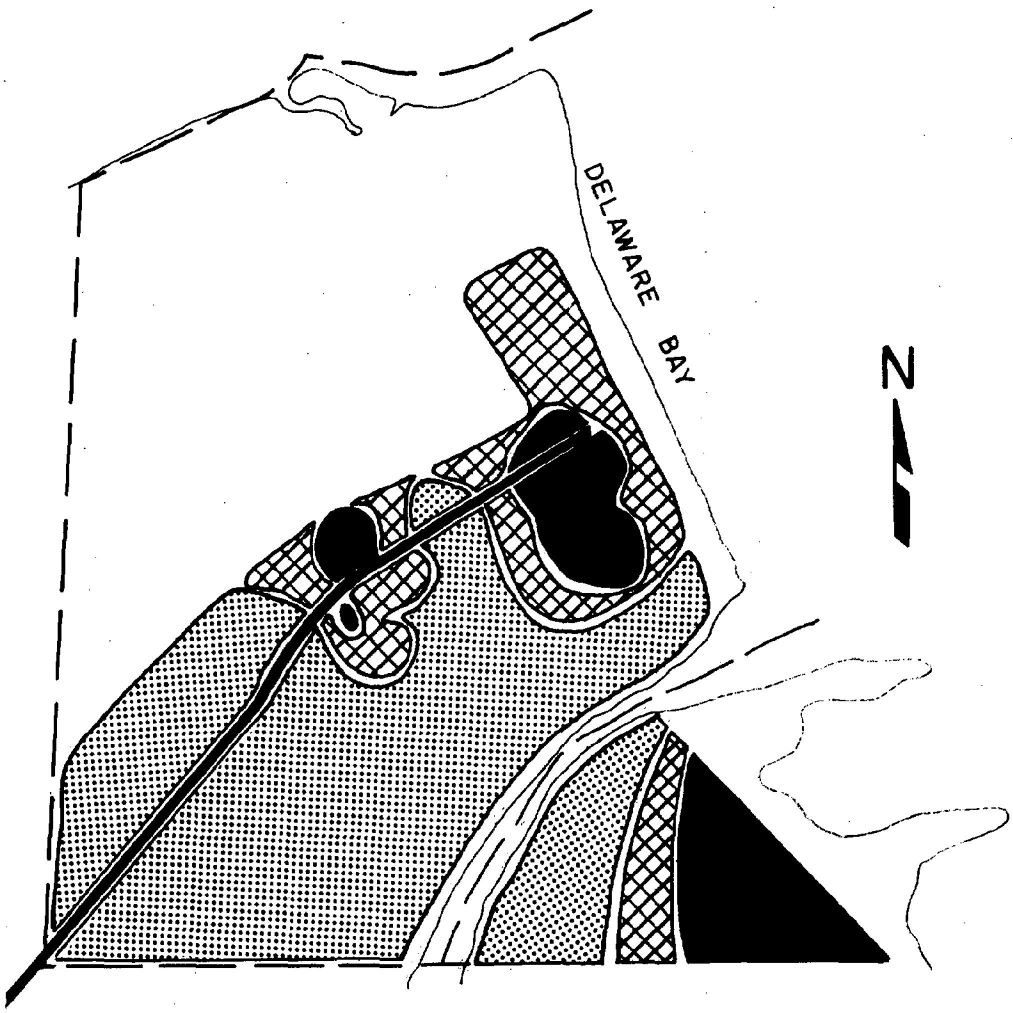
QUESTION 24

HOW FREQUENTLY DOES SEA AND OR BAY WATER REACH YOUR PROPERTY

NUMBER OF INTERVIEWS: 27

- AT LEAST ONCE A YEAR
- APPROXIMATELY ONCE EVERY TWO TO FIVE YEARS
- APPROXIMATELY ONCE EVERY TEN YEARS
- NEVER EXPERIENCED
- NO INTERVIEWS

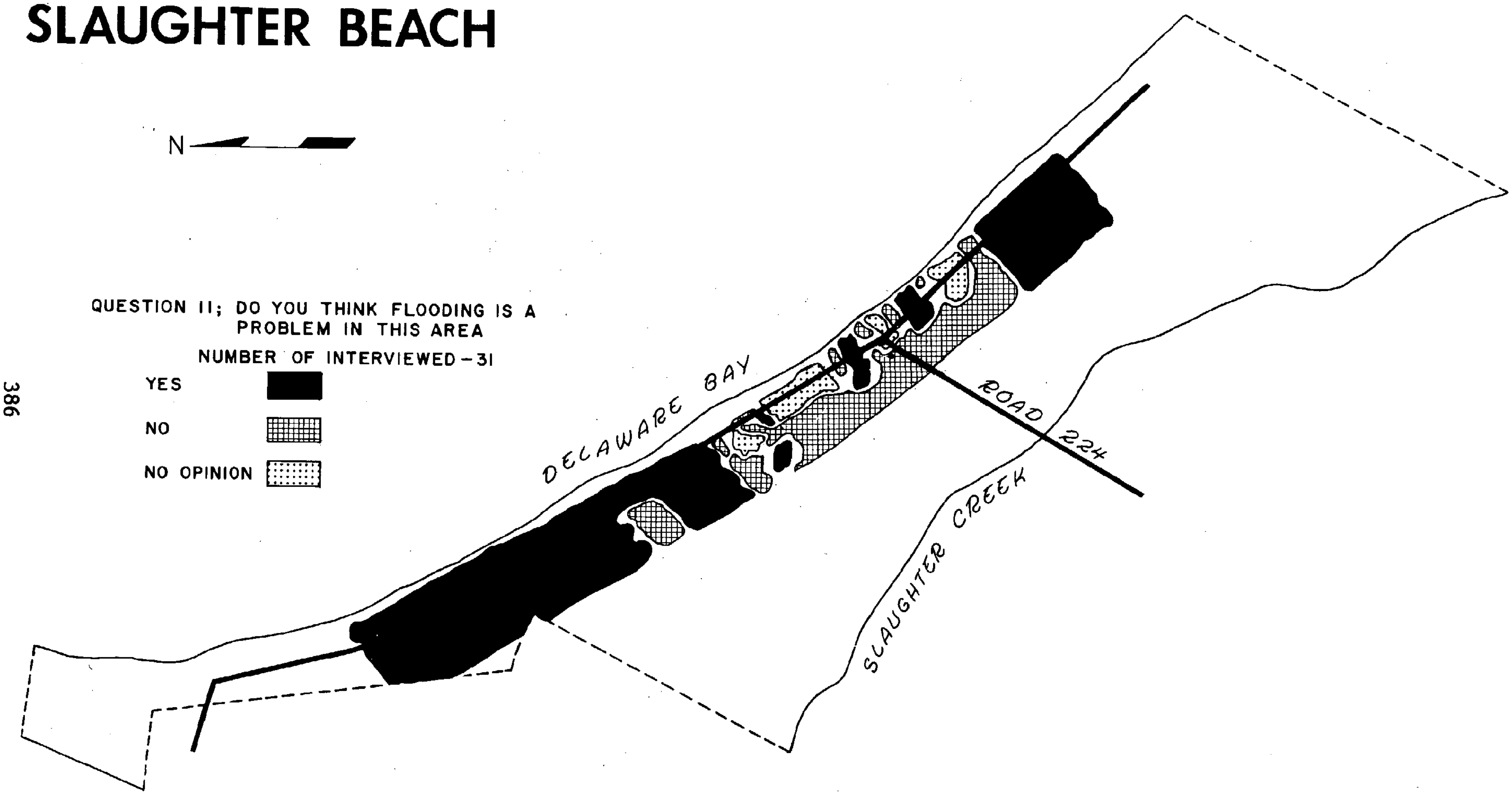
BOWERS



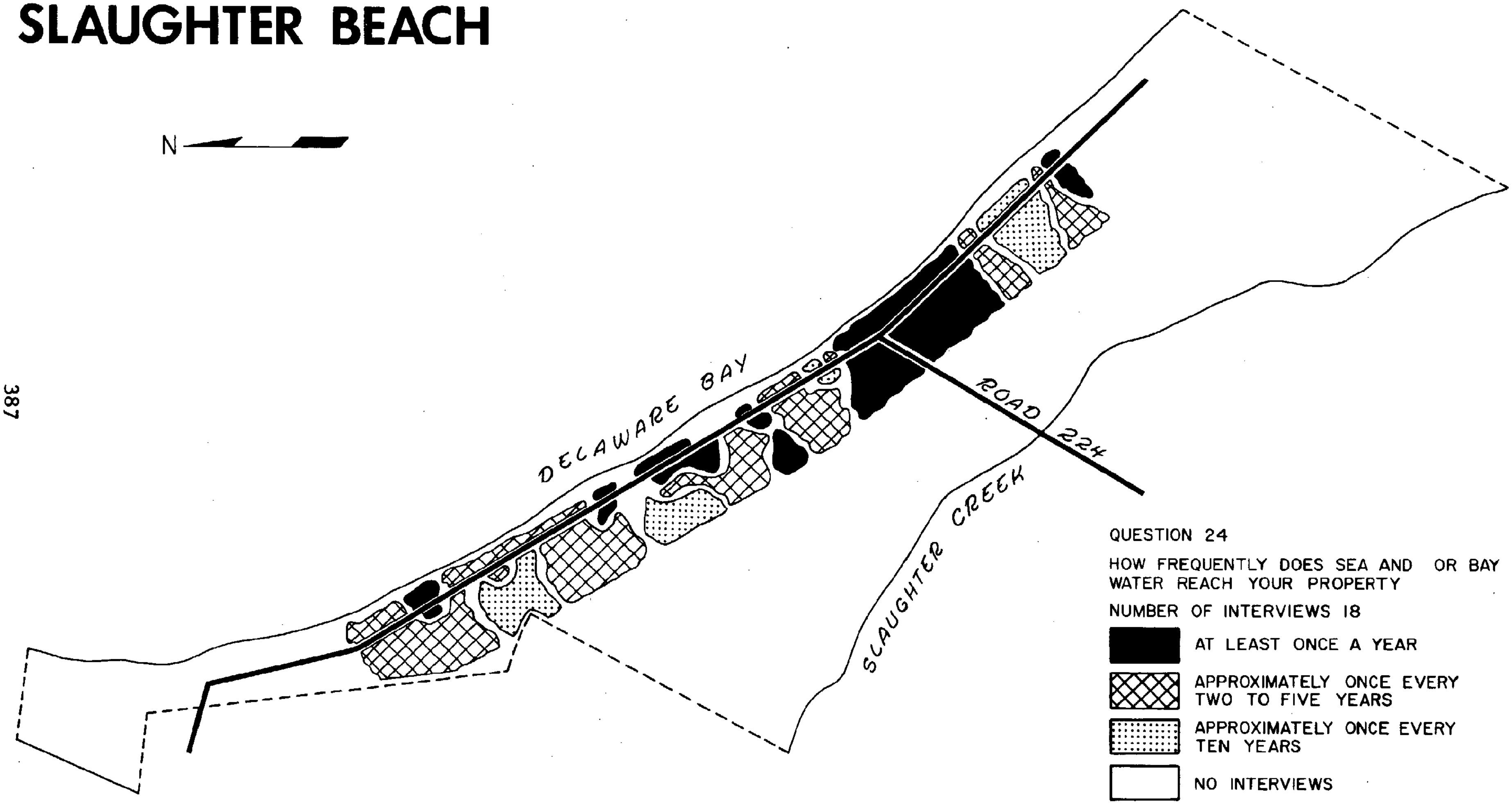
QUESTION 35
IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES, WERE THEY:
NUMBER OF INTERVIEWS: 26

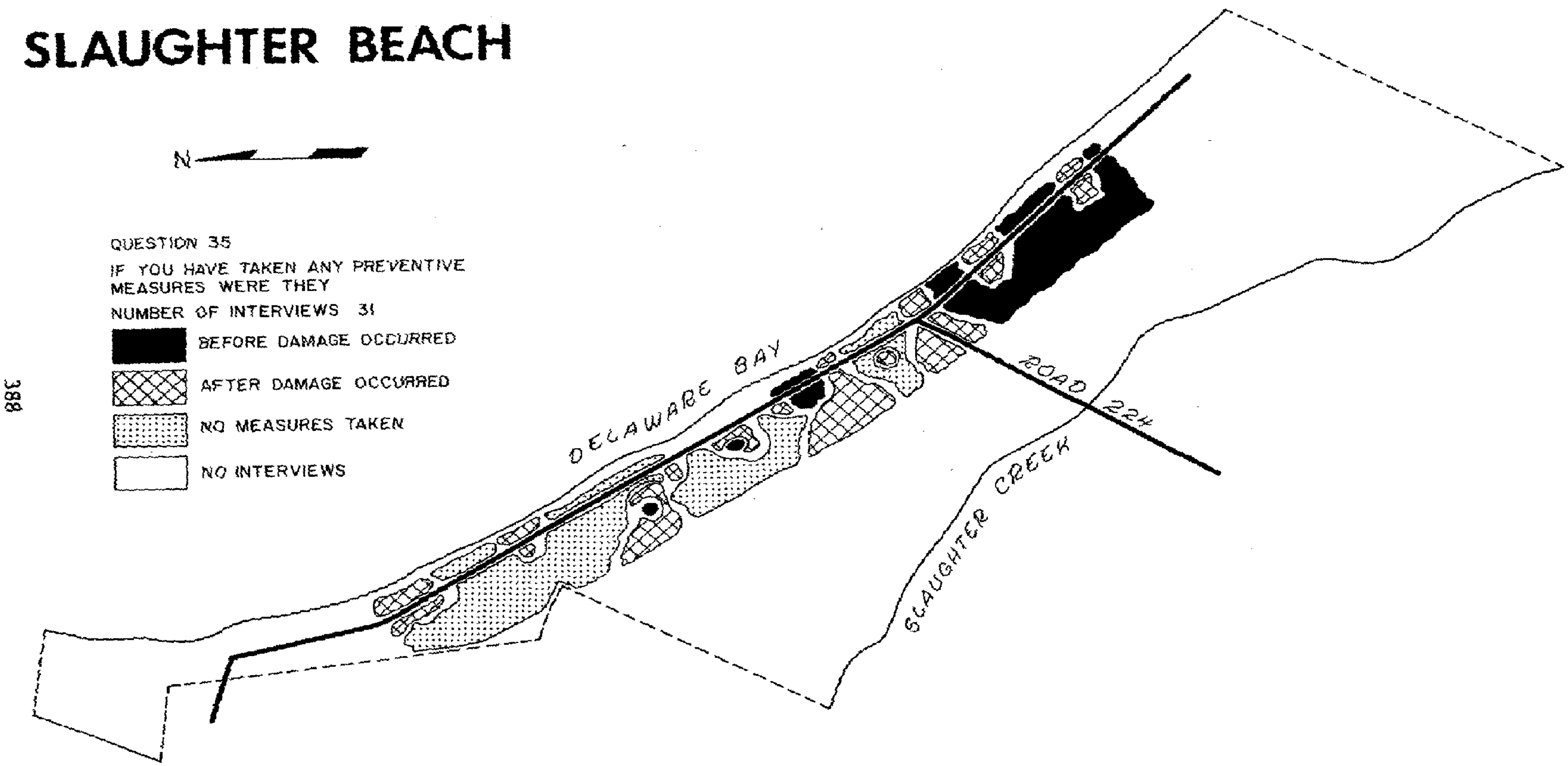
BEFORE DAMAGE OCCURED
AFTER DAMAGE OCCURED
NO MEASURES TAKEN
NO INTERVIEWS

SLAUGHTER BEACH

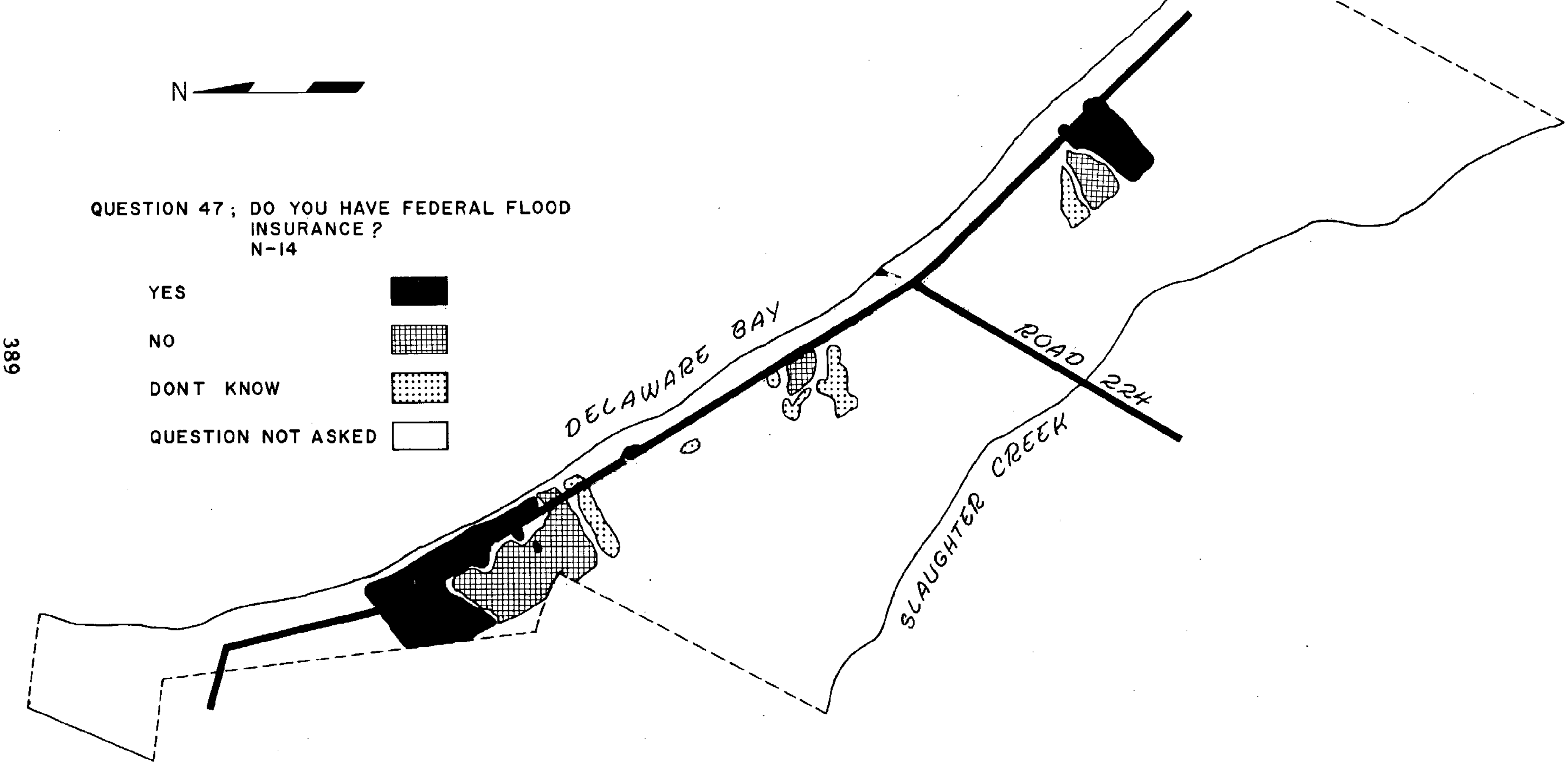


SLAUGHTER BEACH

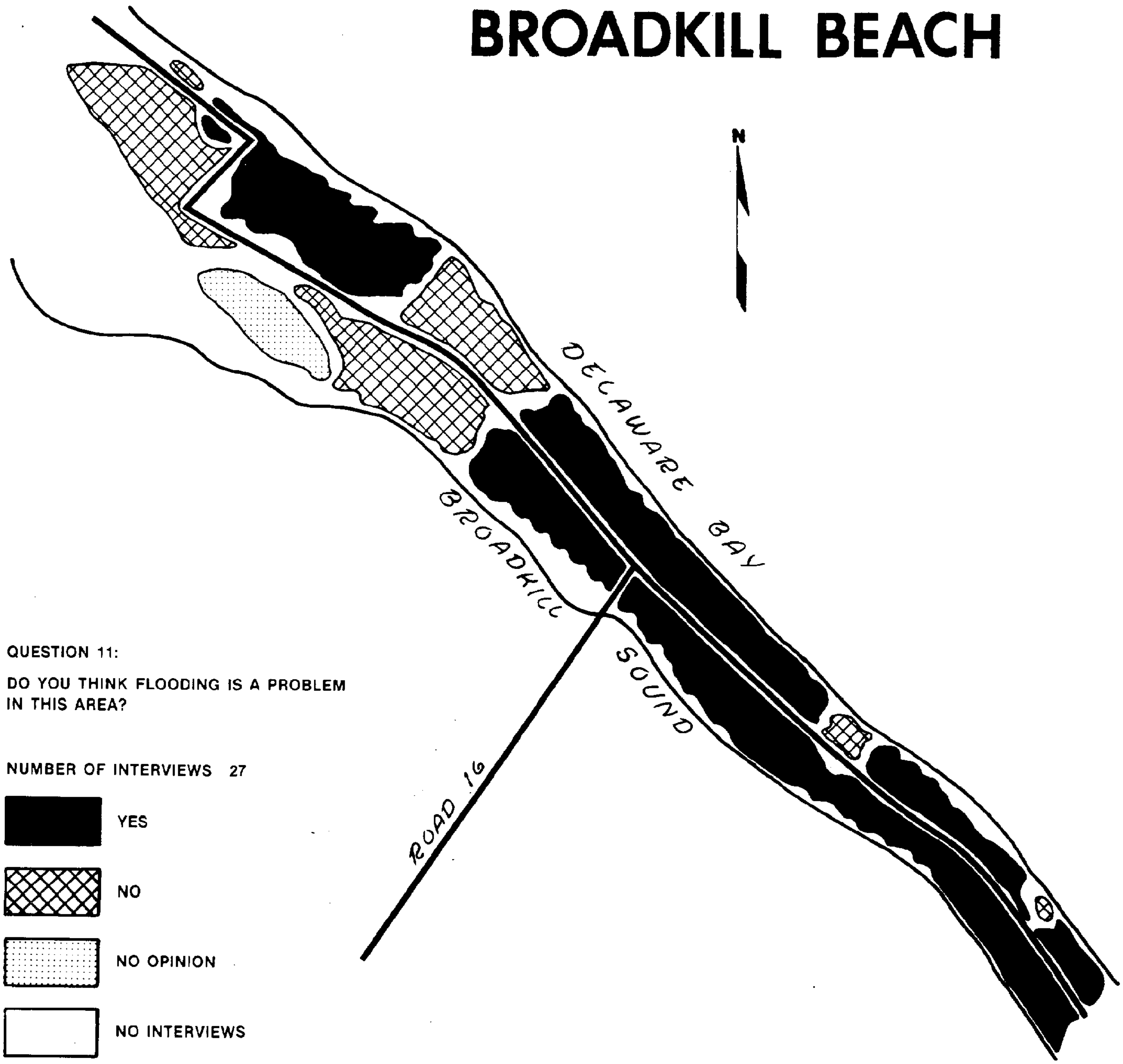



SLAUGHTER BEACH
N
QUESTION 35
IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES WERE THEY
NUMBER OF INTERVIEWS 31
BEFORE DAMAGE OCCURRED
AFTER DAMAGE OCCURRED
NO MEASURES TAKEN
NO INTERVIEWS
DELAWARE BAY
ROAD 224
SLAUGHTER CREEK

SLAUGHTER BEACH



BROADKILL BEACH

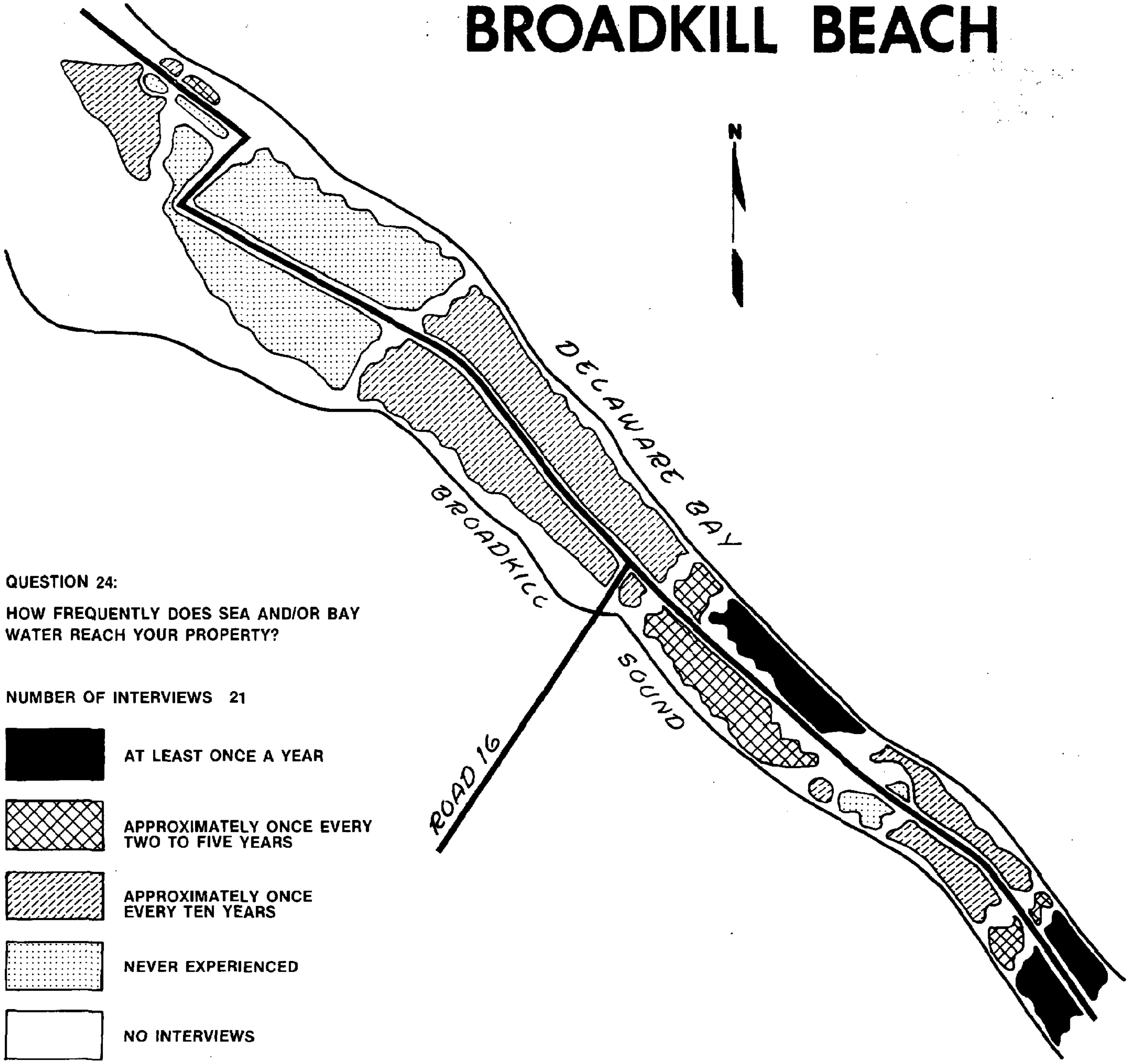


QUESTION 11:

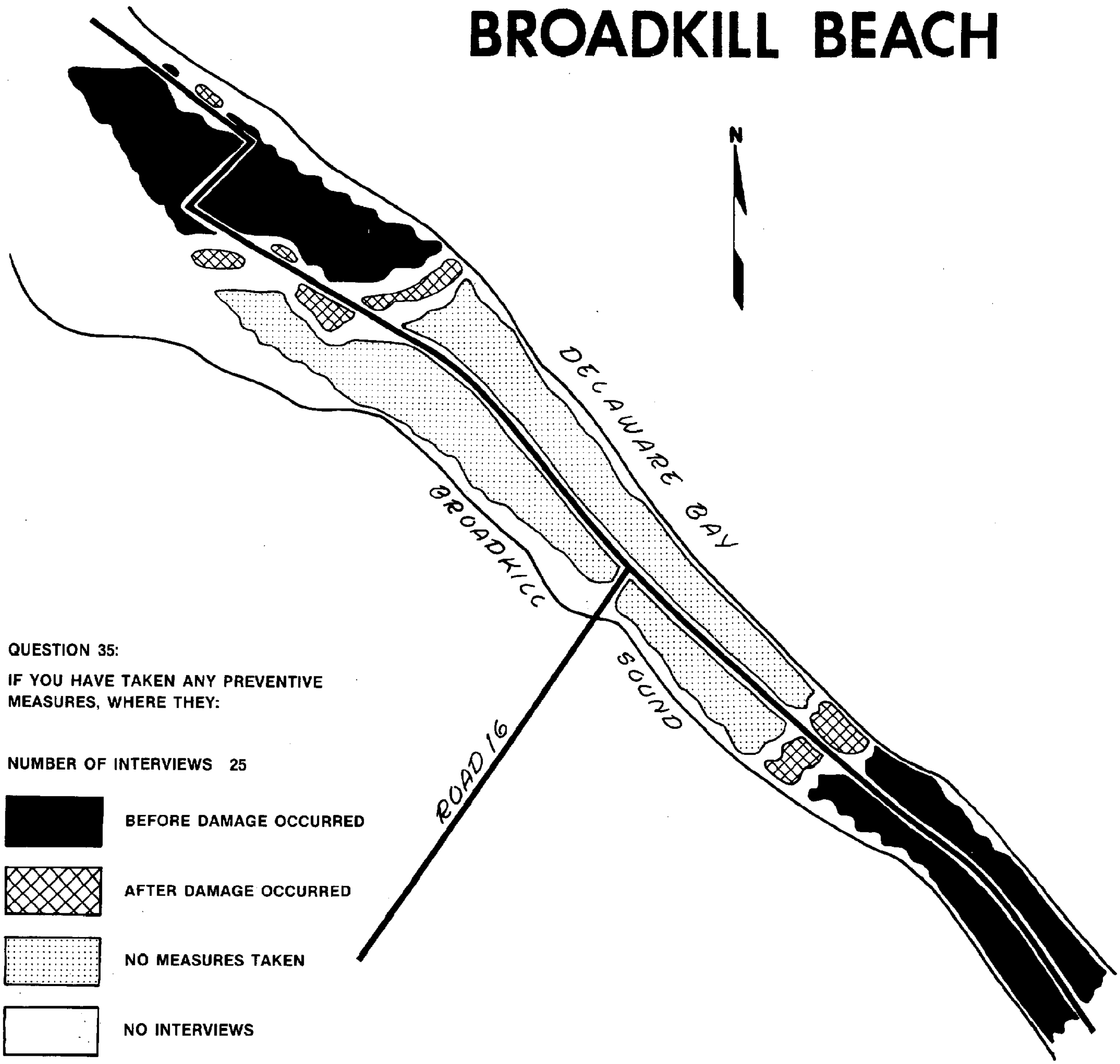
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA?

NUMBER OF INTERVIEWS 27

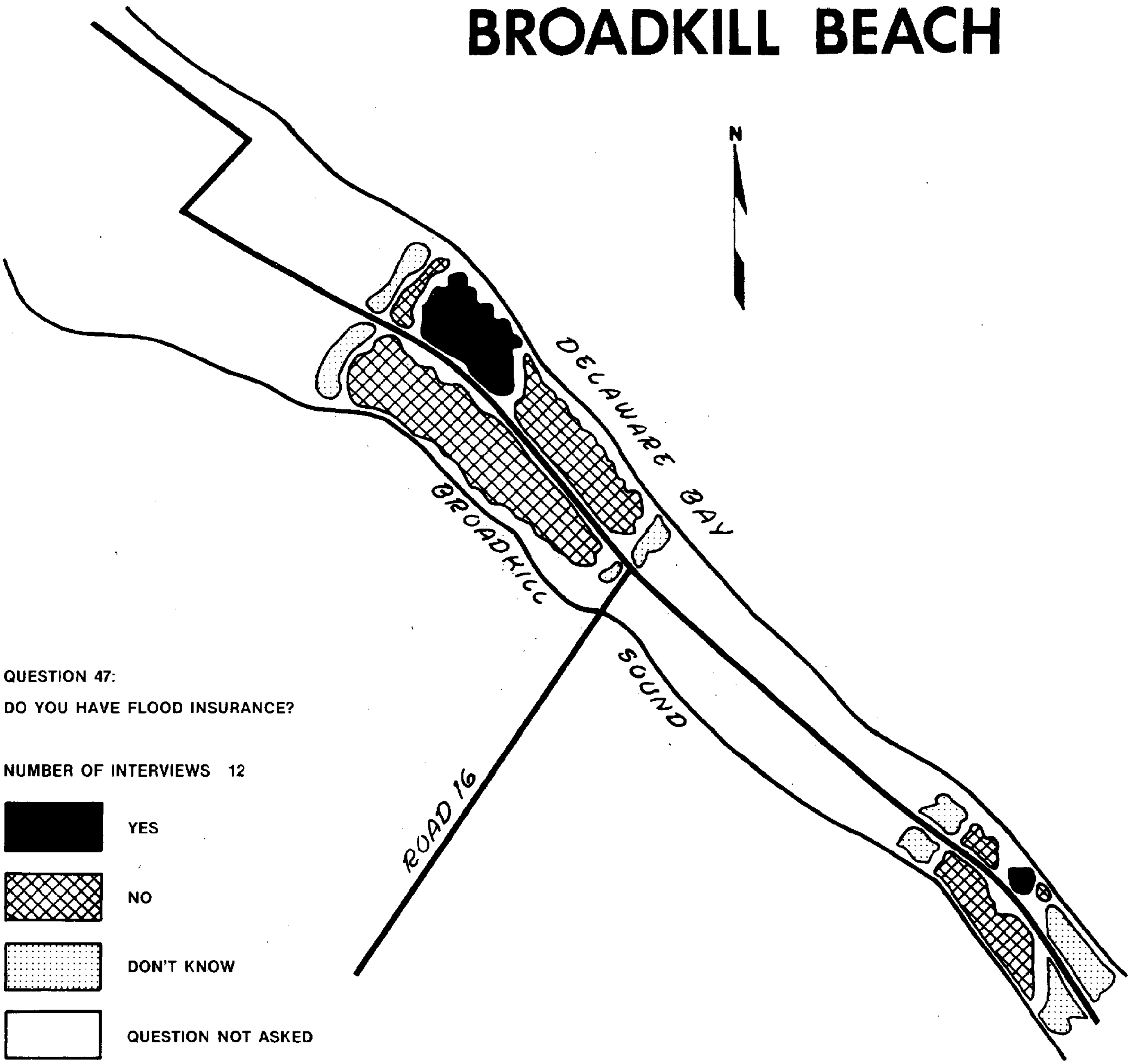
BROADKILL BEACH



BROADKILL BEACH



BROADKILL BEACH



QUESTION 47:

DO YOU HAVE FLOOD INSURANCE?

NUMBER OF INTERVIEWS 12

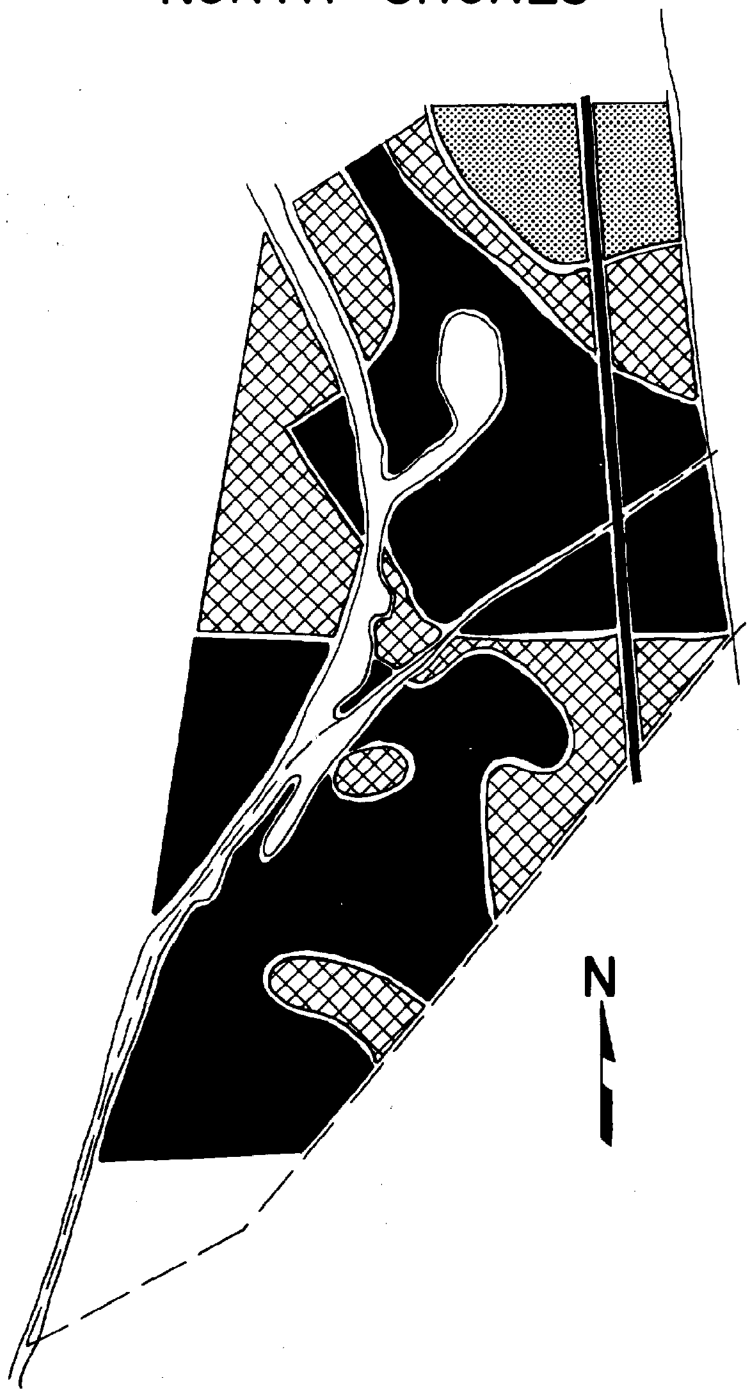
YES

NO

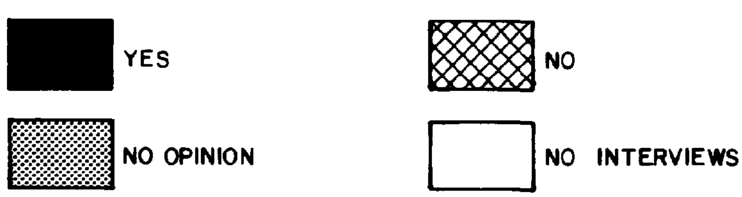
DON'T KNOW

QUESTION NOT ASKED

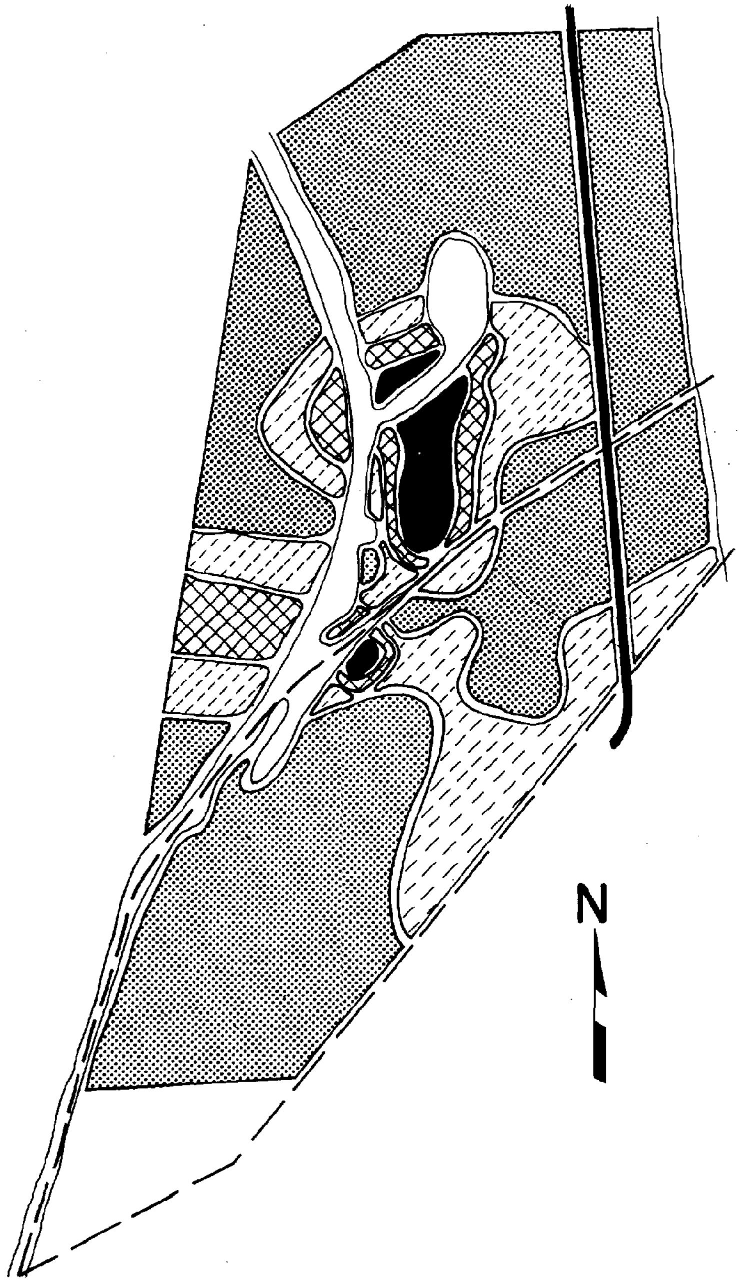
HENLOPEN ACRES AND NORTH SHORES



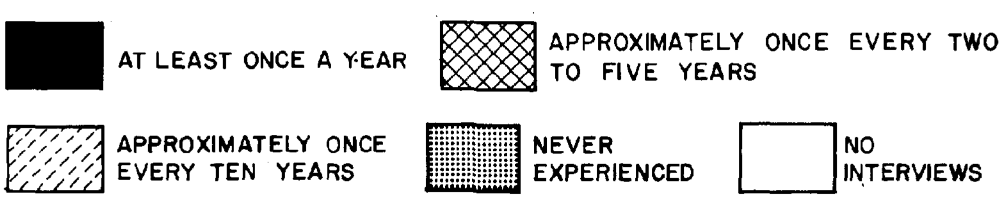
QUESTION 11
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS: 29



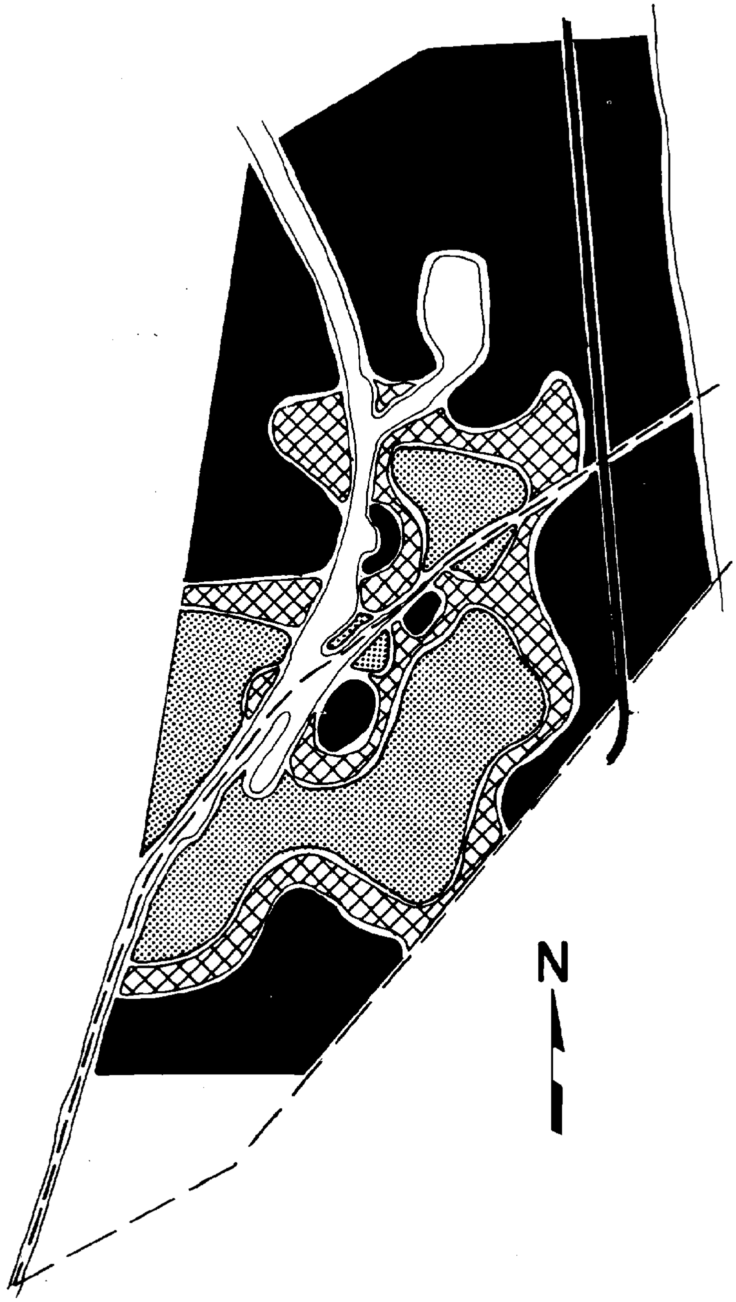
HENLOPEN ACRES AND NORTH SHORES



QUESTION NUMBER 24
HOW FREQUENTLY DOES SEA AND OR BAY WATER REACH YOUR PROPERTY
NUMBER OF INTERVIEWS 24

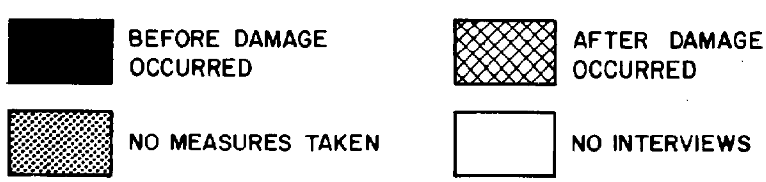


HENLOPEN ACRES AND NORTH SHORES

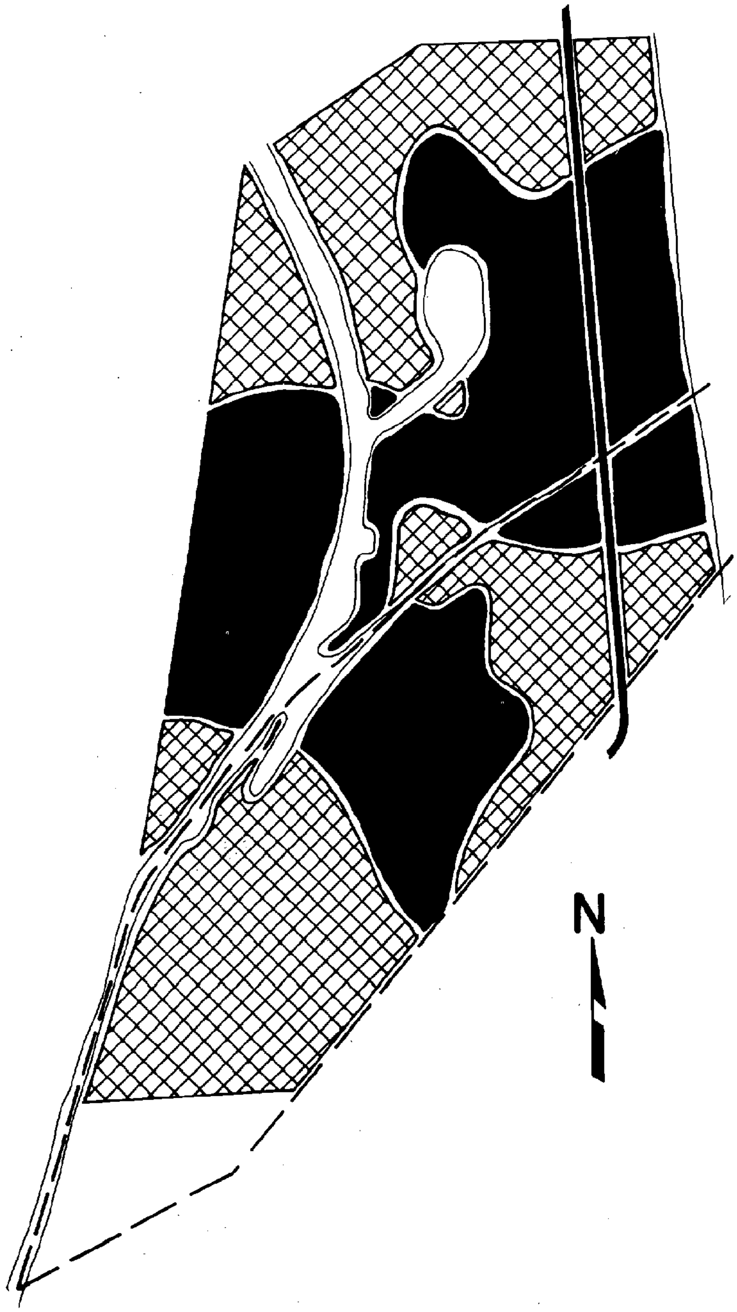


QUESTION 35

IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES WERE THEY:
NUMBER OF INTERVIEWS 28



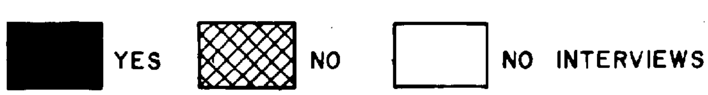
HENLOPEN ACRES AND NORTH SHORES

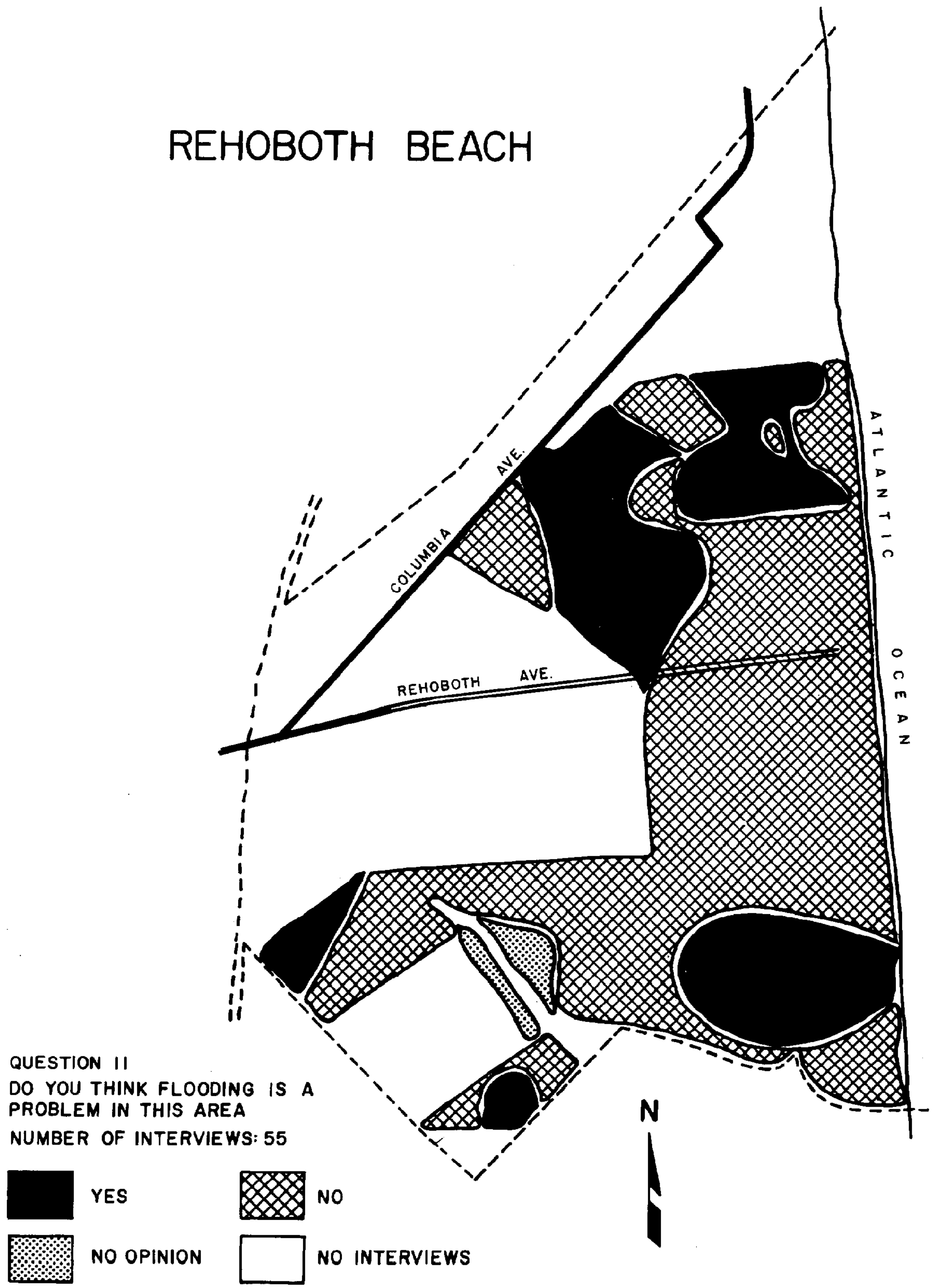


QUESTION 47

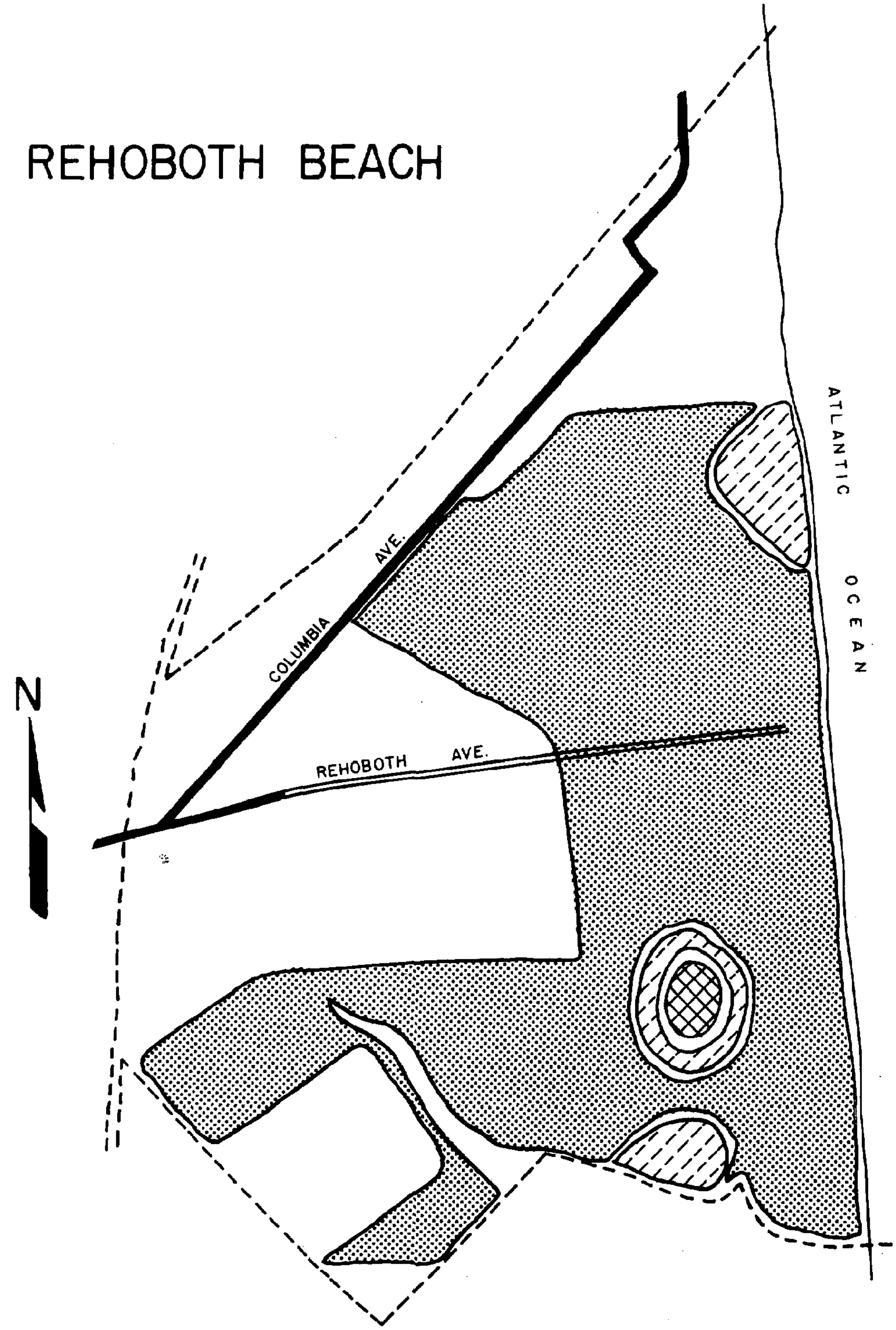
DO YOU HAVE FEDERAL FLOOD INSURANCE

NUMBER OF INTERVIEWS: 29




REHOBOTH BEACH
COLUMBIA AVE.
REHOBOTH AVE.
ATLANTIC OCEAN
N
QUESTION 11
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS: 55
YES
NO
NO OPINION
NO INTERVIEWS

REHOBOTH BEACH

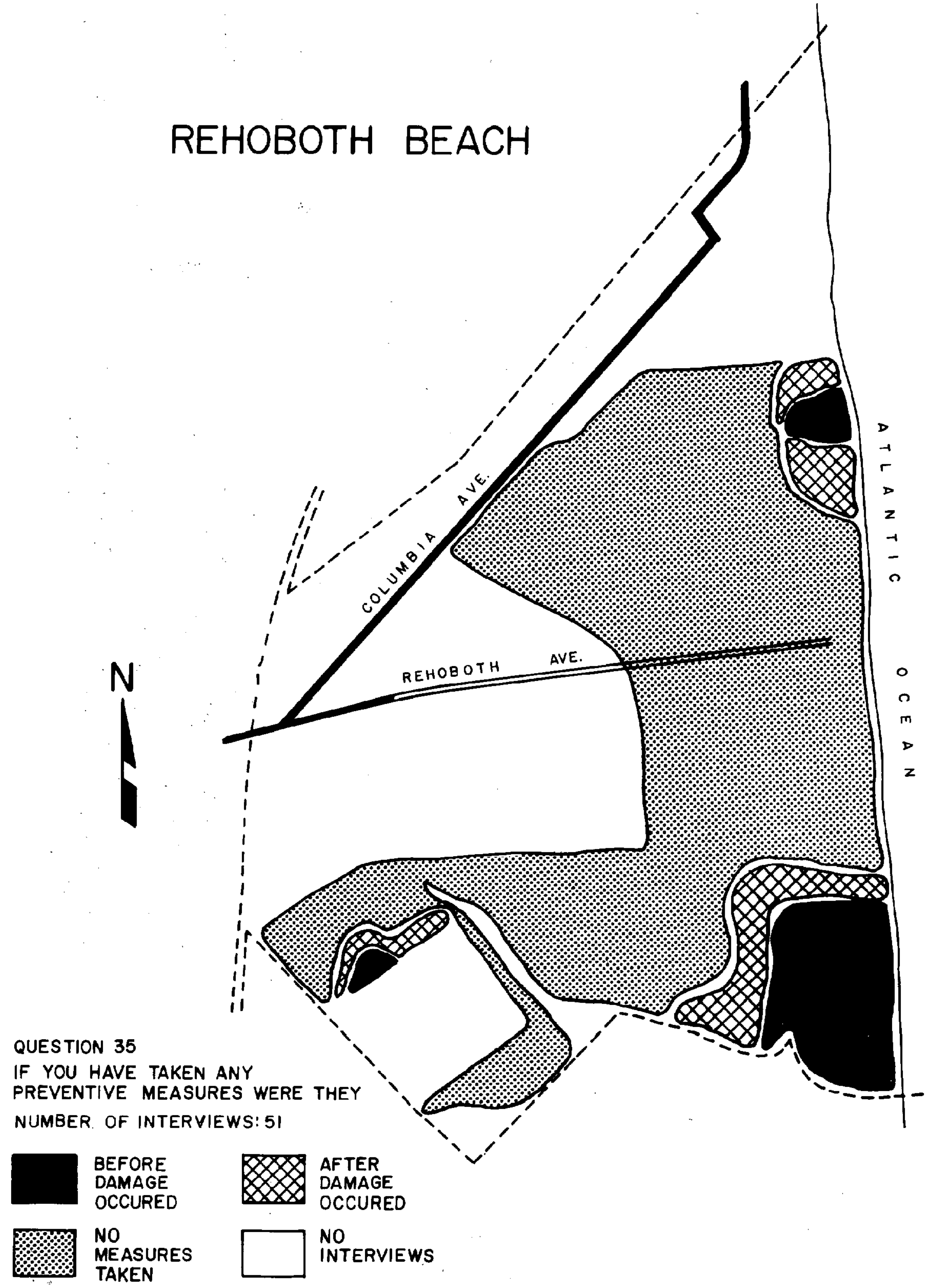


QUESTION 24
HOW FREQUENTLY DOES SEA AND/OR BAY WATER REACH YOUR PROPERTY
NUMBER OF INTERVIEWS: 53

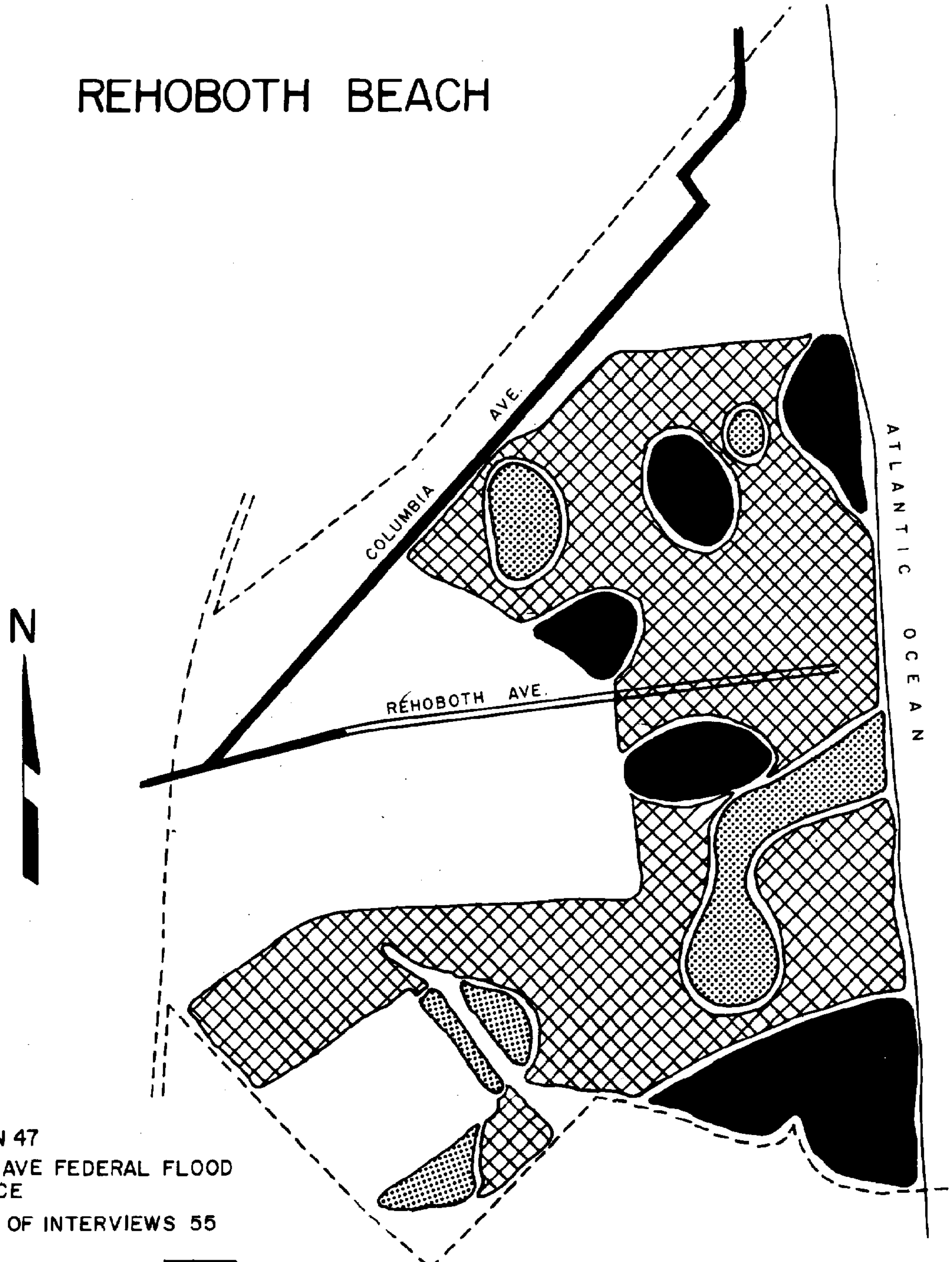
AT LEAST ONCE A YEAR*
APPROXIMATELY ONCE EVERY TWO TO FIVE YEARS
APPROXIMATELY ONCE EVERY TEN YEARS
NEVER EXPERIENCED
NO INTERVIEWS

*Note: This catagory does not apply in this community.

REHOBOTH BEACH



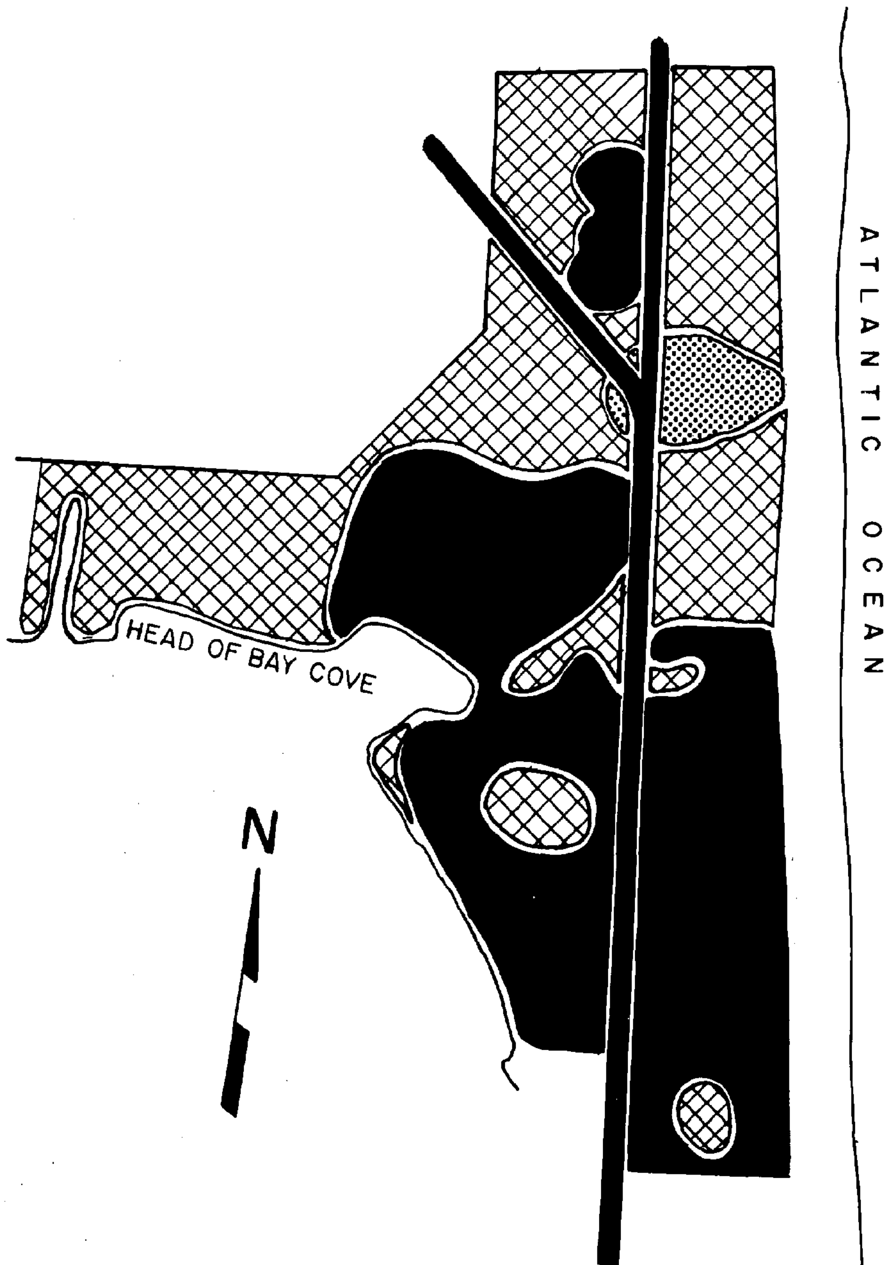
REHOBOTH BEACH



QUESTION 47
DO YOU HAVE FEDERAL FLOOD INSURANCE
NUMBER OF INTERVIEWS 55

YES
NO
DON'T KNOW
NO INTERVIEW

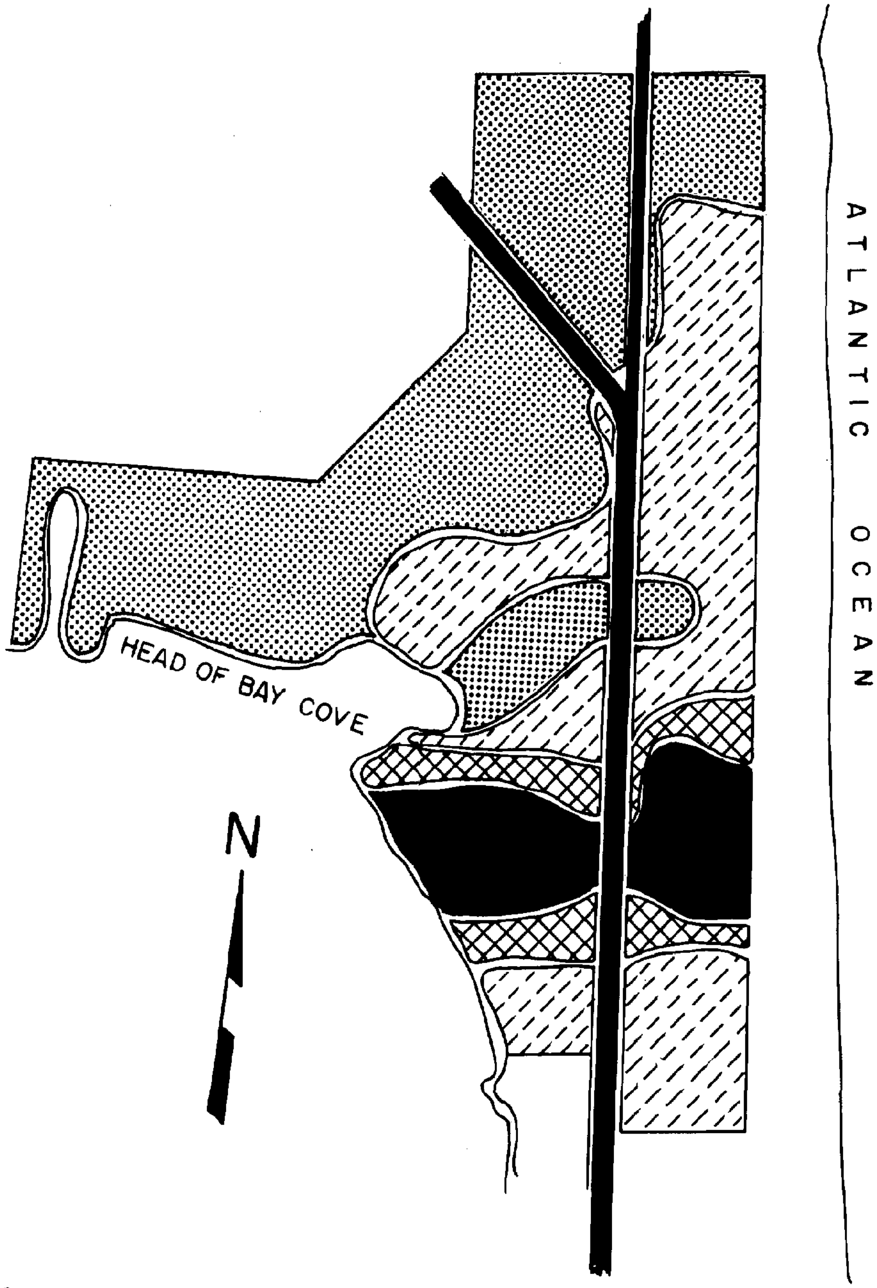
DEWEY BEACH



QUESTION II
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS: 32

YES
NO
NO OPINION
NO INTERVIEWS

DEWEY BEACH



QUESTION 24
HOW FREQUENTLY DOES SEA AND OR BAY WATER REACH YOUR PROPERTY
NUMBER OF INTERVIEWS: 30

AT LEAST ONCE A YEAR

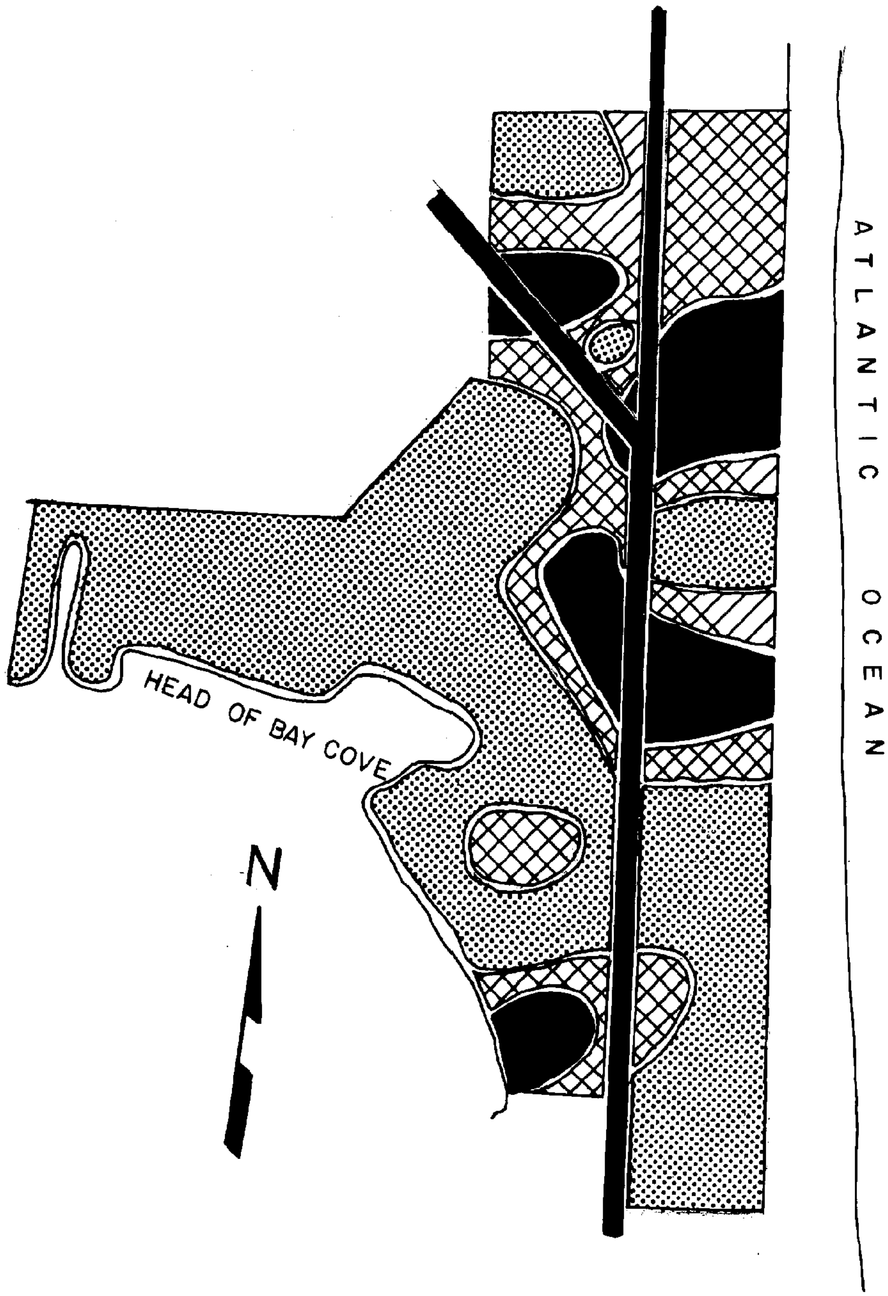
APPROXIMATELY ONCE EVERY TWO TO FIVE YEARS

APPROXIMATELY ONCE EVERY TEN YEARS

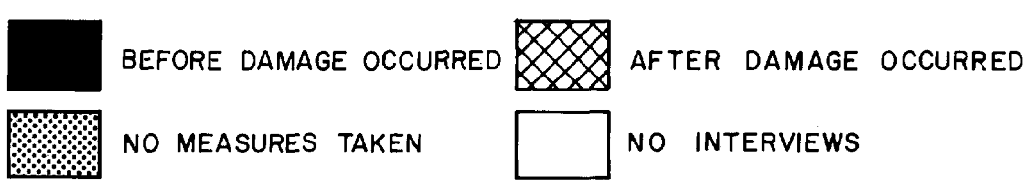
NEVER EXPERIENCED

NO INTERVIEWS

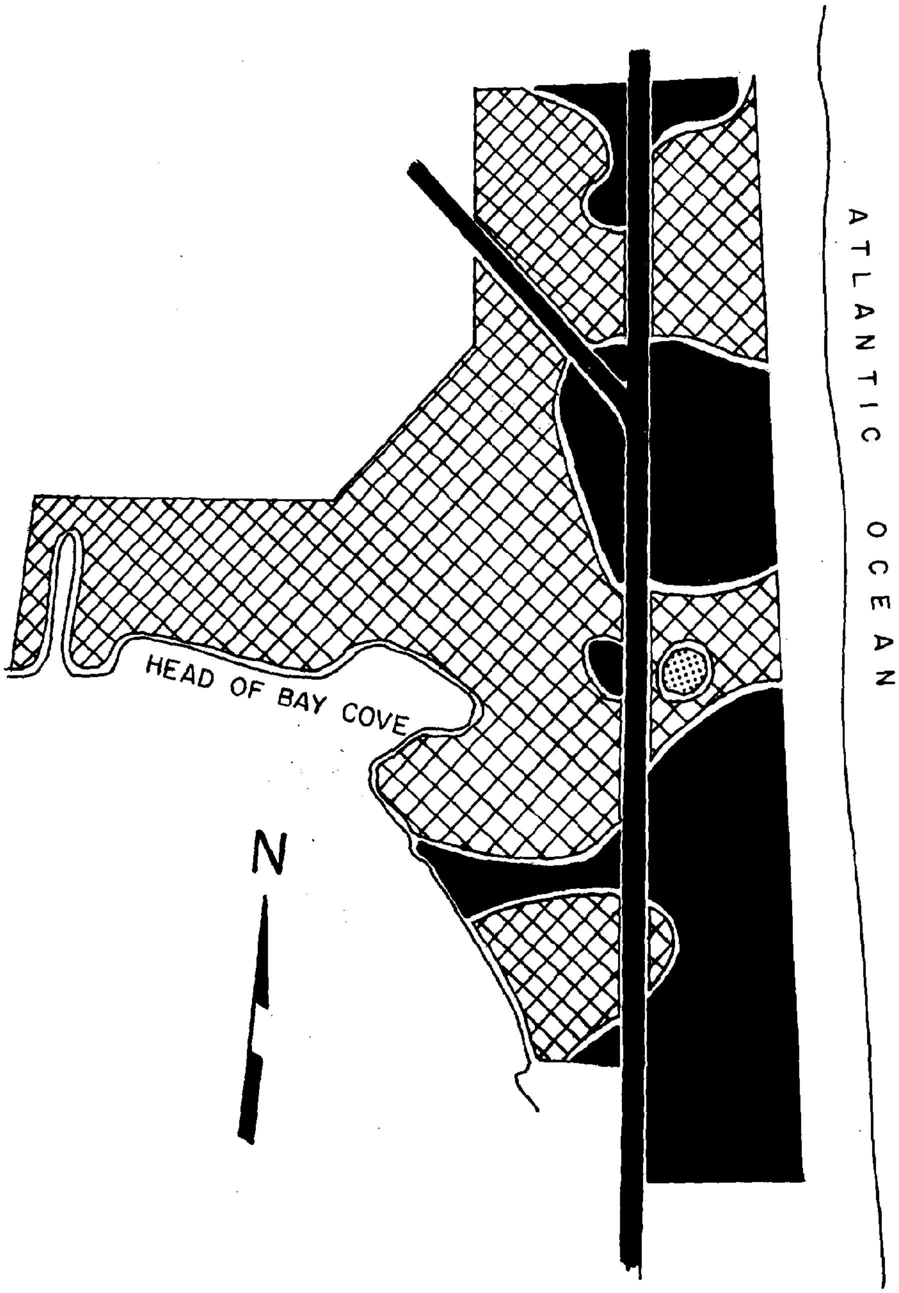
DEWEY BEACH



QUESTION 35
IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES WERE THEY
NUMBER OF INTERVIEWS: 32



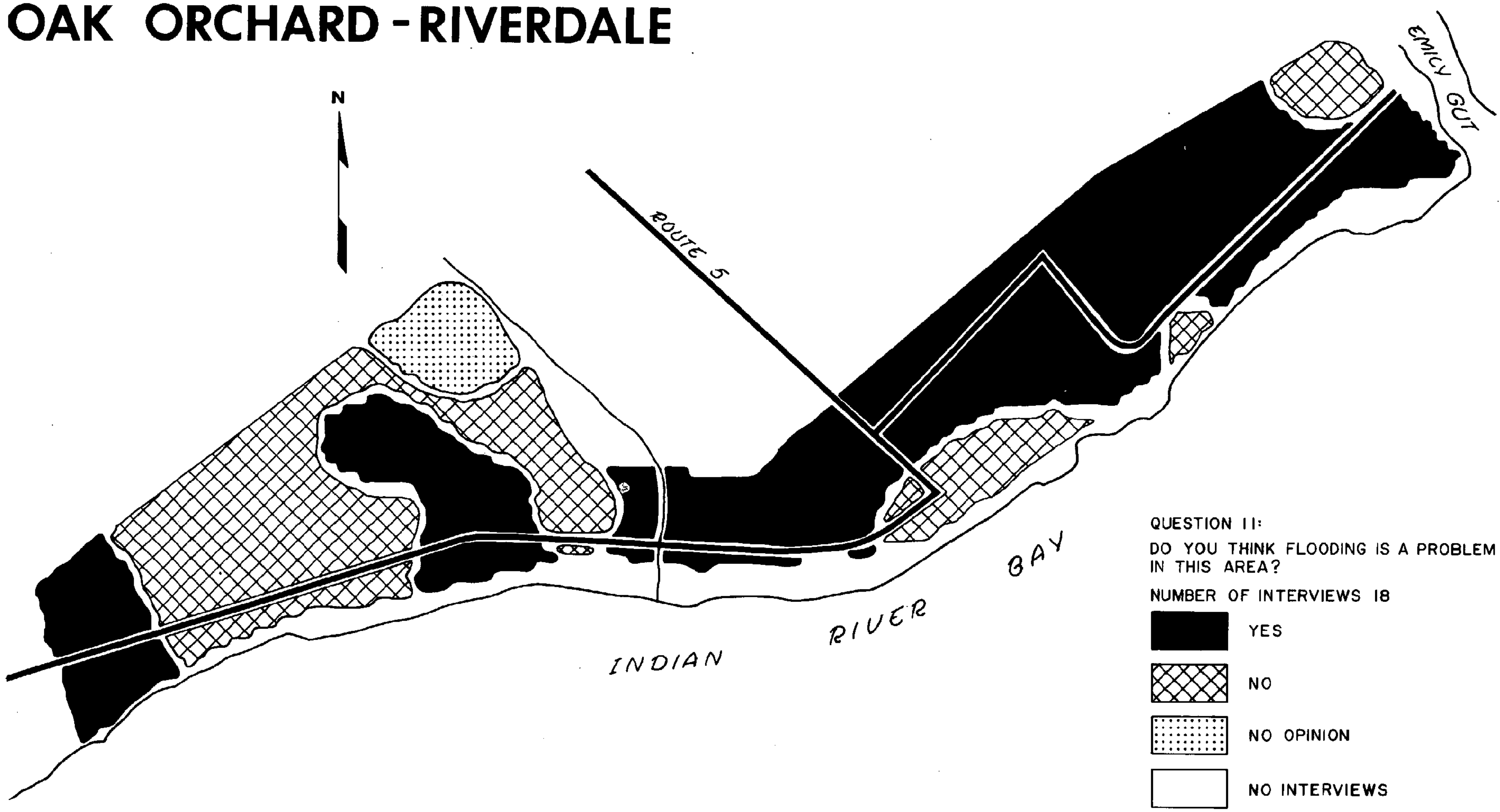
DEWEY BEACH



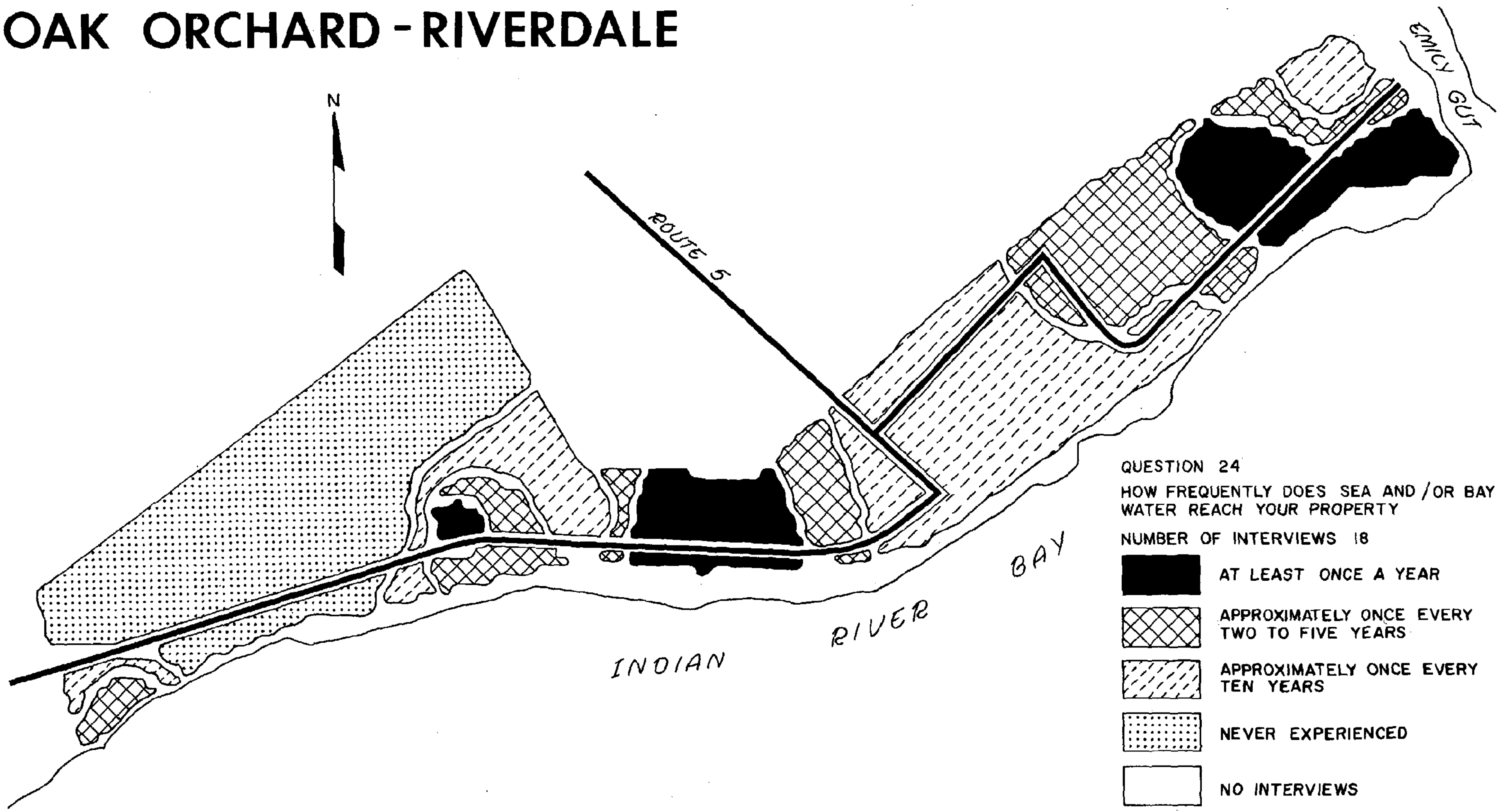
QUESTION 47
DO YOU HAVE FEDERAL FLOOD INSURANCE
NUMBER OF INTERVIEWS: 32

YES
NO
DON'T KNOW
NO INTERVIEWS

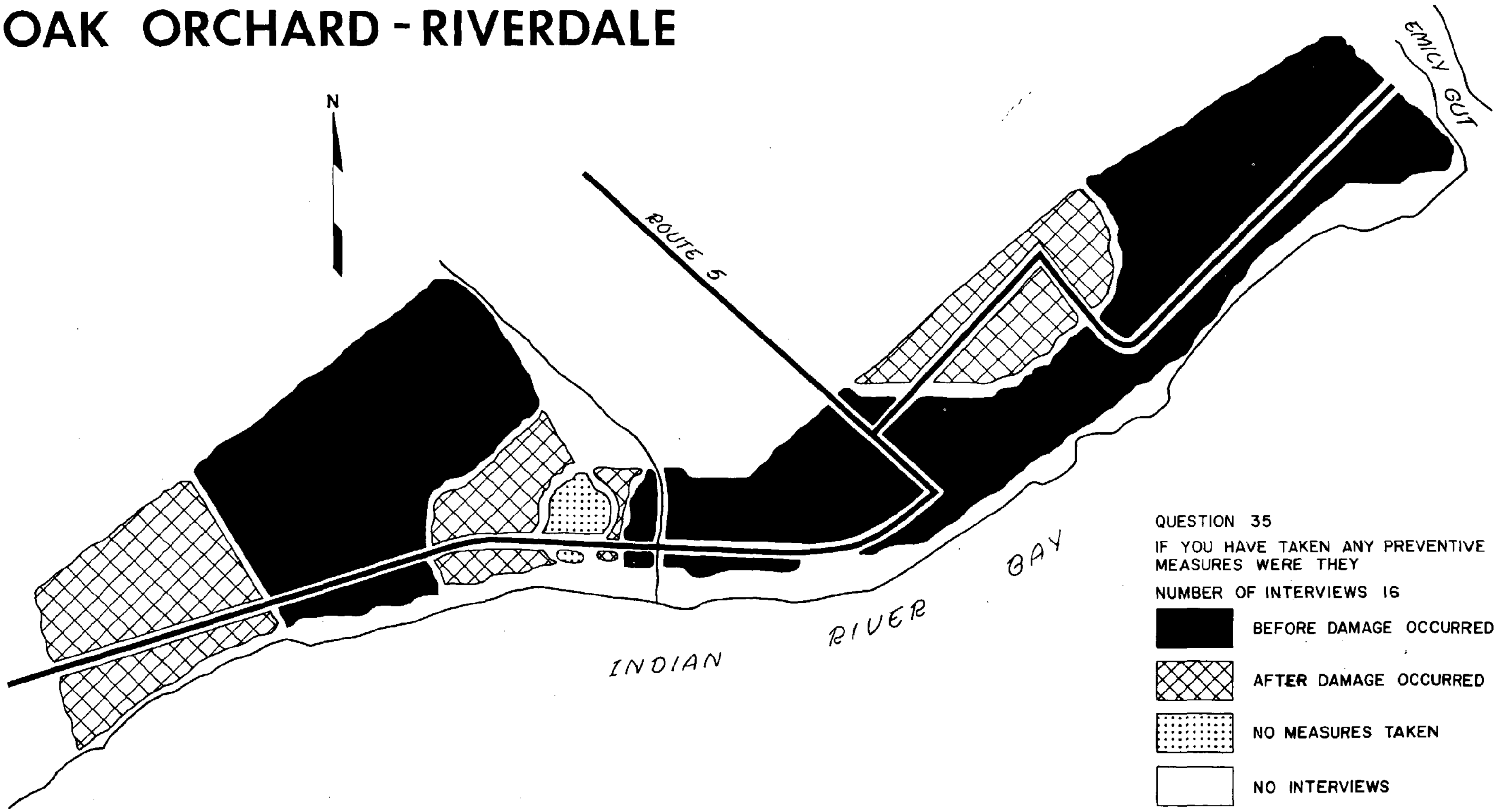
OAK ORCHARD - RIVERDALE



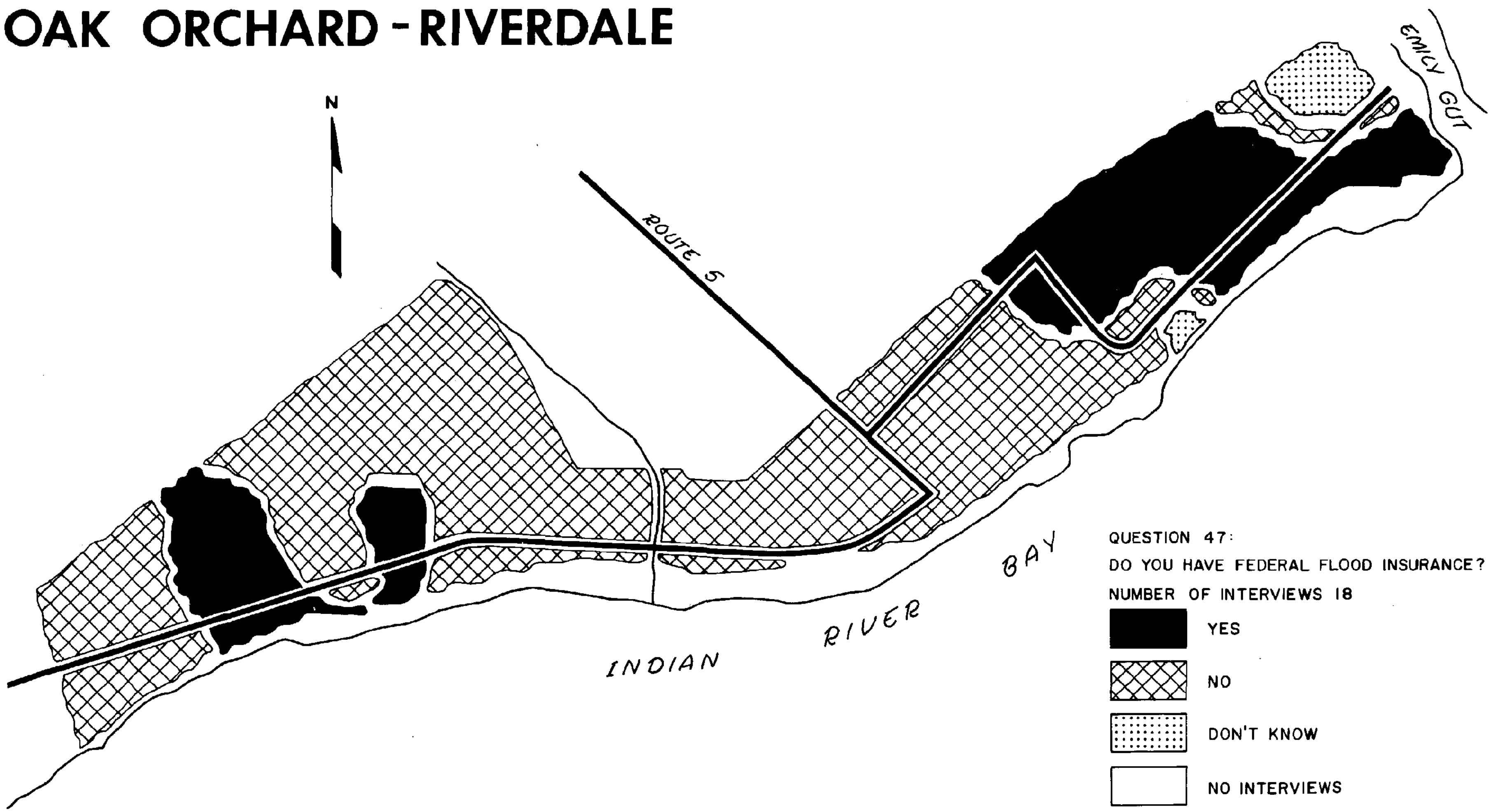
OAK ORCHARD - RIVERDALE



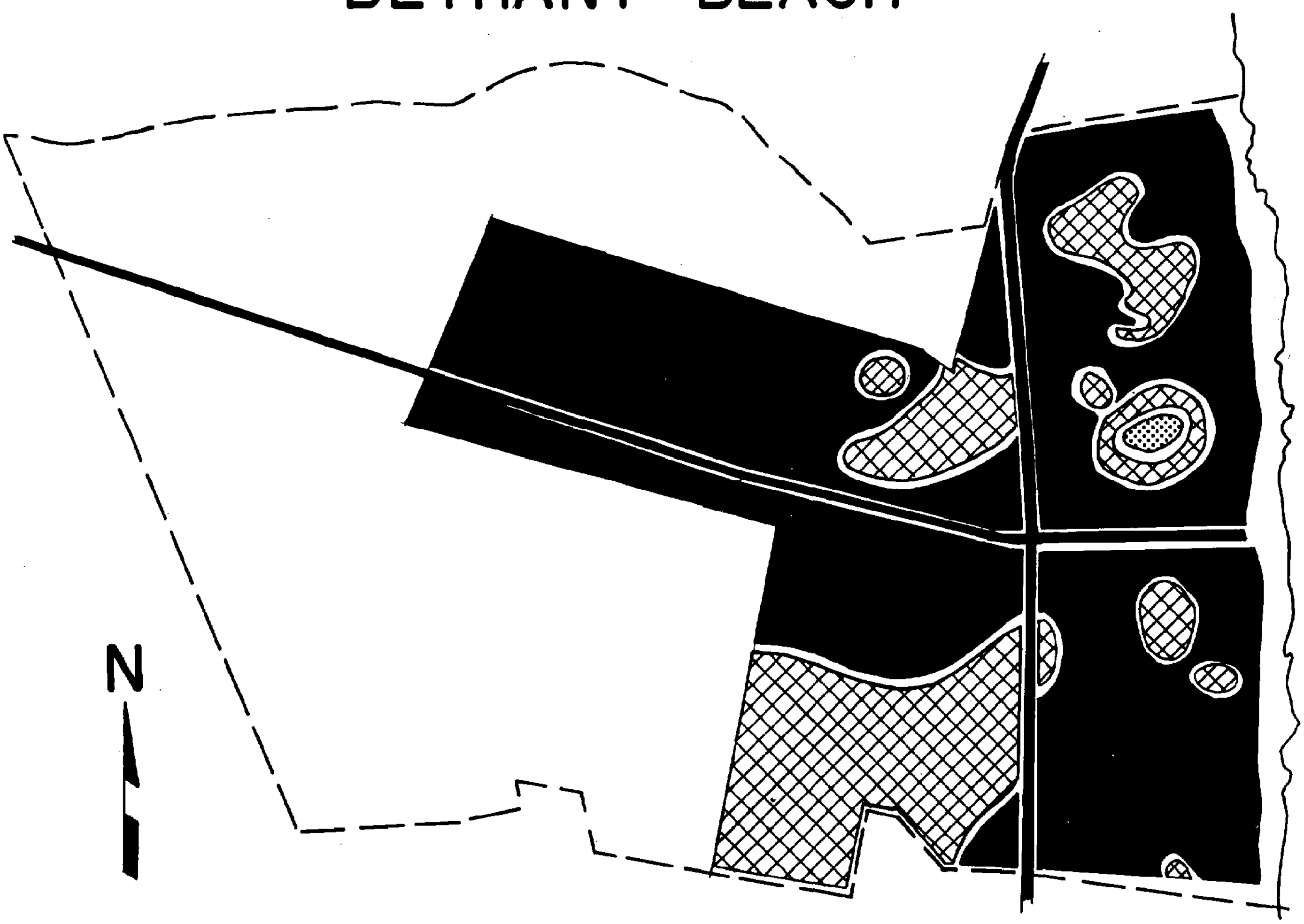
OAK ORCHARD - RIVERDALE



OAK ORCHARD - RIVERDALE



BETHANY BEACH



QUESTION II
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS: 62

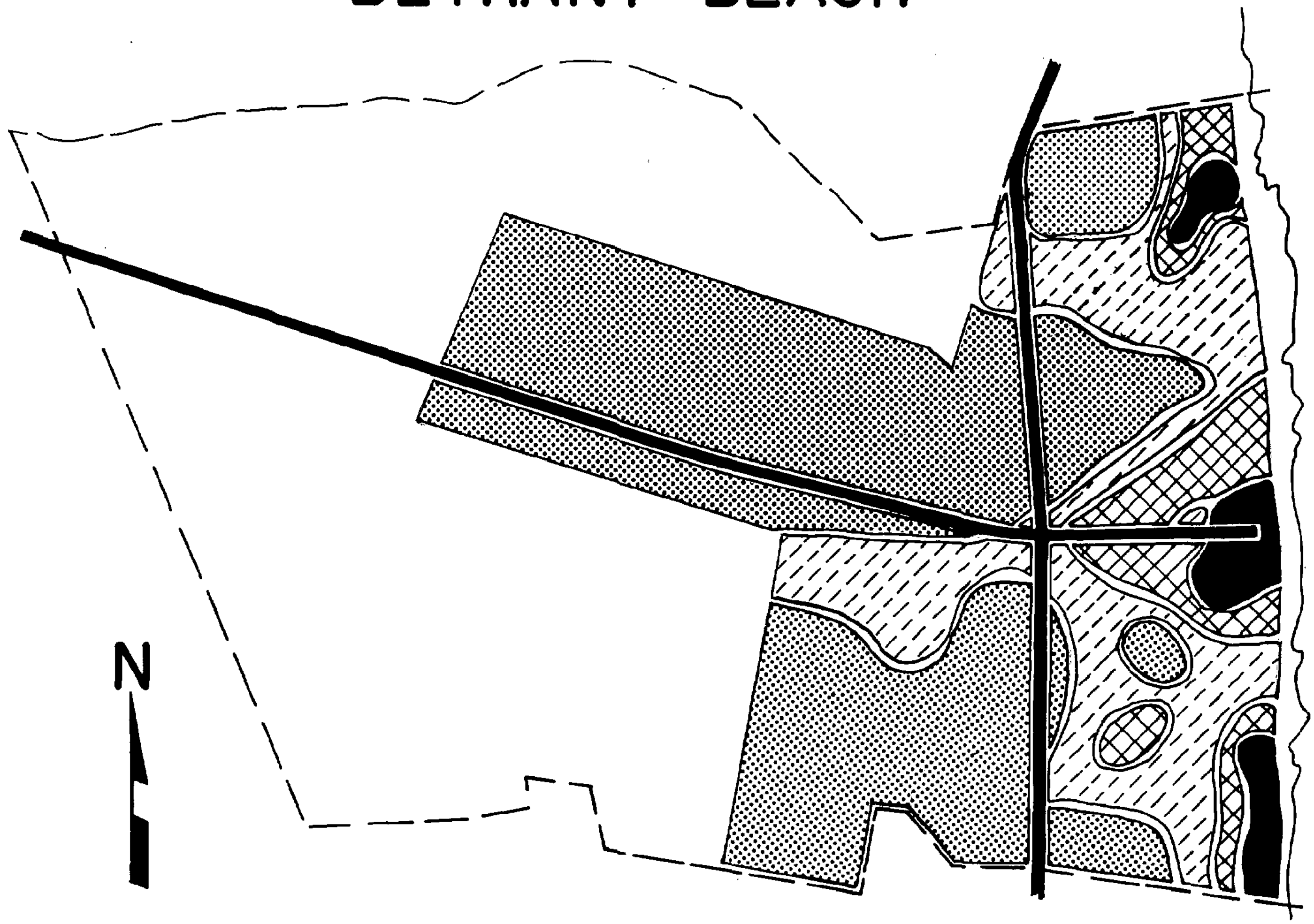
YES

NO

NO OPINION

NO INTERVIEWS

BETHANY BEACH



QUESTION 24
HOW FREQUENTLY DOES SEA AND OR BAY WATER REACH YOUR PROPERTY
NUMBER OF INTERVIEWS: 51

AT LEAST ONCE A YEAR

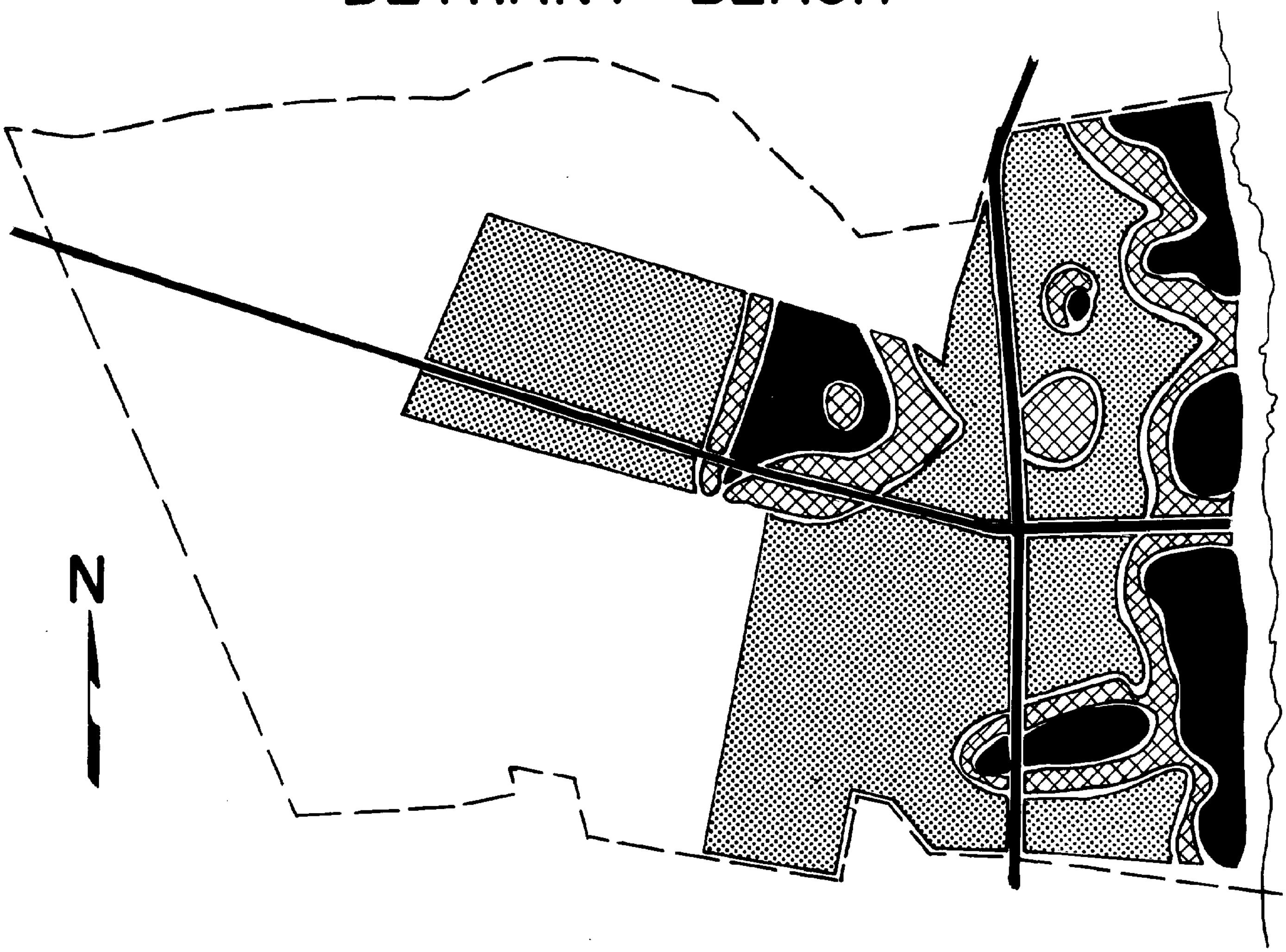
APPROXIMATELY ONCE EVERY TWO TO FIVE YEARS

APPROXIMATELY ONCE EVERY TEN YEARS

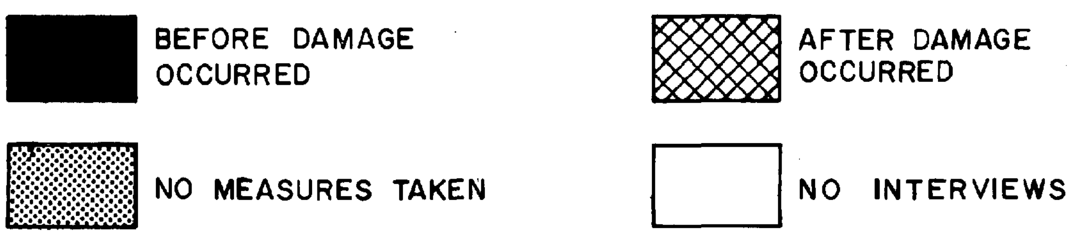
NEVER EXPERIENCED

NO INTERVIEWS

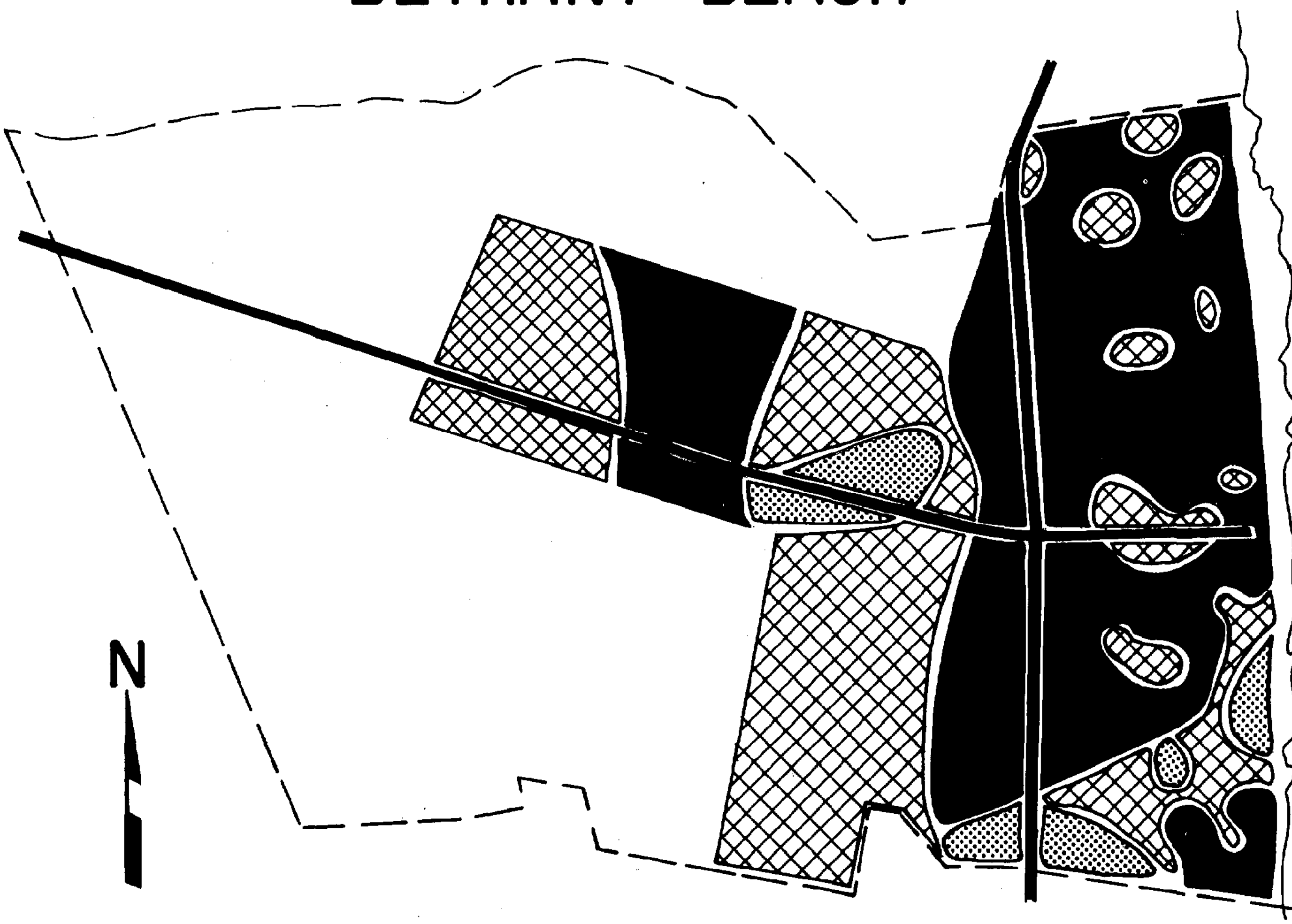
BETHANY BEACH



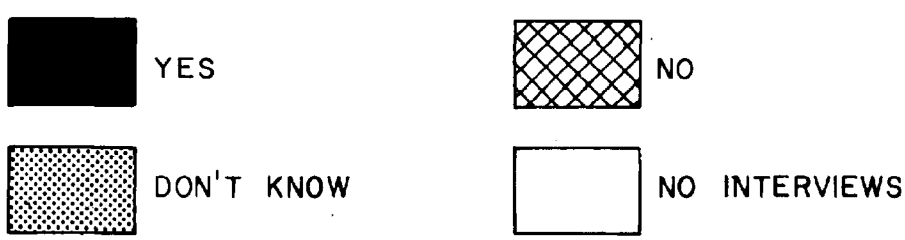
QUESTION 35
IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES WERE THEY.
NUMBER OF INTERVIEWS: 37

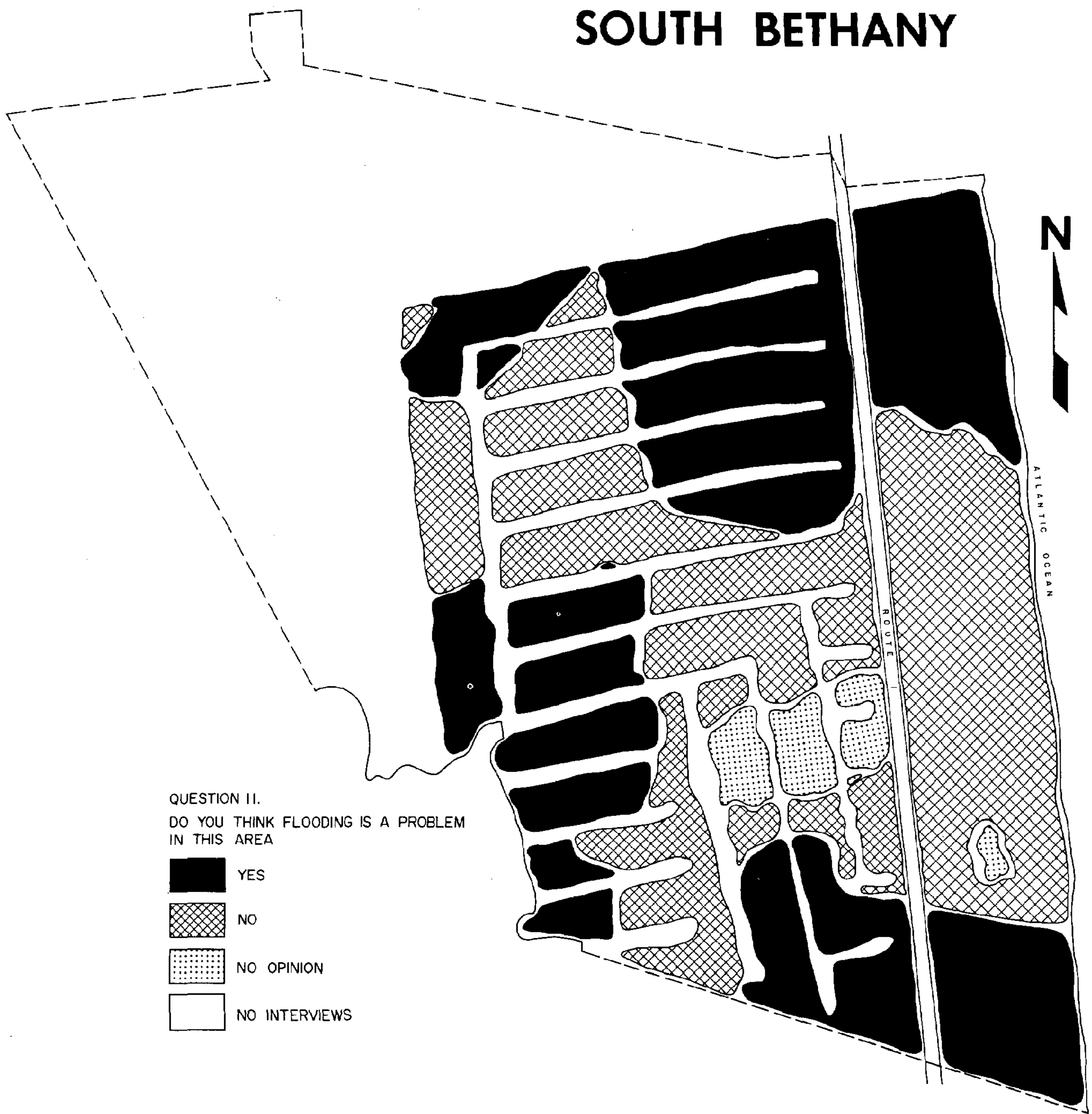


BETHANY BEACH

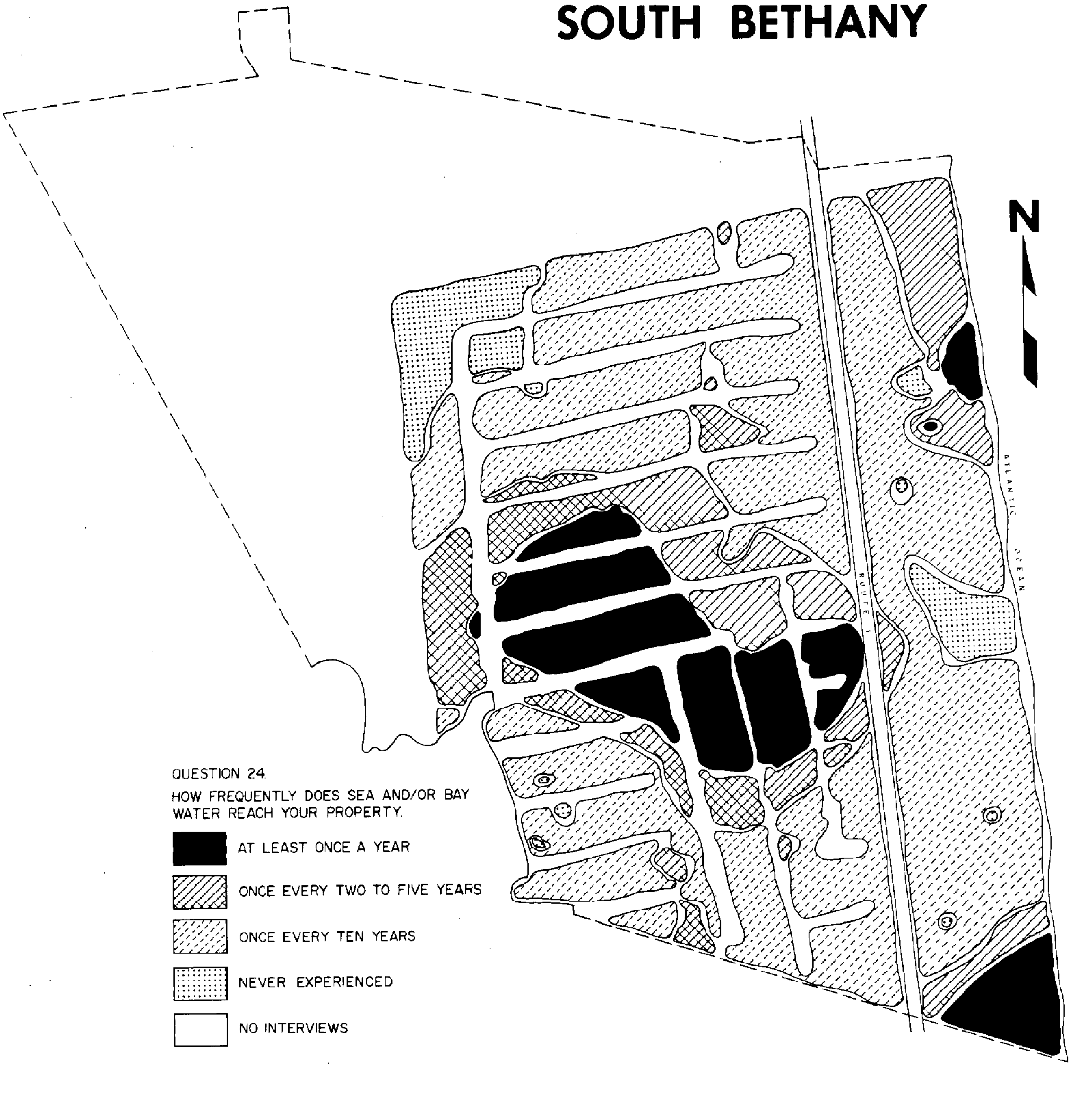


QUESTION 47
DO YOU HAVE FEDERAL FLOOD INSURANCE
NUMBER OF INTERVIEWS: 62

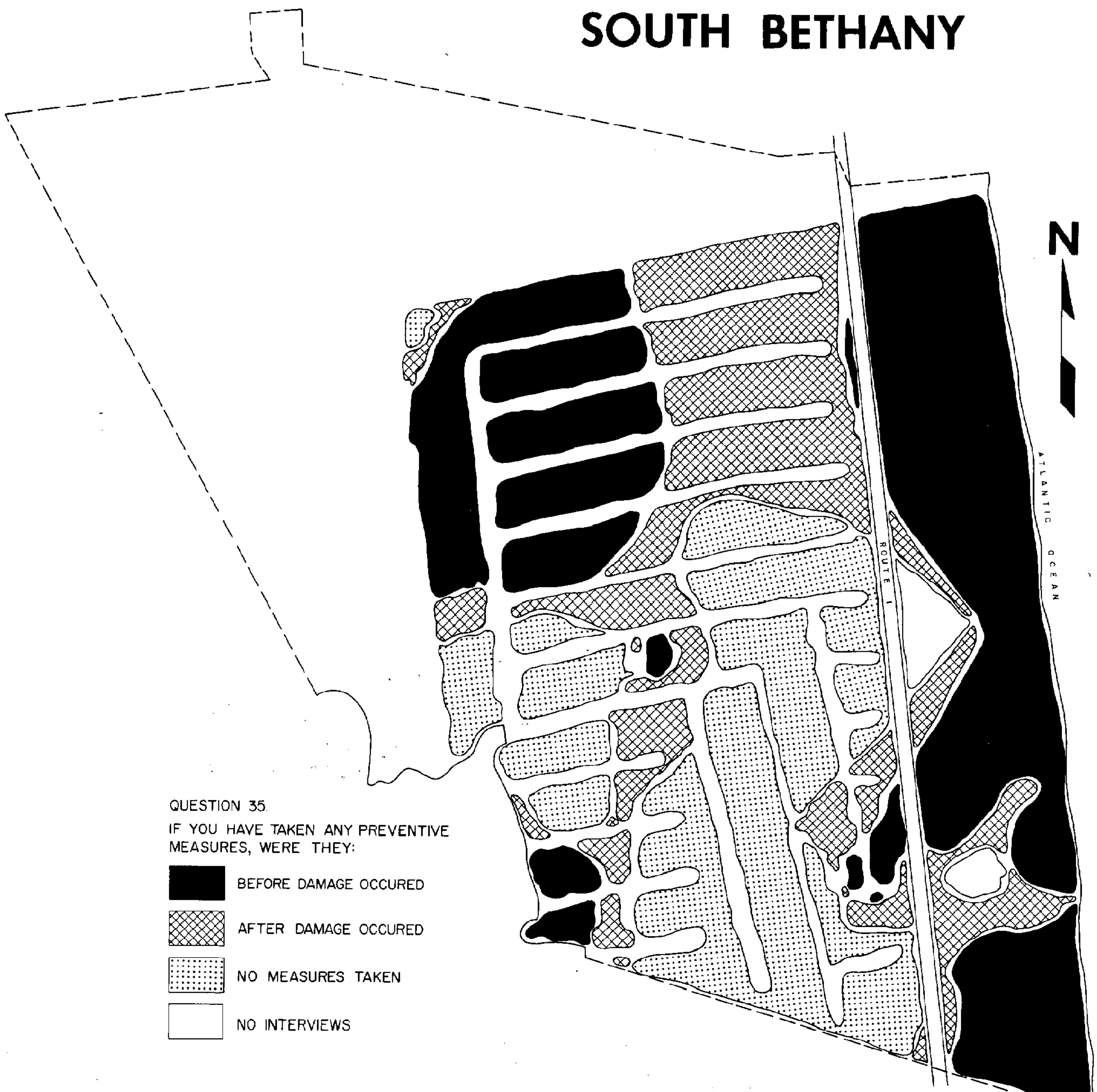


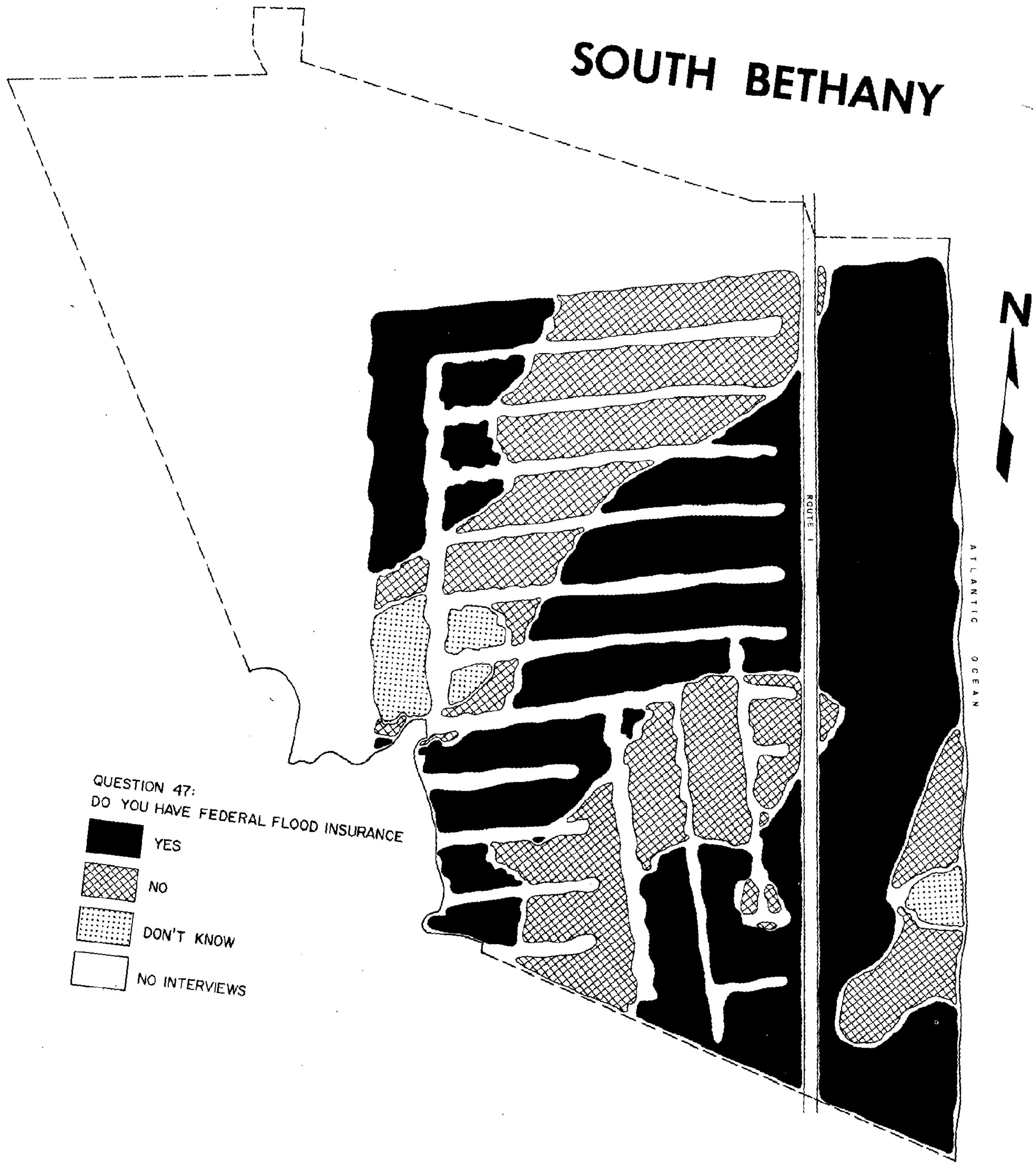

SOUTH BETHANY
N
ATLANTIC OCEAN
ROUTE
QUESTION 11.
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
YES
NO
NO OPINION
NO INTERVIEWS

SOUTH BETHANY

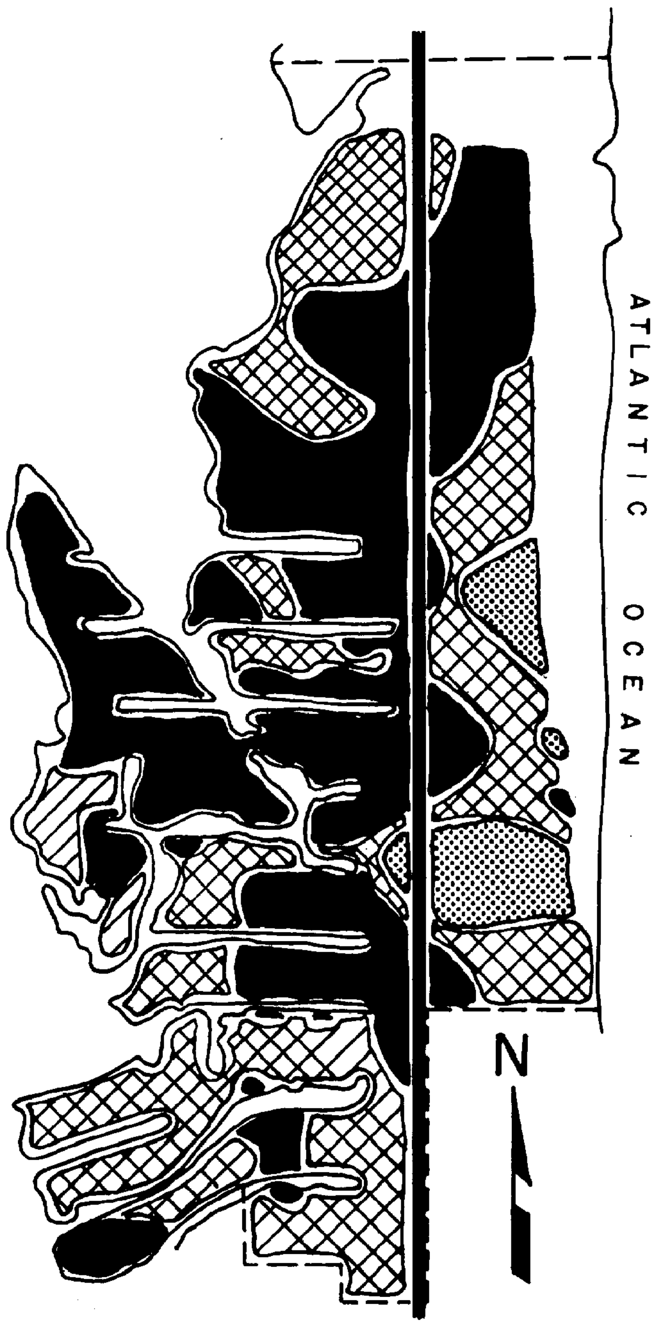


SOUTH BETHANY

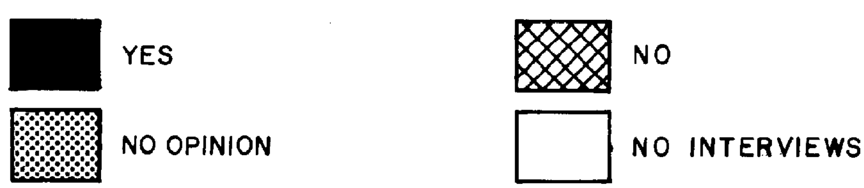



SOUTH BETHANY
N
ROUTE 1
ATLANTIC OCEAN
QUESTION 47:
DO YOU HAVE FEDERAL FLOOD INSURANCE
YES
NO
DON'T KNOW
NO INTERVIEWS

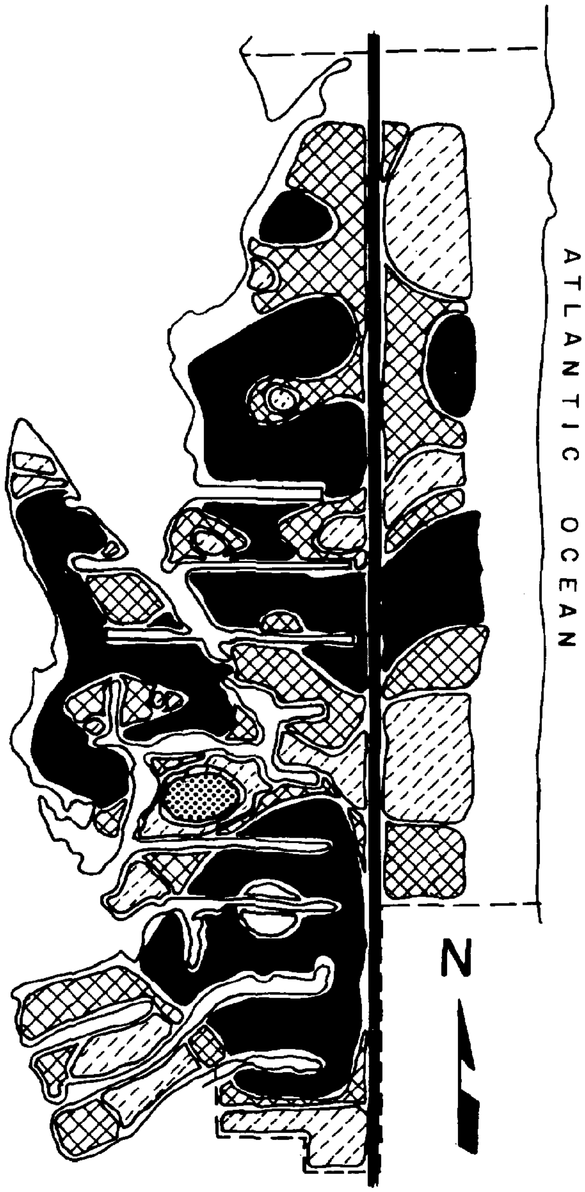
FENWICK ISLAND



QUESTION 11
DO YOU THINK FLOODING IS A PROBLEM IN THIS AREA
NUMBER OF INTERVIEWS: 101



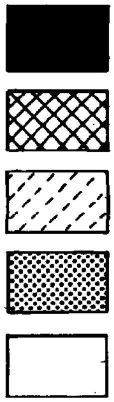
FENWICK ISLAND



QUESTION 24

HOW FREQUENTLY DOES SEA AND OR BAY WATER REACH YOUR PROPERTY

NUMBER OF INTERVIEWS: 85



AT LEAST ONCE A YEAR

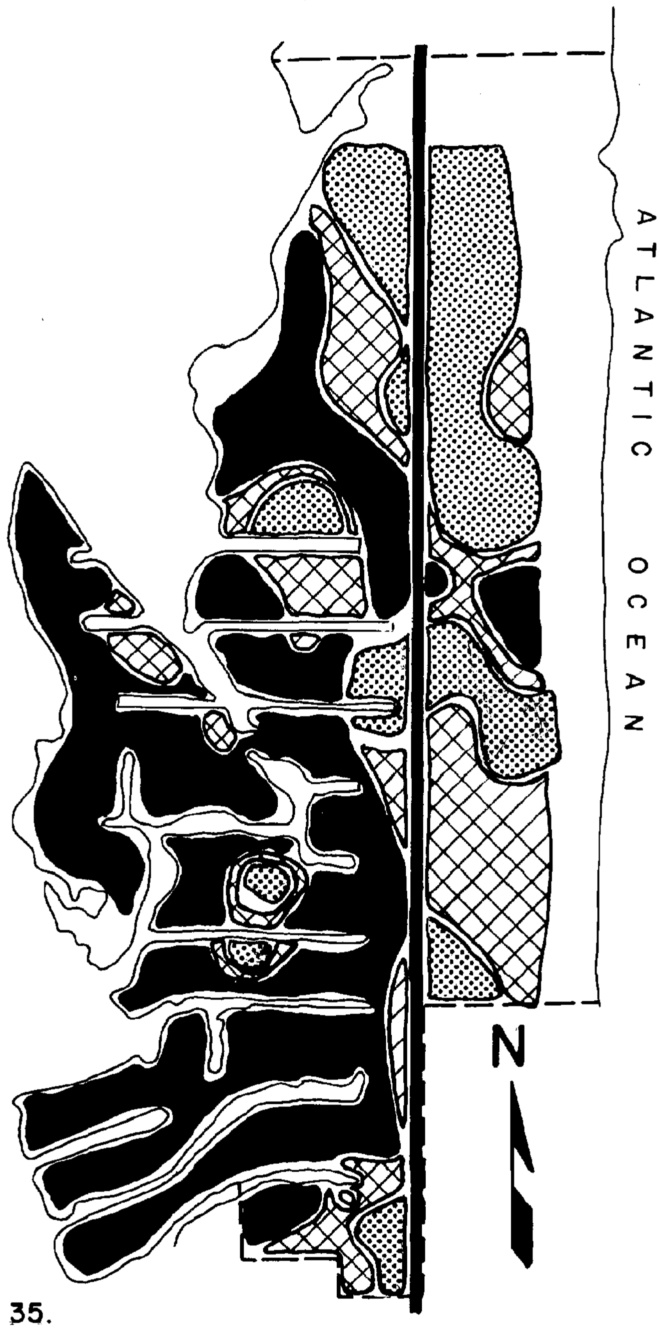
APPROXIMATELY ONCE EVERY TWO TO FIVE YEARS

APPROXIMATELY ONCE EVERY TEN YEARS

NEVER EXPERIENCED

NO INTERVIEWS

FENWICK ISLAND



QUESTION 35.
IF YOU HAVE TAKEN ANY PREVENTIVE MEASURES, WERE THEY:
NUMBER OF INTERVIEWS 90

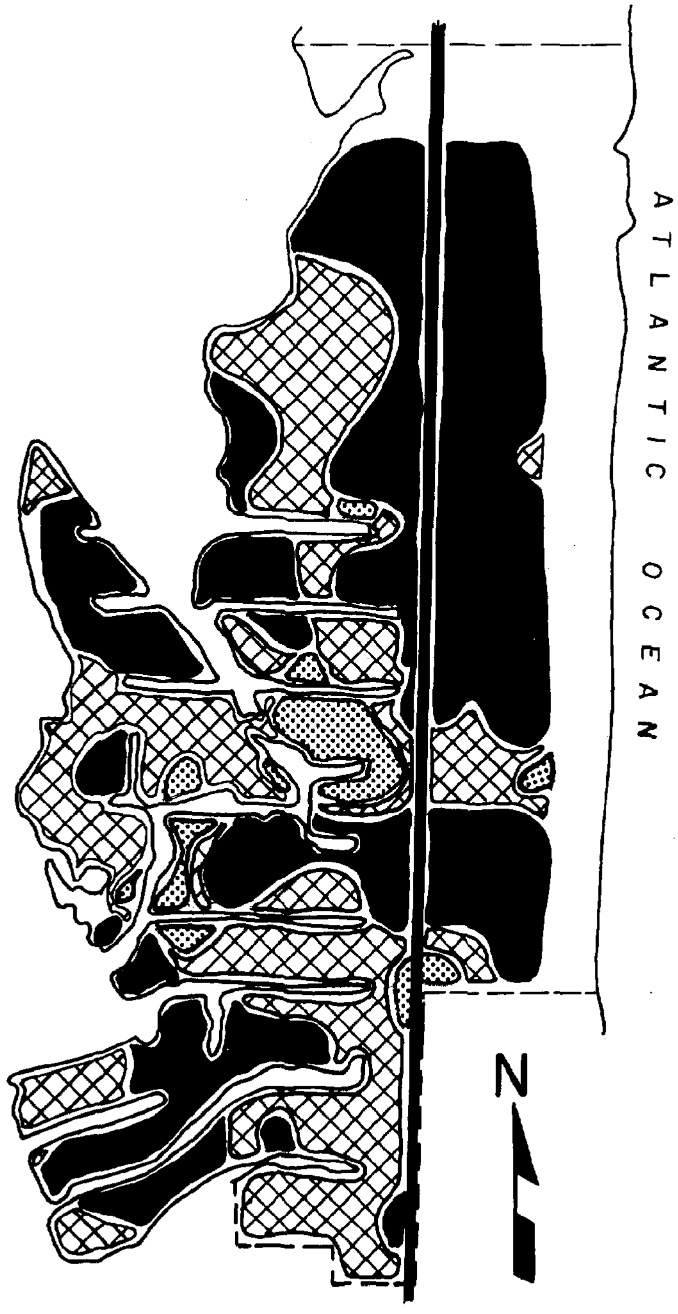
BEFORE DAMAGE OCCURED

AFTER DAMAGE OCCURED

NO MEASURES TAKEN

NO INTERVIEWS

FENWICK ISLAND



QUESTION 47
DO YOU HAVE FEDERAL FLOOD INSURANCE
NUMBER OF INTERVIEWS: 102

YES **NO**
DON'T KNOW **NO INTERVIEWS**

APPENDIX VI

The following photographs were taken following the March 6, 1962 and December 3, 1974 Coastal Storms. They are examples of the type of destruction that took its toll on the Delaware seashore and beaches.

Photo 1 - Bowers Beach, March 22, 1962. Credit: Department of Transportation

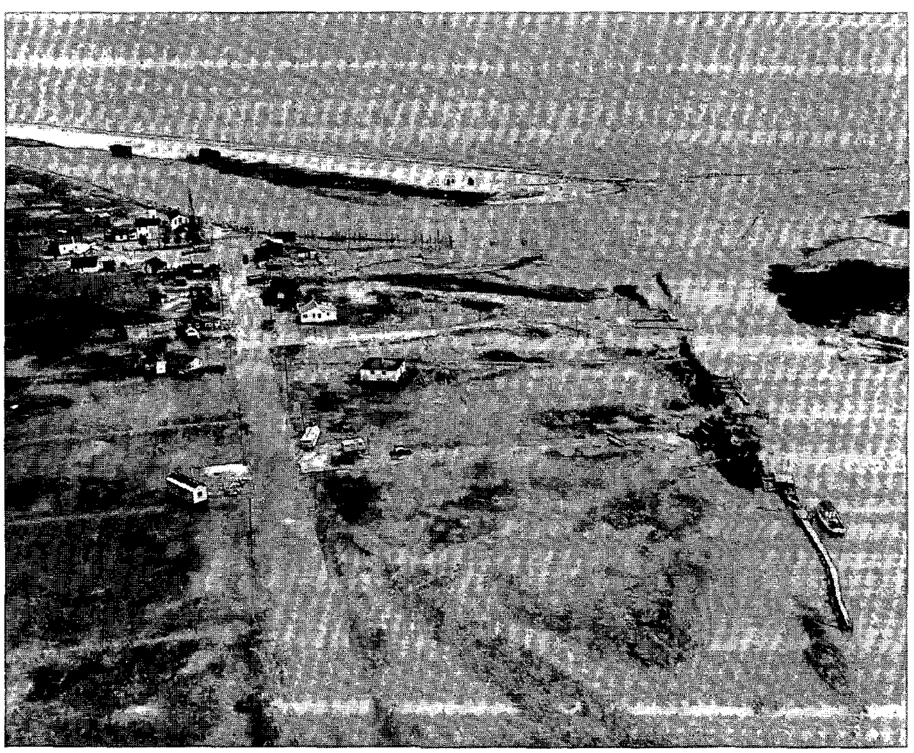


Photo 2 - Mispillion Light, March 22, 1962. Credit: Department of Transportation

Photo 3 - Slaughters Beach, March 22, 1962.
Credit: Department of Transportation

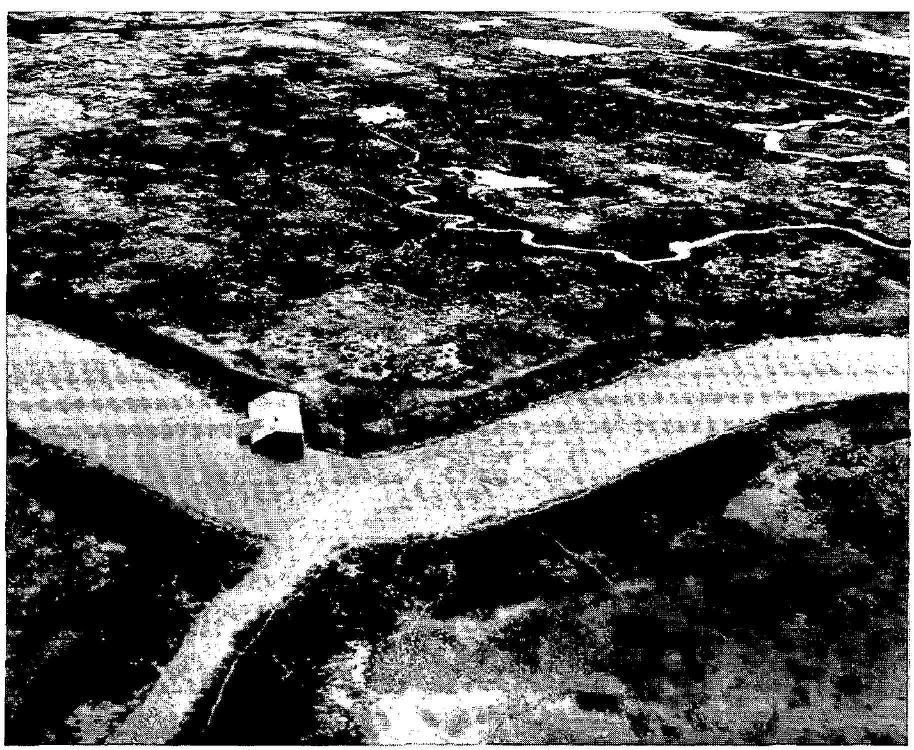


Photo 4 - Slaughters Beach, March 22, 1962.
Credit: Department of Transportation

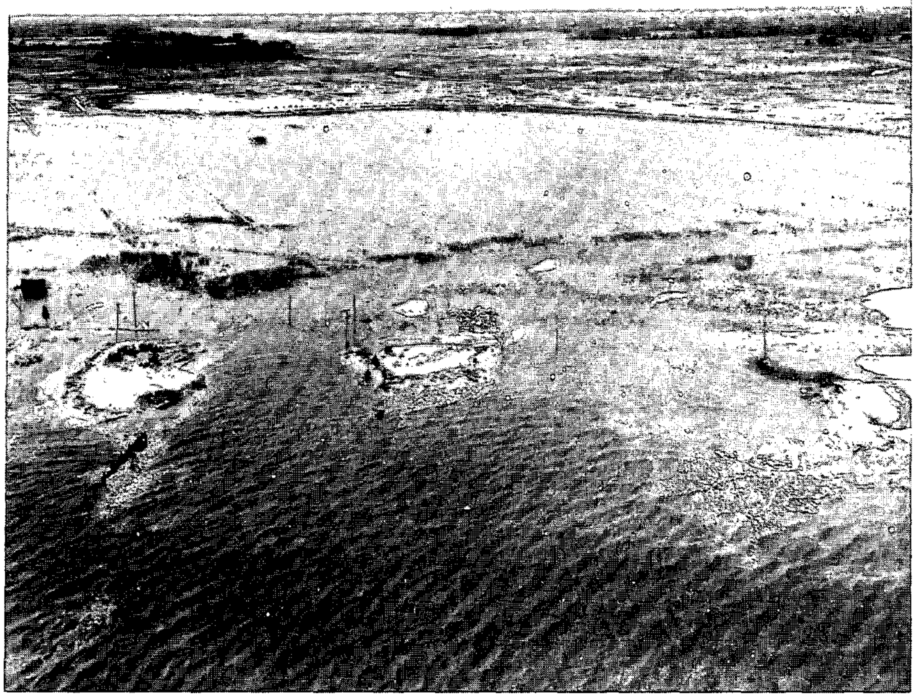


Photo 5 - Slaughters Beach, March 22, 1962.
Credit: Department of Transportation

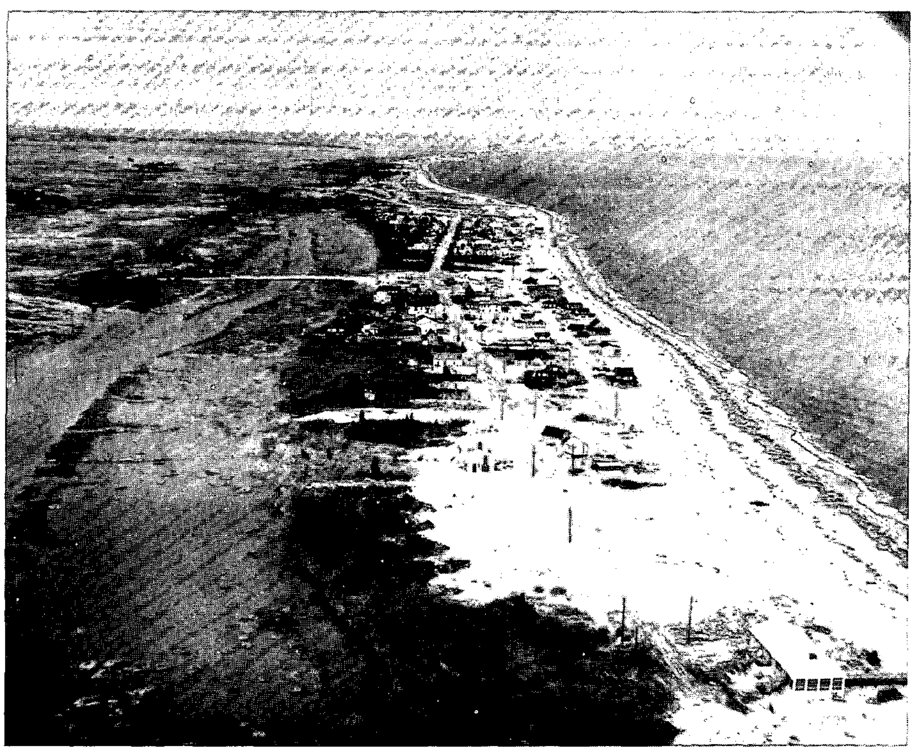


Photo 6 - Broadkill Beach, March 22, 1962.
Credit: Department of Transportation

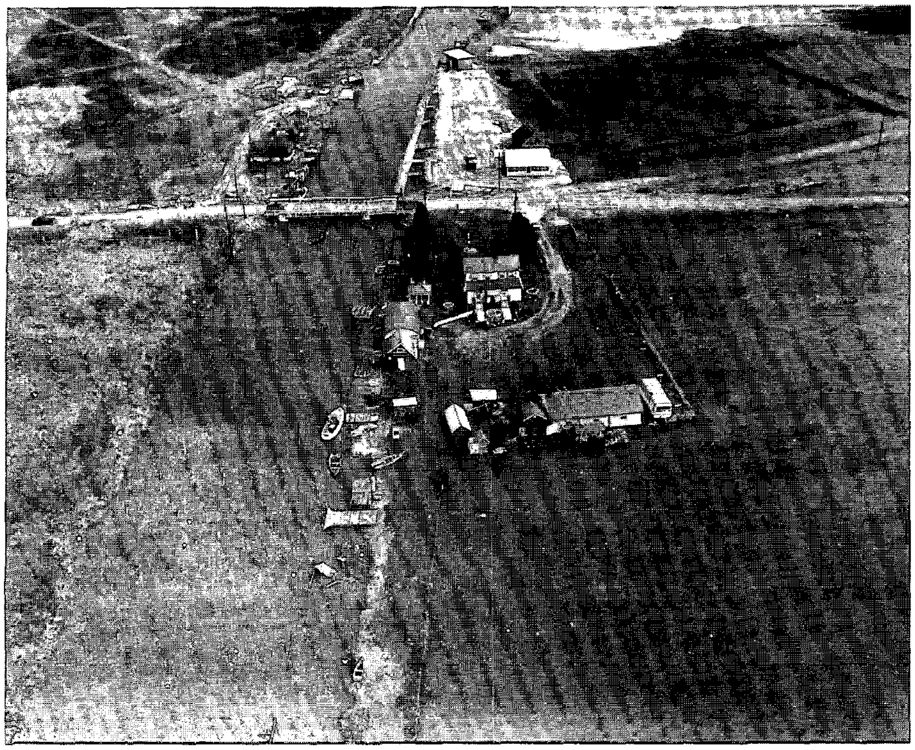


Photo 7 - Cedar Creek Bridge, North Slaughters Beach, March 22, 1962. Credit: Department of Transportation

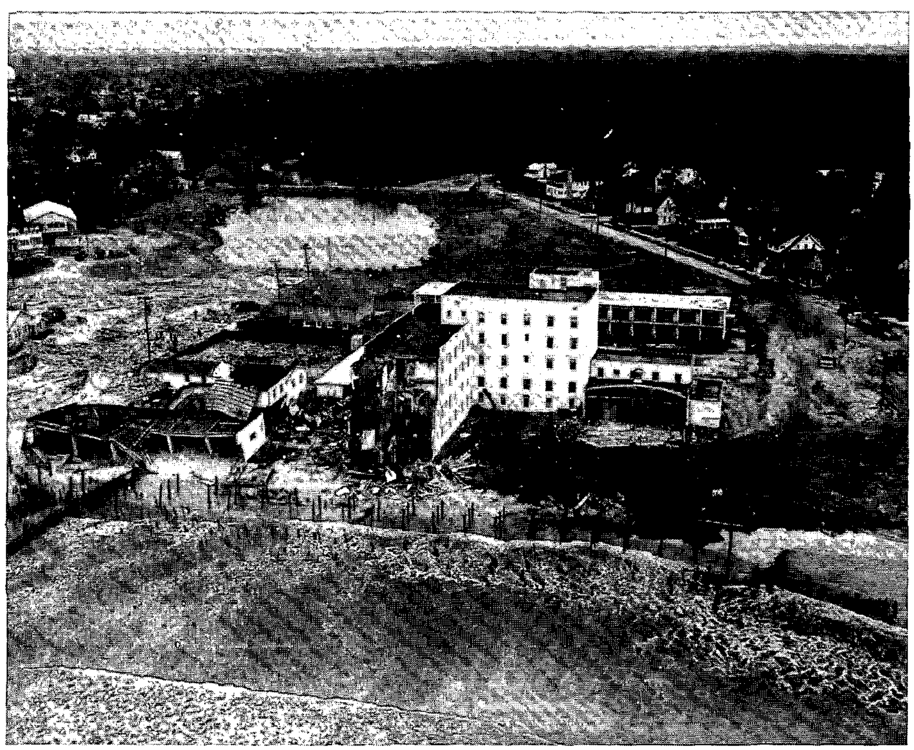


Photo 8 - Rehoboth, Henlopen Hotel, March 13, 1962. Credit: Department of Transportation

Photo 9 - Rehoboth, Rehoboth Avenue, March 13, 1962. Credit: Department of Transportation

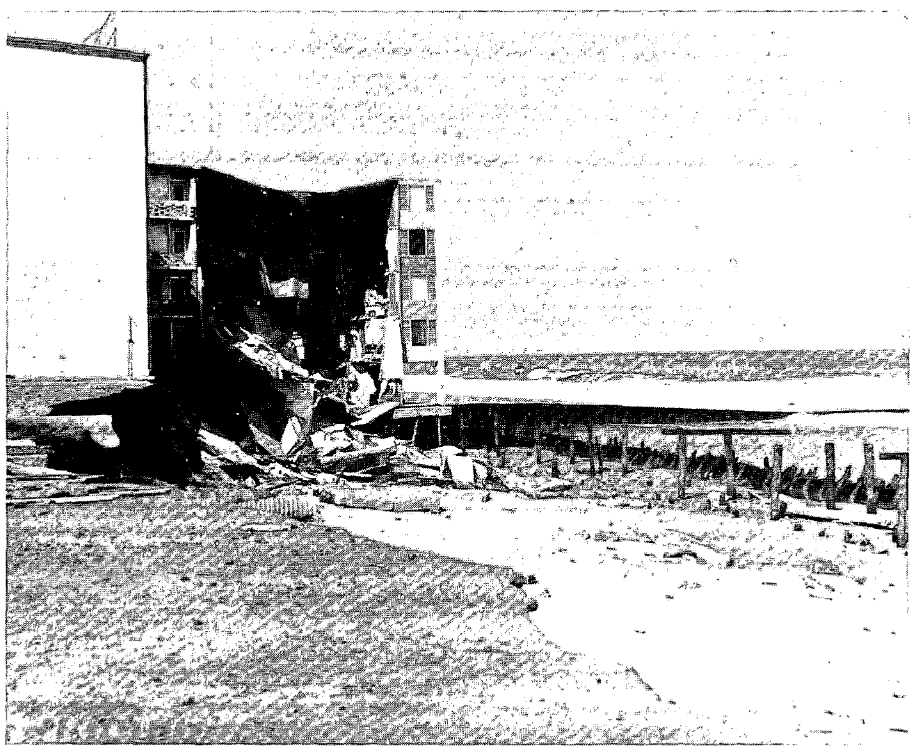


Photo 10 - Rehoboth, Atlantic Sands, March 8, 1962. Credit: Department of Transportation

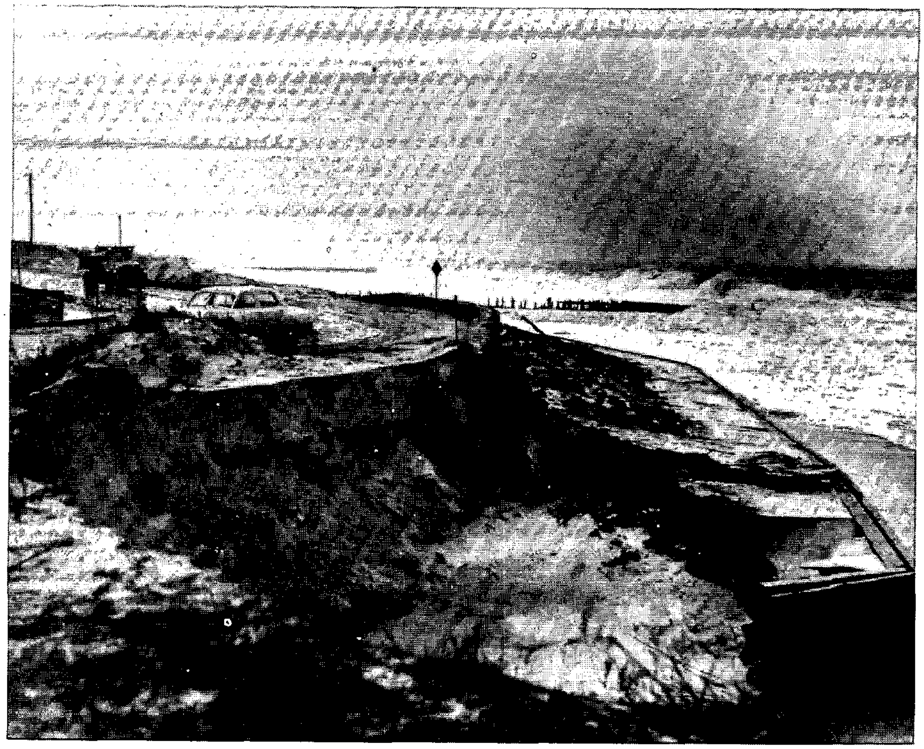


Photo 11 - Rehoboth - North of Henlopen Hotel, March 6, 1962. Credit: Department of Transportation

Photo 12 - Rehoboth, South of Rehoboth Avenue, March 13, 1962. Credit: Department of Transportation

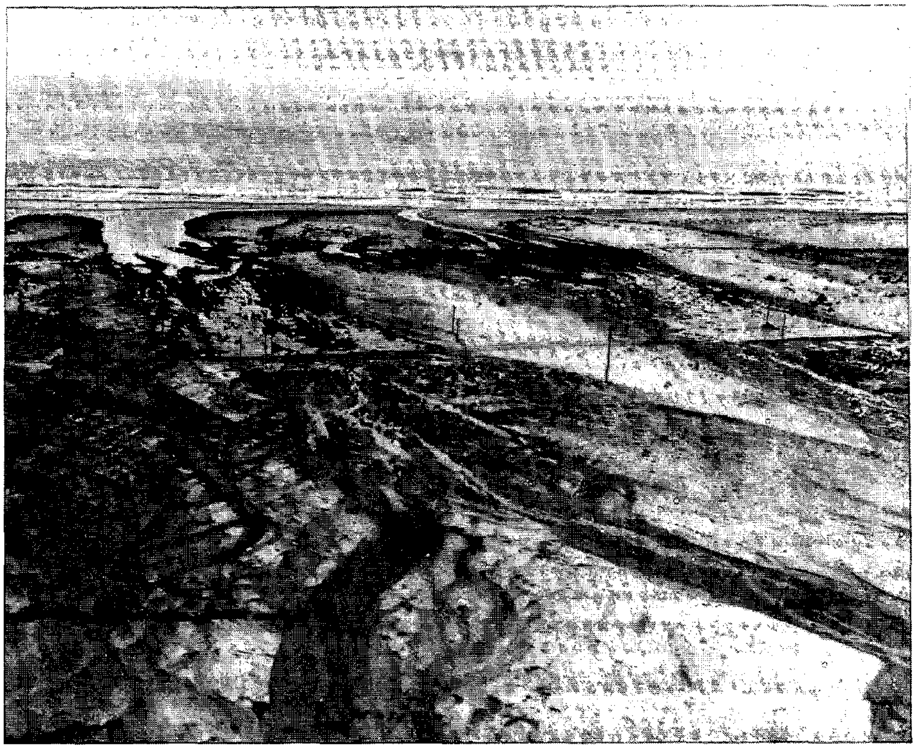


Photo 13 - Delaware Seashore, South of Rehoboth Avenue, March 13, 1962. Credit: Department of Transportation

Photo 14 - Dewey Beach - Bottle and Cork, March 7, 1962. Credit: Department of Transportation

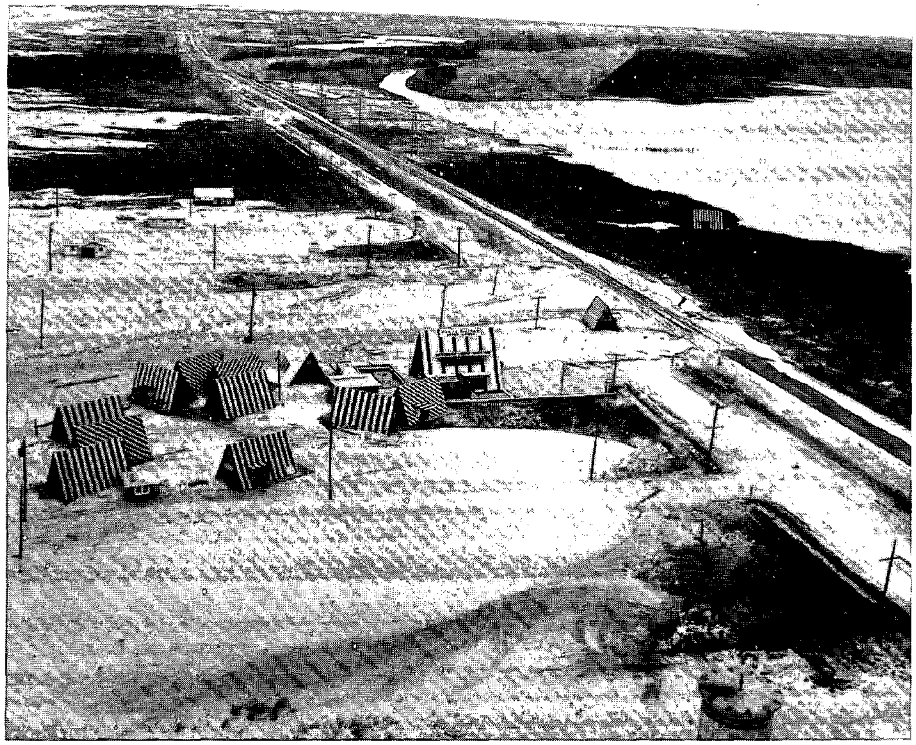


Photo 15 - South side Indian River Inlet,
March 13, 1962. Credit: Department
of Transportation

Photo 16 - North side Indian River Inlet -
Burton Island, March 13, 1962. Credit:
Department of Transportation

Photo 17 - Bethany Beach, March 13, 1962. Credit: Department of Transportation

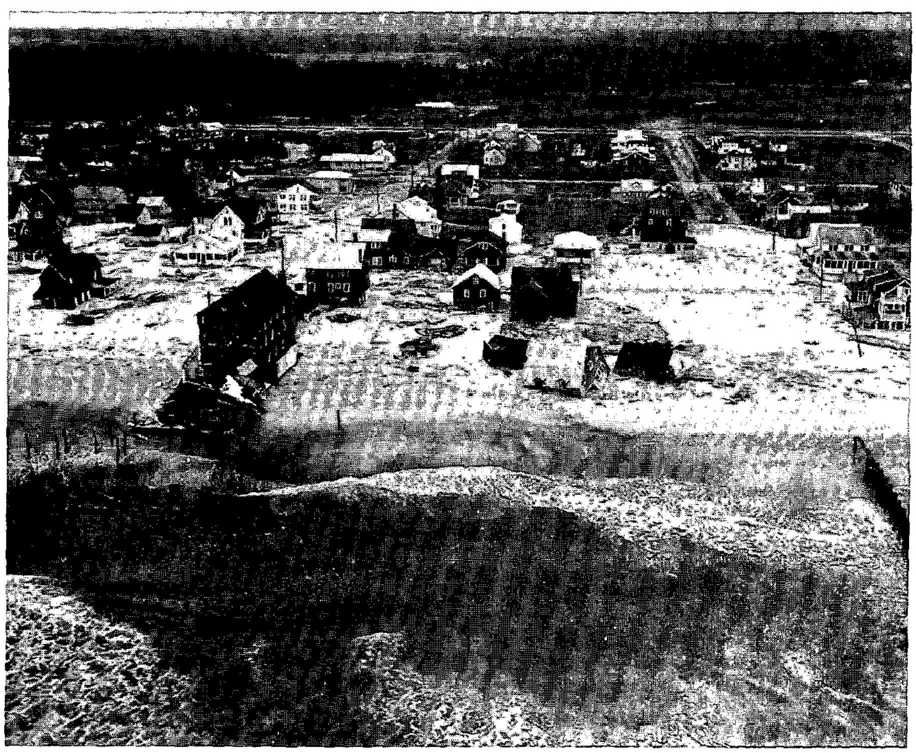


Photo 18 - Bethany Beach, March 13, 1962. Credit: Department of Transportation

Photo 19 - Fenwick Island, March 13, 1962. Credit: Department of Transportation

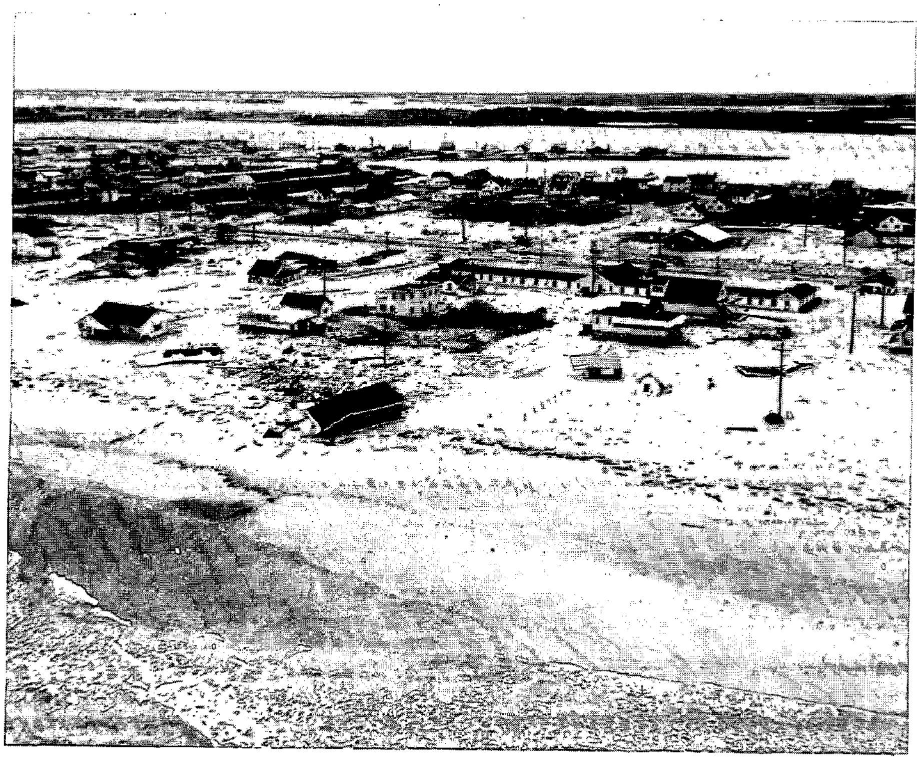


Photo 20 - Fenwick Island, March 13, 1962. Credit: Department of Transportation

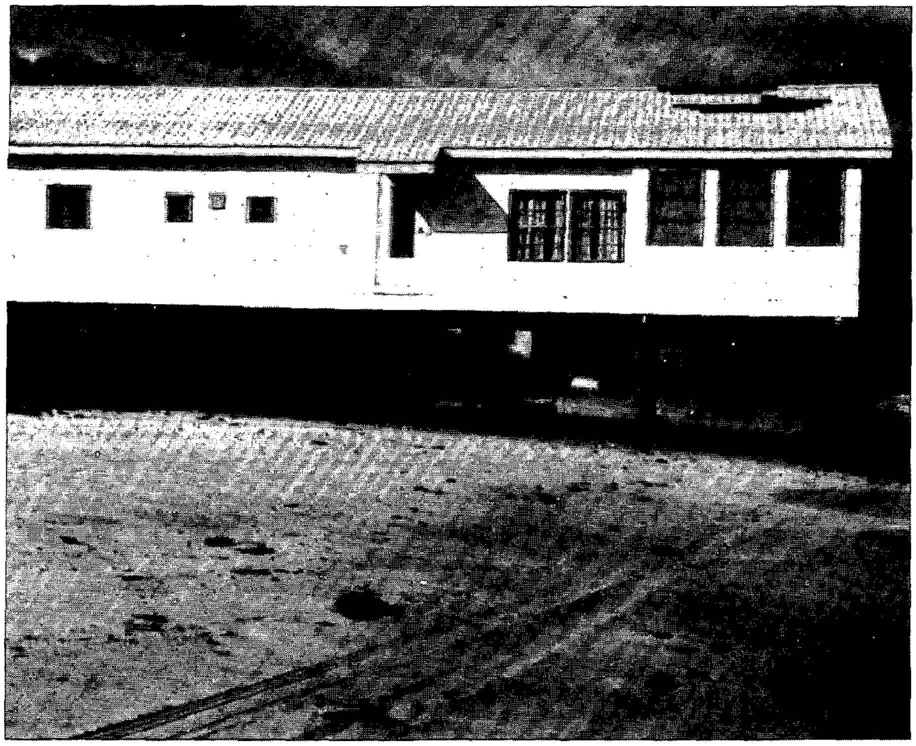


Photo 21 - Undermining and damage to dwellings built seaward of the duneline at Broadkill Beach, DE, December 3, 1974. Credit: F.J. Swaye

Photo 22 - Flood damage and mud deposits from the storm of December 1, 1974 in Bowers Beach, DE. Credit: F.J. Swaye

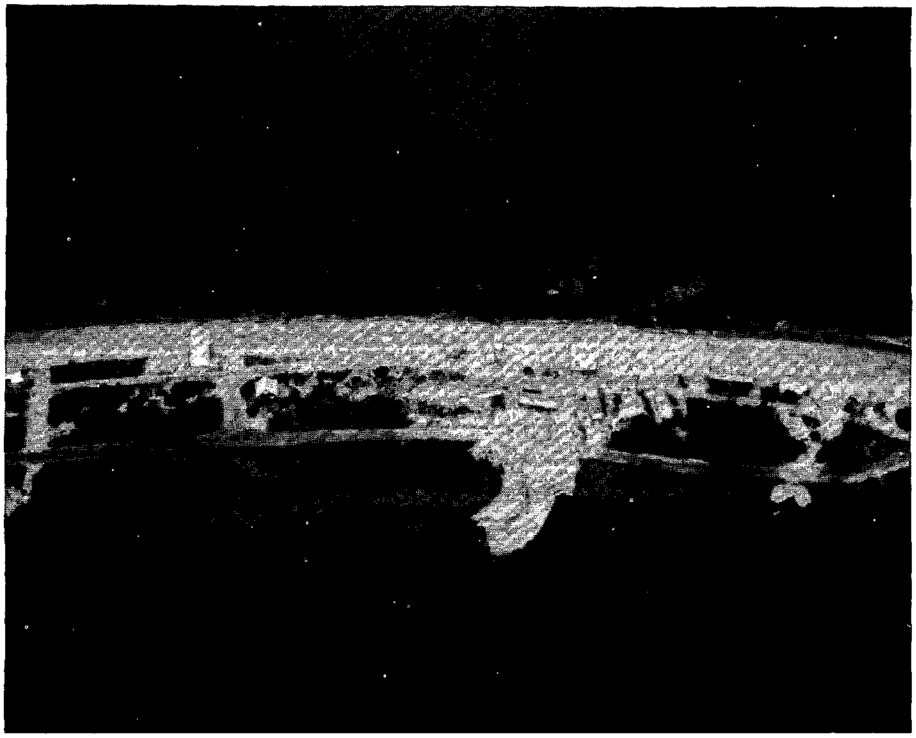


Photo 23 - Aerial photograph of washovers and mobile homes swept from their foundations during the December 1, 1974 storm at Broadkill Beach, DE. Credit: Gary Davis

Photo 24 - Autos, mobile homes and roads partially covered with washover sands at Broadkill Beach, DE after the December 1, 1974 coastal storm. Credit: F.J. Swaye

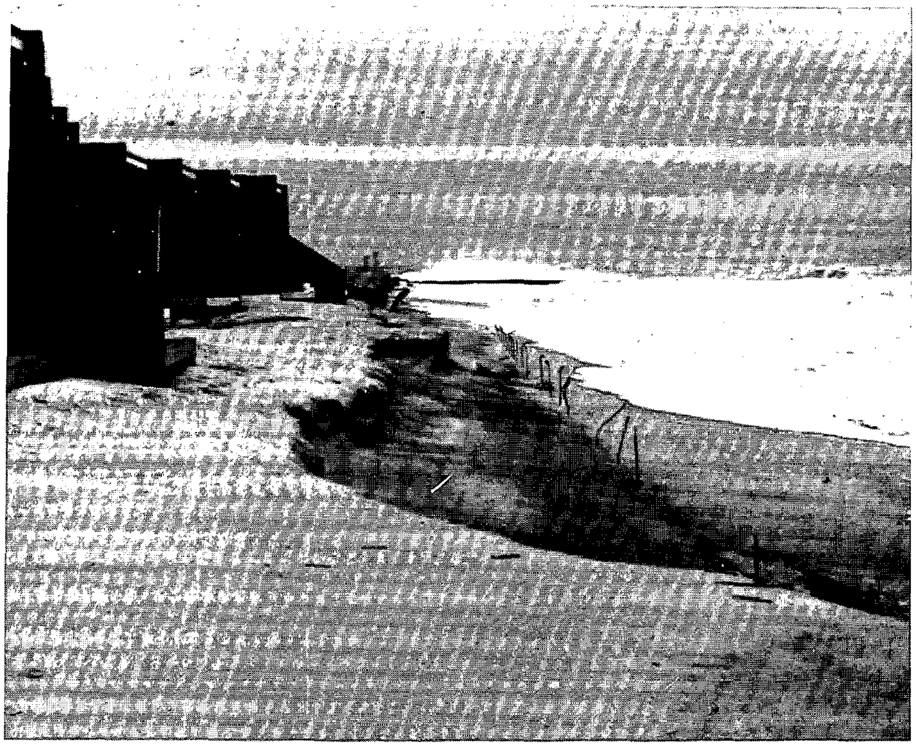


Photo 25 - As the storm of December 1, 1974 subsides, the risk of building too close to the beach becomes evident. Credit: Department of Transportation

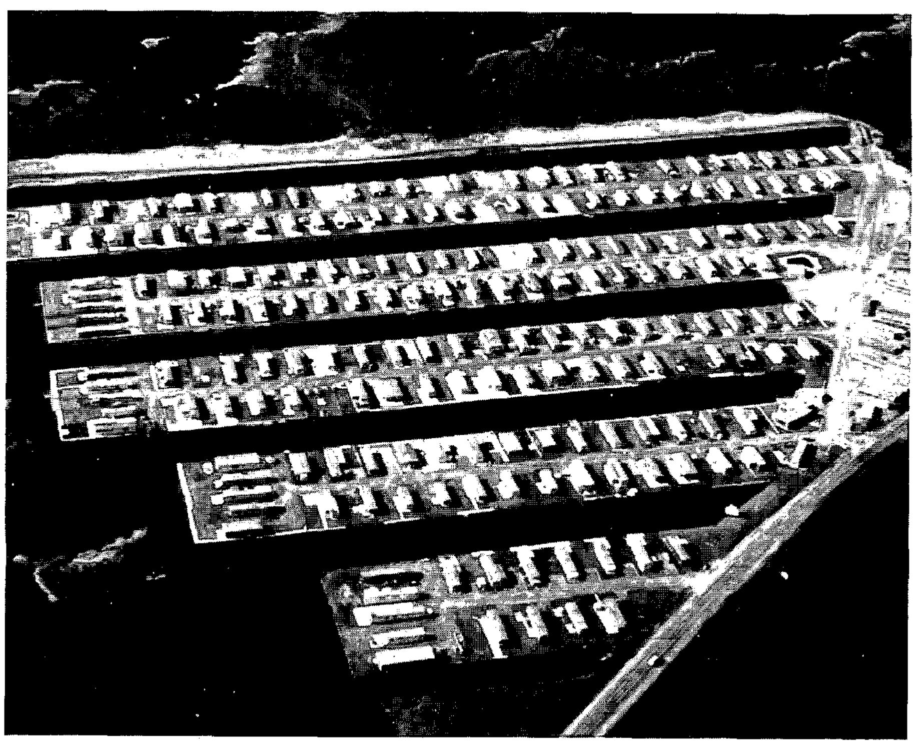


Photo 26 - A typical mobile home park carved from the tidal marshlands. Such developments are particularly vulnerable to future coastal storms. Credit: F.J. Swaye

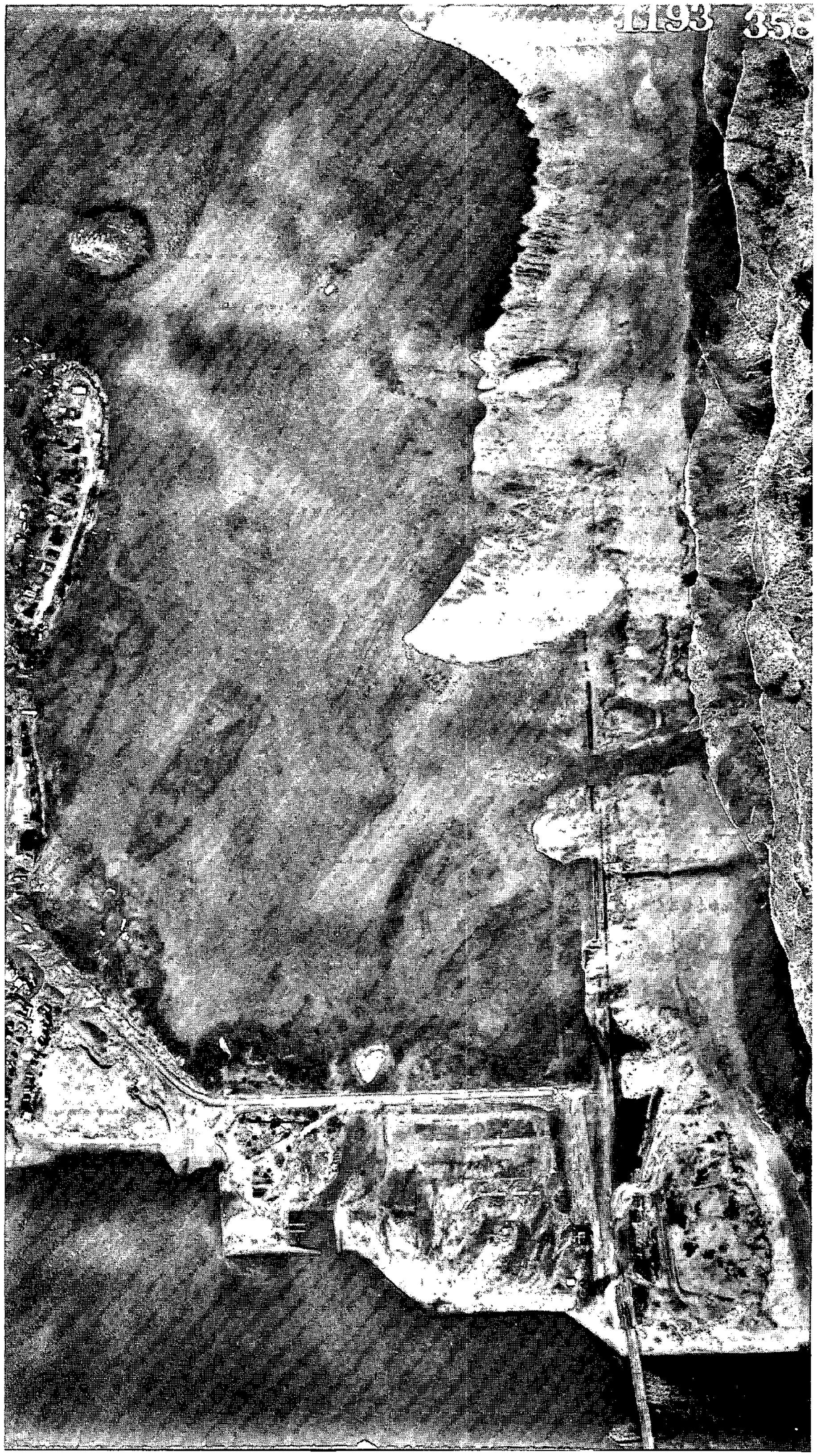


Photo 27 - North side of Indian River Inlet, March 8, 1962. This photo is an example of the series used for photo interpretation in preparing the storm damage map in this report.

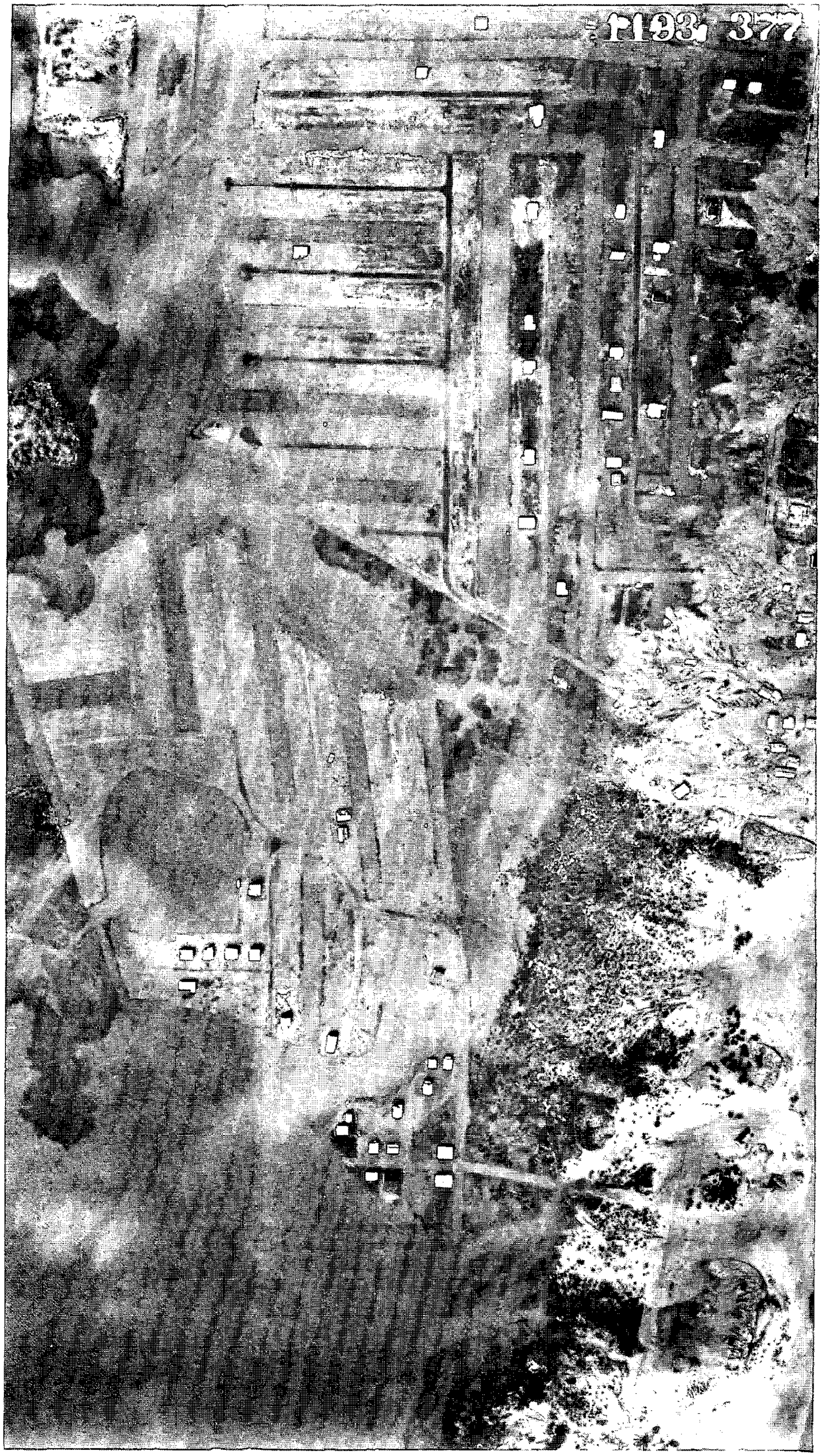


Photo 28 - Southern area of South Bethany, March 8, 1962. Notice the limited amount of development in 1962 and washover dunes from the ocean. This photo is an example of the series used for photo interpretation in preparing the storm damage map in this report.

Photo 29 - Northern area of Fenwick Island, March 8, 1962. This photo is an example of the series used for photo interpretation in preparing the storm damage map in this report.

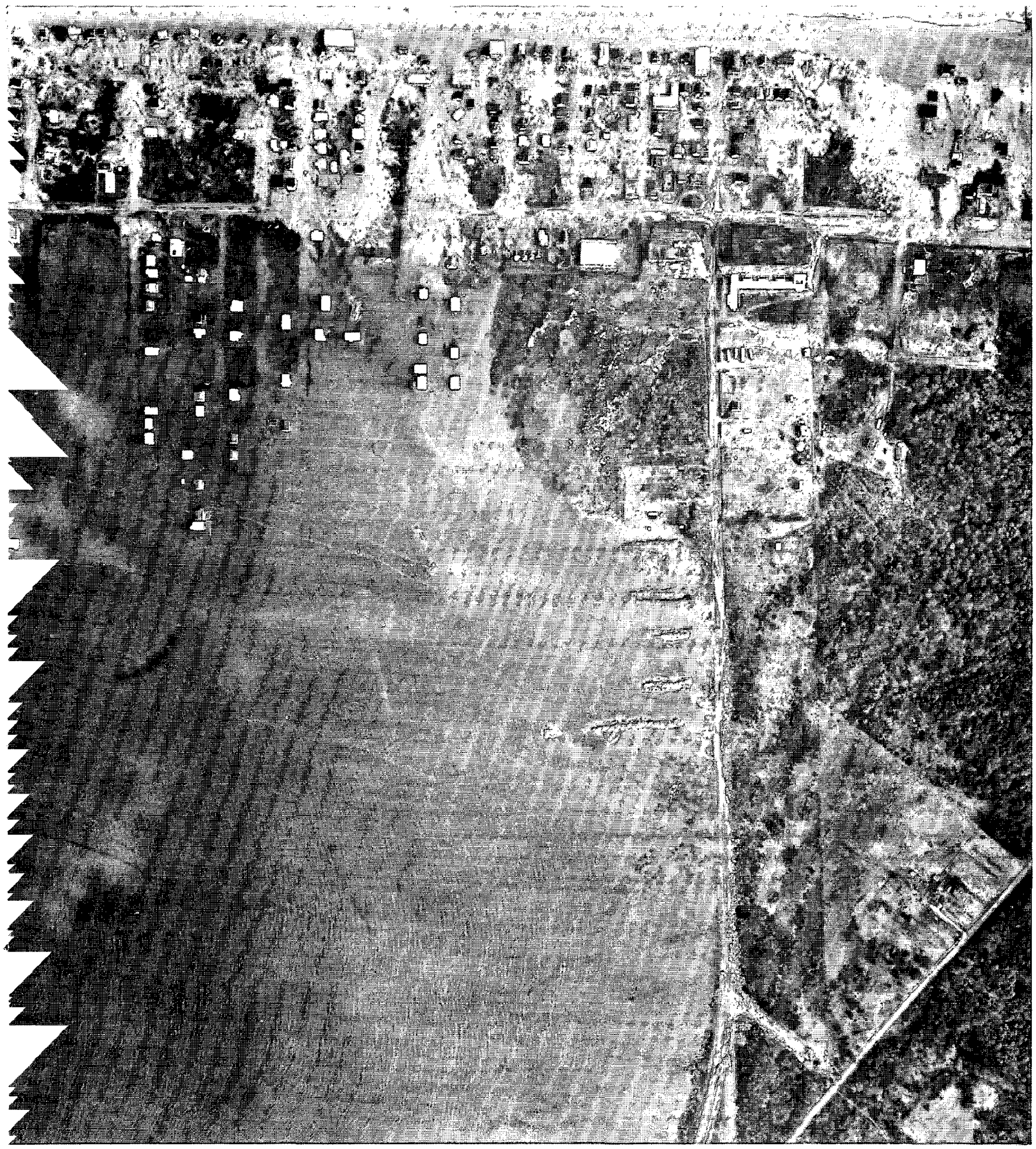


Photo 30 Southern area of Fenwick Island, March 8, 1962. This photo is an example of the series used for photo interpretation in preparing the storm damage map in this report.

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