HURRICANE STUDY

ATLANTIC COAST
DELAWARE - MARYLAND LINE
TO
GARGATHY INLET, VIRGINIA

18 OCTOBER 1963

U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

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SYLLABUS

The District Engineer finds that hurricane-induced high tides along the Atlantic Coast cause flood damage at Ocean City, Maryland and Chincoteague, Virginia. He presents plans of protection for both of these locations. He finds, however, that the cost of protection would exceed the estimated savings in damage. He reports, also, that local interests are unwilling to meet required terms of local cooperation, including a cash contribution of 30 percent of the first cost of the project, and accordingly recommends that no improvement be undertaken at this time. The District Engineer recommends, however, that this report be published and distributed to appropriate officials in the area who may find the information contained therein of use in the establishment of flood plain regulatory measures and evacuation procedures.

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U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE 3, MARYLAND

NABEN-R 18 October 1963

SUBJECT: Hurricane Study - Atlantic Coast from the Delaware-Maryland Line to Gargathy Inlet, Virginia

TO: Division Engineer
U. S. Army Engineer Division, North Atlantic
ATTN: NADEN-R

I. AUTHORITY

1. Authorization and purpose. This report is made in accordance with Public Law 71, 84th Congress, 1st session, which reads in part, as follows:

> "Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled: That in view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954 and September 11, 1954, in New England, New York and New Jersey coastal and tidal areas extending south to South Carolina, and in view of the damages caused by the other hurricanes in the past, the Secretary of the Army, in cooperation with the Secretary of Commerce and other Federal agencies concerned with hurricanes, is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred.
>
> "SEC. 2. Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of

methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams and other structures, warning services or other measures which might be required."

II. DESCRIPTION

2. General. The area covered by this report includes the Atlantic Coast of Maryland and Virginia from the Delaware-Maryland line to the Southern boundary of the United States Army Engineer District, Baltimore, about 16 miles south of Chincoteague, Virginia. The length of shoreline included is about 55 miles. This portion of the Atlantic Coast is characterized by a barrier beach, averaging less than a mile wide, extending from Delaware Bay south to Chincoteague, Virginia. South of Chincoteague, the shoreline is crenulate and incised by inlets and winding sloughs. North of the inlet at Ocean City, the barrier beach is known as Fenwick Island; south of the Ocean City inlet, the barrier is known as Assateague Island. The latter is virtually uninhabited although a real estate developer has, in recent years, subdivided approximately 15 miles of the island and claims to have sold some 4,000 lots to persons intending to build permanent residences or summer cottages. At present, the only access to Assateague Island is by ferry. During the summer of 1960, however, the Chincoteague-Assateague Bridge and Beach Authority, created by the Virginia General Assembly in 1956, initiated construction of a bridge to link Chincoteague Island with Assateague Island. The Authority believes that access to the island will aid in the development of the beach as a tourist attraction. The State of Maryland is also contemplating construction of a bridge across Chincoteague Bay about 10 miles south of Ocean City to provide access to Assateague Island. The State of Maryland is acquiring 640 acres of the island to be used in development of an ocean-front public park. A portion of Assateague Island is operated as a national wildlife refuge by the United States Fish and Wildlife Service. The locality is shown on plate No. 1.

3. Ocean City, Maryland. Ocean City, Maryland's most popular summer resort, is located on the barrier beach. Although Ocean City has a permanent population of only 952, approximately one-half million vacationists visit the resort each season. Prior to 1933, there was no stabilized inlet through the barrier beach to the waters of Sinepuxent and Chincoteague Bays. On several occasions, however, storms had opened temporary inlets but these openings closed almost as rapidly as they opened. On 23 August 1933, a severe storm opened an inlet in the barrier beach at the south end of Ocean City. On 13 September 1933, the Chief of Engineers was authorized to stabilize the inlet in lieu of construction of an authorized project some five miles to the south. The stabilization was accomplished by construction of two stone jetties. The north jetty has been so successful in impounding sand that during the period 1934 to 1956, it was necessary several times to increase both

its length and its height. As a result of this impounding of sand, Ocean City boasts one of the finest bathing beaches along the Atlantic Coast. The stabilized inlet has been of great value to commercial fishermen as well as to sport fishermen and recreational boating enthusiasts.

4. Most of the buildings in Ocean City are of wood frame construction, two and three stories in height, containing furnished apartments and rooms which are rented during the summer months to vacationists. Typical structures are shown on the following pages. From the inlet north to N. Division Street, a distance of about one-half mile, the boardwalk along the beach is lined with amusements, refreshment stands, bath houses and souvenir shops. On the beach adjacent to the boardwalk at the inlet is a large paved metered parking lot. North of N. Division Street, the boardwalk is fronted primarily by hotels, motels and rooming houses. Most of the community's commercial establishments are located in the area between N. Division Street and the inlet, although some restaurants, food stores and gift shops are scattered throughout the town.

5. Chincoteague, Virginia. The only other community of any size withing the study area is Chincoteague, Virginia, on the west side of Chincoteague Island which lies in Chincoteague Bay. Chincoteague Island is separated from Assateague Island by Assateague Channel. Chincoteague, unlike Ocean City, is not a resort town. Most residents derive their livelihood from the commercial seafood industry. The remainder of the Atlantic Coast included in this report, the 16-mile reach south of Chincoteague, consists of Wallops Island and sparsely developed Assawoman Island. Wallops Island is Federally-owned and is now occupied by the National Aeronautics and Space Agency.

III. PROBLEMS UNDER INVESTIGATION

6. Hurricane surge studies. Studies were conducted by the Beach Erosion Board staff to determine hurricane surge heights that can be expected on the open coast and at points in Chesapeake Bay. The studies, published in Miscellaneous Paper No. 3-59, "Hurricane Surge Predictions for Chesapeake Bay," indicate that a surge of 11.1 feet above predicted astronomic tide is possible on the open coast from a hurricane with the intensity of that of 14 September 1944.

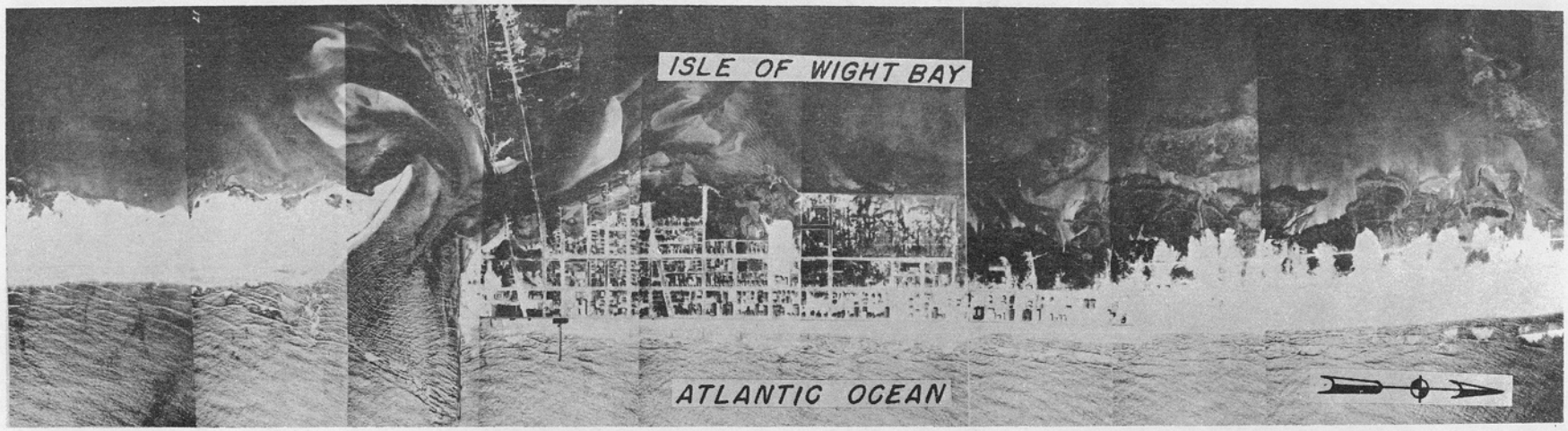
7. The hurricane of 14 September 1944 was selected as the design storm because, although it did not pass inshore in the Mid-Atlantic States, it is the most intense storm of record for this section of the Atlantic Coast. The most critical path for the design hurricane to obtain the maximum surge on the open coast would be an approach perpendicular to the shoreline. Predictions for surge on the open coast at the mouth of the Chesapeake Bay are also valid for any point along the

coast in the study area since the offshore physical features are similar. The maximum surge for the open coast was determined by a formula that was calibrated with well-documented wind and tide data obtained during Hurricane Audrey (1956) which approached perpendicular to the coast in the Gulf of Mexico. Surges were computed for two hypothetical hurricanes - Hurricanes "A" and "B". Hurricane "A" is the 14 September 1944 hurricane transposed to approach perpendicular to the coast and Hurricane "B: is similar to "A: except that wind speeds are 5 m.p.h. greater. The maximum surges for the two hypothetical hurricanes were computed as 11.1 feet for Hurricane "A" and 12.2 feet for Hurricane "B". For the purpose of this report, the surge computed for Hurricane "A" has been selected as the design surge, while that for "B" is considered the maximum probable surge.

8. Tides. Since there are no continuous records of tides at Ocean City, there are insufficient data for construction of a reliable frequency curve. The tide at Ocean City was estimated at 7.5 feet above mean low water during the storm of August 1933, which created the present inlet to Sinepuxent Bay. The same storm caused a record high tide at Baltimore where continuous records of tides are available for a period of about 57 years. A frequency curve constructed on the basis of Baltimore data indicates that the August 1933 storm has a chance of occurrence of about once in eighty-three years. By the same correlation, the Baltimore curve shows that a storm at Ocean City of the magnitude of the design storm has a chance of occurrence of about once in one thousand years. A crest stage gage installed at Ocean City in 1957 showed that during Hurricane Donna, in 1960, the tide reached 8.0 feet. Frequency data used by the staff of the Beach Erosion Board for the design of an emergency protective barrier on Fenwick Island after the March 1962 storm were based on frequency curves available for Long Island and in the Cooperative Beach Erosion Study, Barnegat Inlet to Cape May, New Jersey. The frequency data were approximately as follows:

	Still Water Elevation	
Frequency	Above mean sea level	Above mean low water at Ocean City
1 in 20 yrs.	7.1	8.6
1 in 10 yrs.	6.5	8.1
1 in 2 yrs.	5.5	7.0
1 in 1 yr.	5.1	6.6
1 in 0.5 yr.	4.7	6.2
1 in 0.2 yr.	4.2	5.7

9. Wind. A tabulation of the yearly cumulative average winds over the North Atlantic Coast compiled from the records of the Hydrographic Office of the United States Navy, indicates that winds blowing toward Ocean City from the offshore are predominantly southerly. The southerly winds are, however, of relatively low velocity. The design storm is based on damaging winds from the northeast and east. The

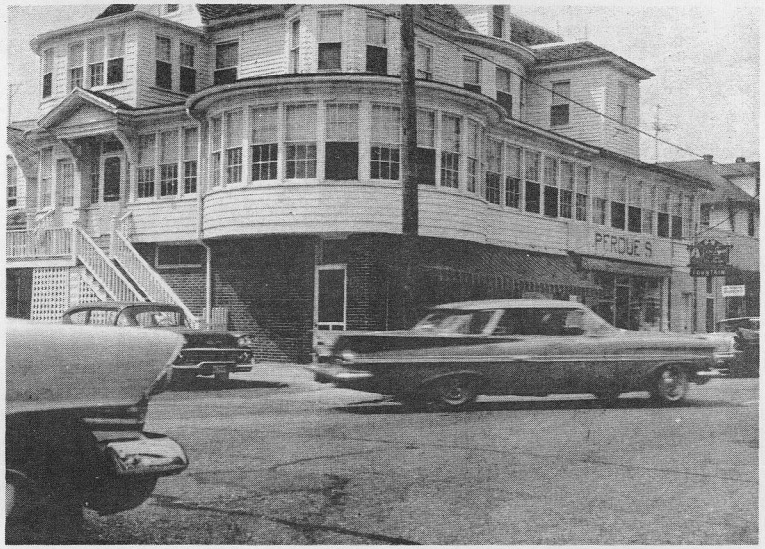


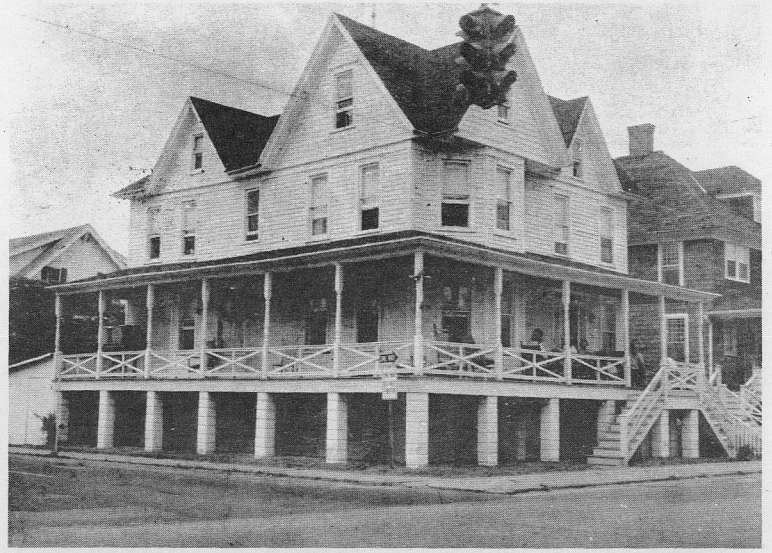
Aerial photographs, Ocean City, Md. 1934 (top) - 1956 (bottom)
Photographs show how the jetty at the inlet has increased the width of the beach

View of Ocean City, Maryland looking north from the inlet - July 1960

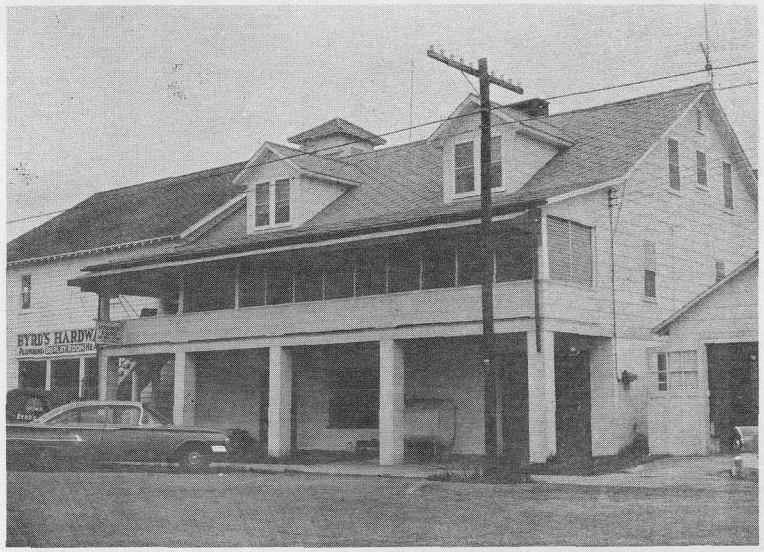
View of Ocean City, Maryland looking west from the inlet - July 1960

Typical structures east side of Baltimore Avenue, Ocean City, Md. - July 1960





Typical structures west side of Baltimore Avenue, Ocean City, Md. - July 1960



Typical structures east side of Philadelphia Avenue, Ocean City, Md. - July 1960

Typical structures west side of Philadelphia Avenue, Ocean City, Md. - July 1960

maximum winds would be 105 m.p.h. during a hurricane of design storm magnitude.

10. Waves. The deep-water wave for the design hurricane was computed to be 25 feet and would break in 32 feet of water. Since the design tide is 14 feet, the design wave would break at a point where the offshore bottom has an elevation of 18 feet below mean low water. The proposed protection would have a slope of 1 on 20 from +14 at the boardwalk to the existing offshore bottom. The design wave would break at least 640 feet from the boardwalk. The runup for a 25 foot deep-water wave over an offshore slope of 1 on 20 would be on the order of six feet. A six foot wall would be provided at the boardwalk to protect against runup.

11. Flood damages. The barrier beach extending from the Maryland-Delaware boundary south to the vicinity of Chincoteague, Virginia, has a maximum elevation, not including sand dunes, of about 12 feet above mean low water. Tides seven feet or more above normal could sweep unimpeded over the low-lying beach and cover portions of Ocean City with two feet of water. Damages to roads and streets would be significant, but the greatest damage, exclusive of possible loss of lives, would be the loss of business resulting from evacuation of the area during the vacation season. The average elevation of the town of Ocean City is 7 feet and tides above this level would cause damage to residences and business establishments located in the community. The majority of the structures between the inlet and 14th Street are two story frame buildings. Average annual damages for this section of Ocean City are estimated to be $275,000 at September 1963 price level. Farther south, Chincoteague would be severely flooded by tides of the same magnitude. The greatest damages at that location would probably be damages to residences and salt water contamination of water-supply wells. A small amount of damage would also be suffered by the seafood industry established at that location by boat damage and inundation of packing houses. Average annual damage at Chincoteague, exclusive of damages which could not be prevented by construction of protective works, is estimated to be $40,000. The area between Ocean City, Maryland and Chincoteague, Virginia is virtually uninhabited at the present time and inundation would cause little or no monetary damage. Ocean City and Chincoteague are the only two locations along the coast line where protection from inundation caused by hurricane-induced tides and wave action might possibly be feasible from an economic standpoint. As the spring range of tide at Ocean City is 4.1 feet and that in the Atlantic Ocean at Chincoteague is 4.5 feet, protection from a surge of 11.1 feet on the coast would have to be a minimum of 15.2 feet and 15.6 feet at Ocean City and Chincoteague, respectively.

12. The maximum tides at Ocean City and Chincoteague are estimated by the United States Coast and Geodetic Survey to have been

7.5 feet and 8.7 feet, respectively, above the Atlantic Ocean mean low water datum plane, during the storm of August 1933.

13. The March storm was complex in structure and unusual in behavior. The pattern of the storm gave 50 miles per hour on-shore winds a long fetch, generating waves at Ocean City, Maryland estimated to be 10 and 15 feet high. The storm's behavior, stationary for a while and then moving slowly eastward, made the waves persist for several days. The unusually high wind-driven tides, superimposed on normally high spring tides, produced tides 9 feet above mean low water at Ocean City; one and one-half feet higher than the previous record which occurred during the August 1933 hurricane.

14. The storm was more severe and more damaging than any previously known to have affected the area. Practically the entire barrier beach from the Maryland-Delaware line to the Maryland-Virginia line was under water at some time during the storm from high tides or from wave wash over the barrier. The damage along Fenwick Island varied with the amount of beach existing before the storm. At the inlet, on the south end of the island where the jetty system had impounded a beach about 800 feet wide, damage to structures from wave action was minor. As the beach narrowed gradually north of the inlet, destruction mounted rapidly. At about 41st Street there was further severe increase in wave damage to structures. From this point northward damages were even more severe. In the vicinity of 71st Street a breach approximately 50 feet wide was cut through to the bay. South of the inlet, Assateague Island was severely pounded, dunes were leveled and seas as high as 6 feet reportedly swept over the island. The small breach that existed in the beach adjacent to the South jetty, and in the barrier beach about one mile south, were widened to the extent that immediate steps were required to close them. Further south on the island a sand fence 15 miles long and the dune it created were reported completely lost.

15. The area of major damage was Metropolitan Ocean City, Fenwick Island from the inlet north to the Maryland-Delaware line. Virtually every property experienced some type of damage, ranging from the deposit of sand and debris around buildings to flooding and structural damage on up to complete destruction or disappearance of buildings. One life was reported lost at Ocean City as a result of the storm. Total damages are estimated at $15,290,000. Typical damages are shown on the following pages.

IV. PROPOSED SOLUTIONS AND PROJECT FORMULATION

16. Chincoteague, Virginia. Protection of the Town of Chincoteague could only be accomplished by construction of a circumjacent wall. Local interests at Chincoteague realize the need for hurricane

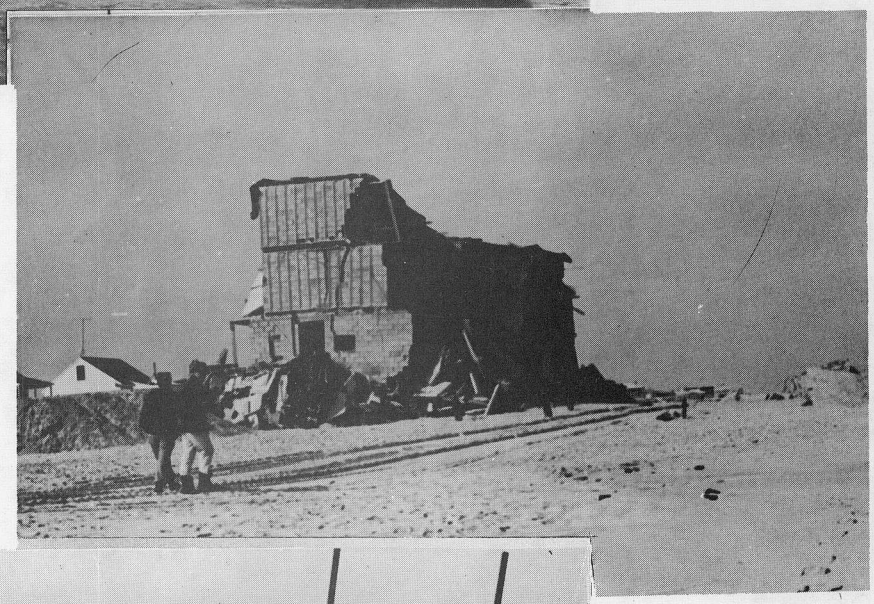
TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962

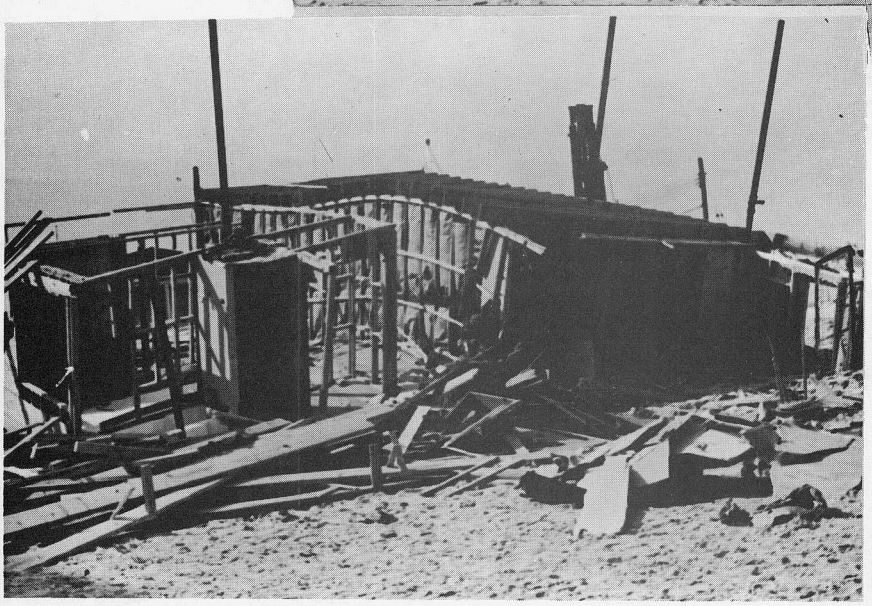
Damage along boardwalk.

TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962

Flagship Motel

These buildings under construction were severely damaged.





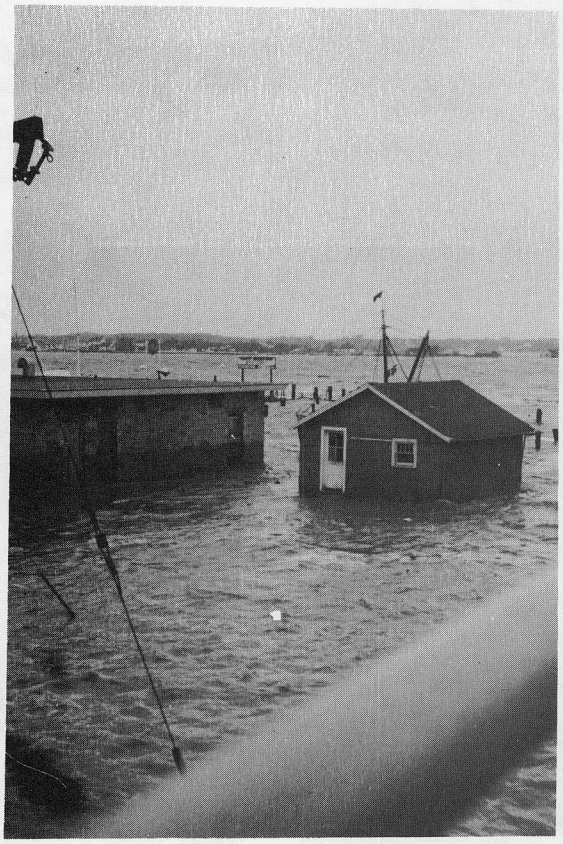
Jamaican Motel

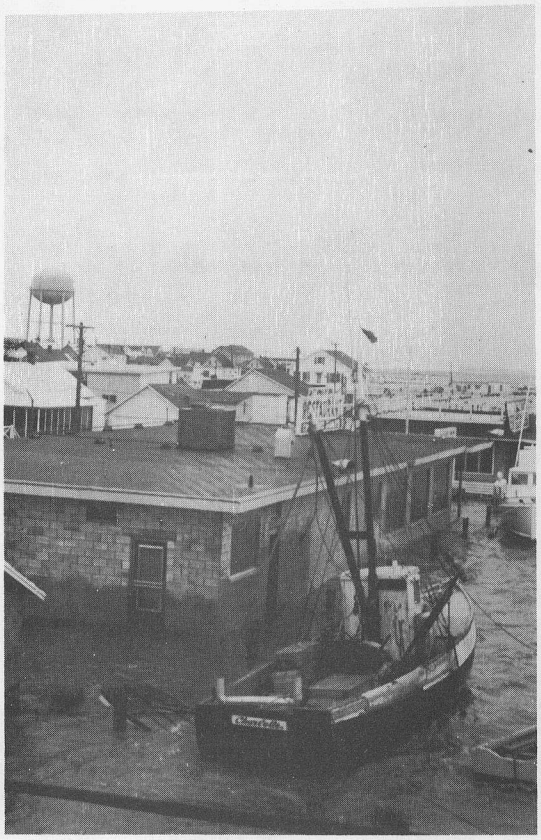
Motel near 45th Street

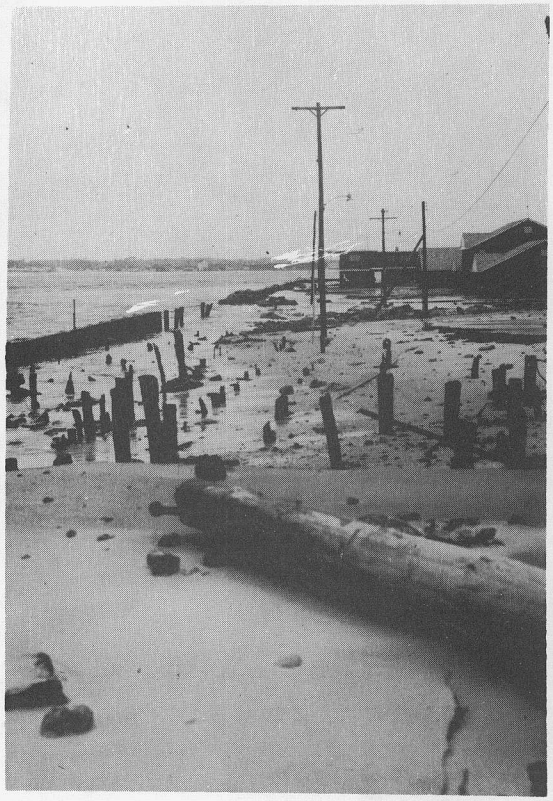
TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962

Sand deposits throughout Ocean City area.

TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962

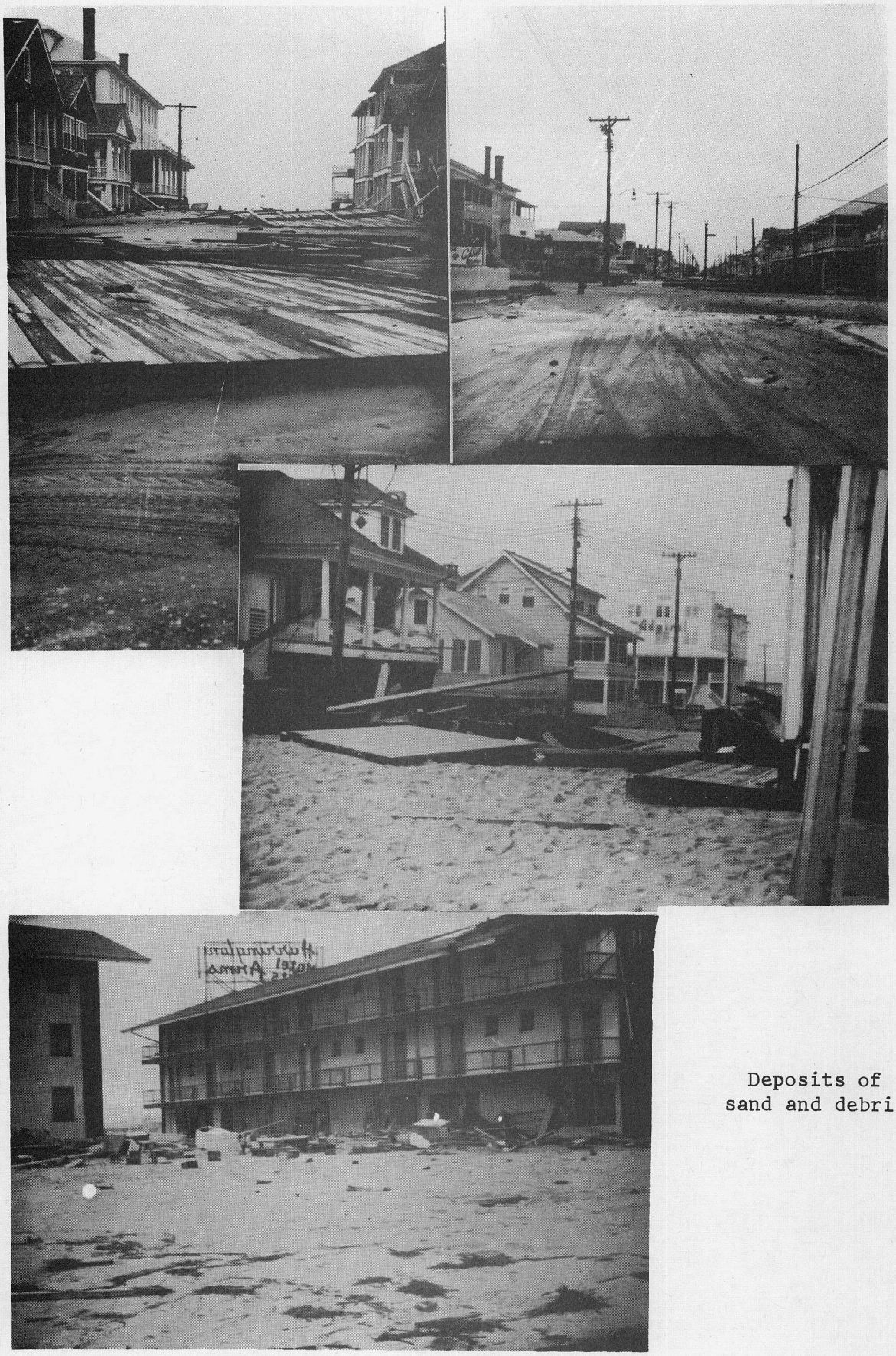






Tidal flooding of waterfront facilities.

TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962



Deposits of sand and debris.

TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962

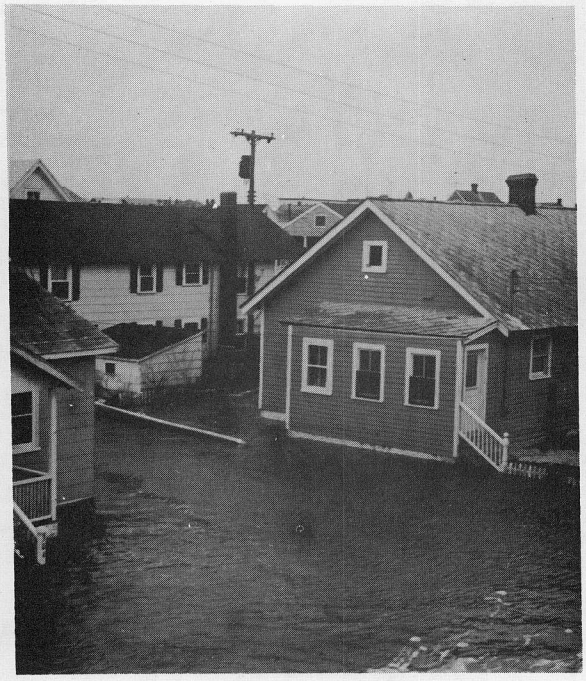
Stardust Motel

Oceanic Motel

Damage to beachfront motels.

Sea Scape Motel

TYPICAL DAMAGES FROM THE STORM OF 6-8 MARCH 1962



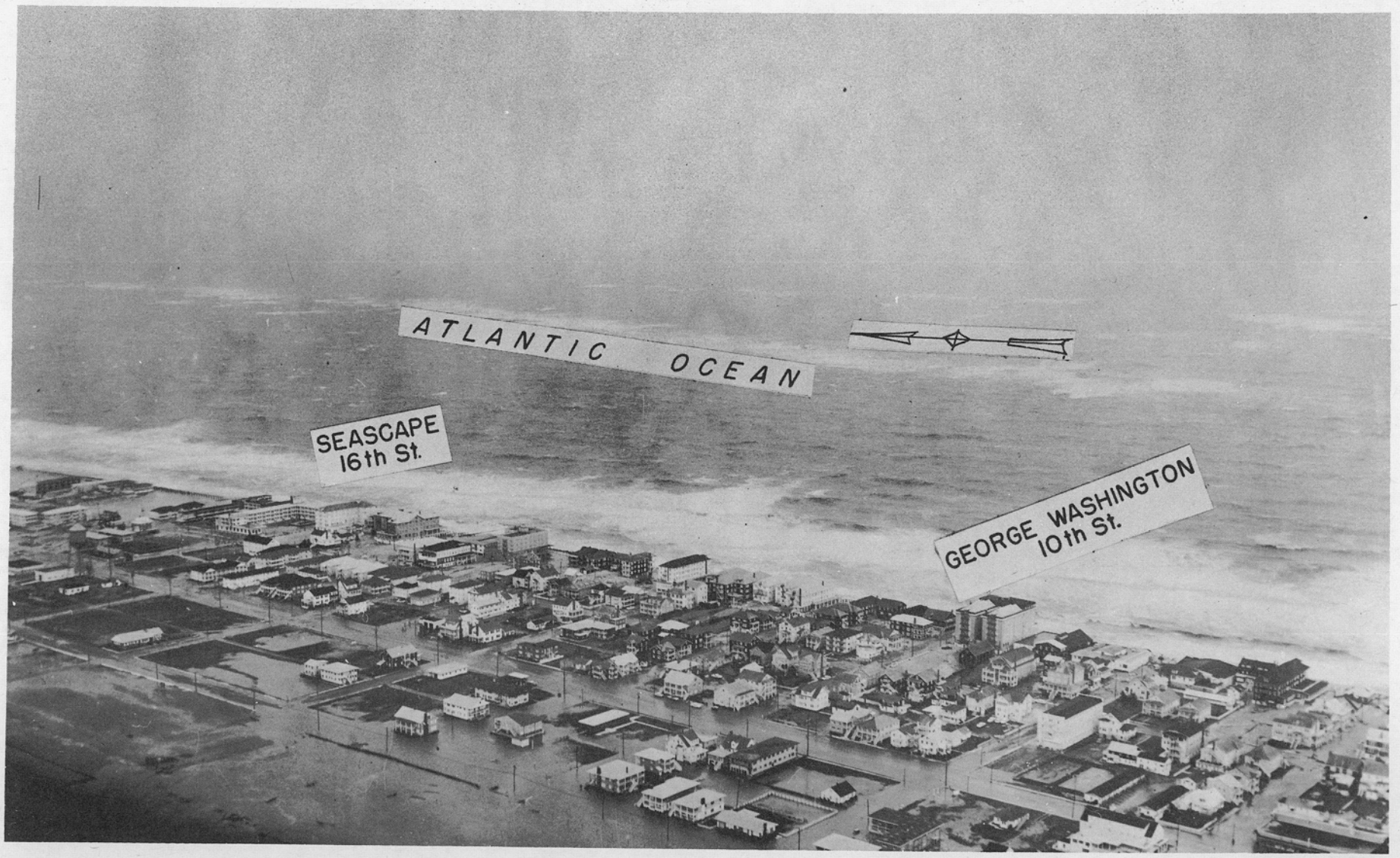
Tidal flooding in residential areas of Ocean City.

Ocean City. The inlet on 8 March 1962.

8 March 1962. At the inlet the broad, high beach protected the lower end of town.

8 March 1962. The wide beach here kept damage to a minimum.

8 March 1962. Moderate damage. Boardwalk decking was torn off and sections crashed into buildings. Sand filled the streets.



Ocean City, Md., on 7 March 1962 during the storm.

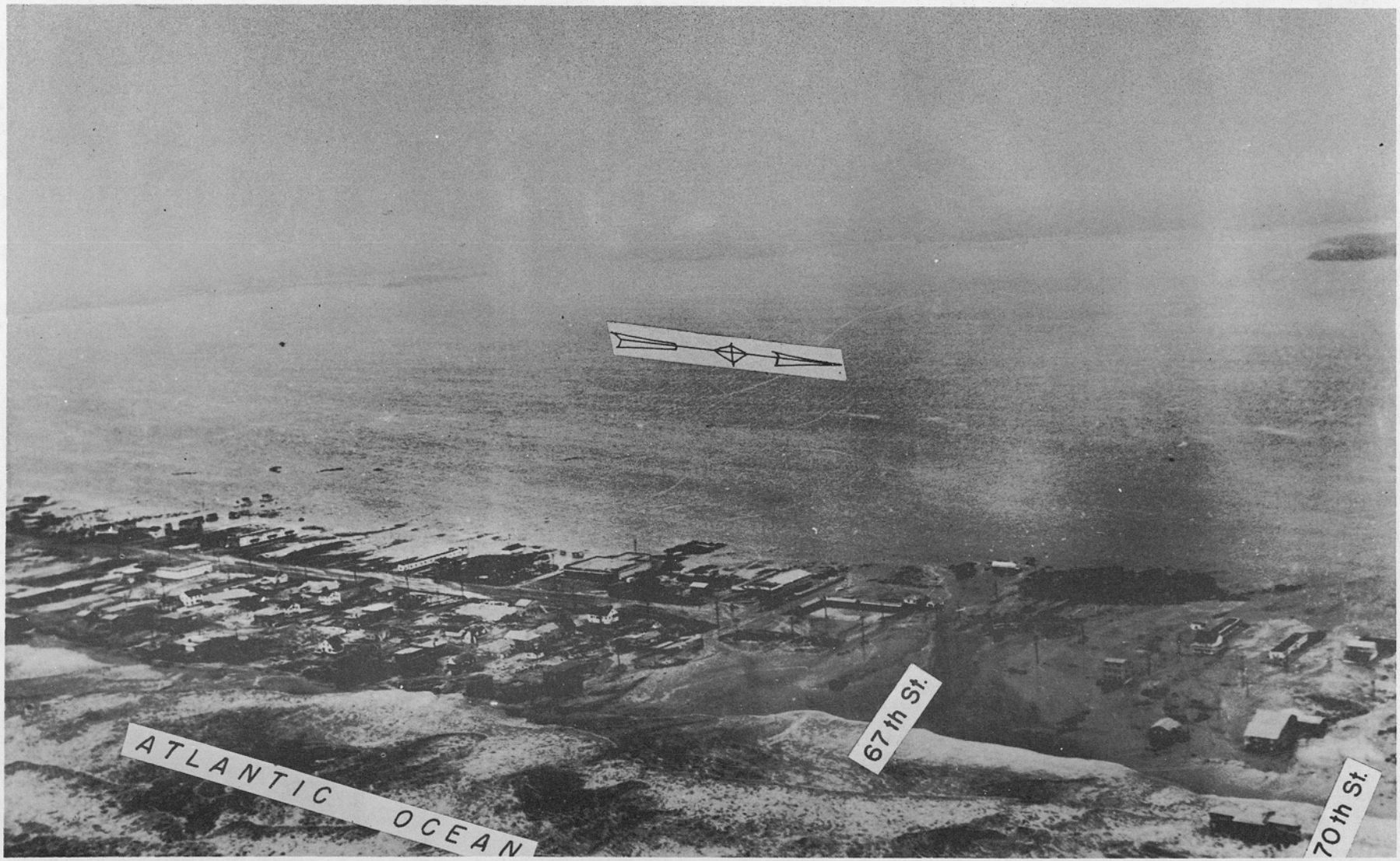
8 March 1962. With little protection from the narrow beach, damage was heavy. Stringers and some piling from the boardwalk were swept away.

8 March 1962. Waves in this reach soon washed away the narrow beach, virtually destroyed the boardwalk, and attacked buildings directly.

Ocean City, Md., on 7 March 1962 during the storm.

Ocean City, Md., on 7 March 1962 during the storm.

Very heavy damage. Entire buildings were washed away.



Ocean City, Md., on 7 March 1962 during the storm.

Ocean City, Md., on 7 March 1962 during the storm.

Assateague Island on 8 March 1962 during the storm.

protection, and at a public hearing held in Chincoteague, on 12 December 1956, in supporting a request for a harbor of refuge, claimed that the storms of 1933 and 1936 caused boat damages of $100,000 and $325,000, respectively. Investigation showed, however, that the estimates included unavoidable damages by wind. Damage that could be prevented by provision of a wall, 20 feet above mean low water, includes the flooding of homes and business houses and damage caused by violent wave action. Since the chance of occurrence of a tidal surge of the magnitude of that cause by the 1933 storm is about one in 82 years, the average annual tangible benefits which would accrue from protection against such storms would not nearly be enough to justify the cost of protective works. Local interests claim that they are financially unable to participate in any program for protection.

17. By resolution dated 7 February 1963 the Town Council of Chincoteague requested the Corps of Engineers to construct a dike on the north side of Lewis Creek to prevent wave action to the waterfront of this exposed section of Chincoteague. A copy of the resolution is contained in Appendix C. It was determined by field investigation that the problem described by local interests could be largely alleviated if the elevation of the marsh on the north side of Lewis Creek was raised by placing thereon material dredged from the navigation channel during maintenance dredging of the project "Waterway on the Coast of Virginia." The Mayor and Council of Chincoteague later advised that the use of the marsh for disposal of dredged material constituted a satisfactory solution to the problem they described in their resolution of 7 February 1963.

18. Ocean City, Maryland. The boardwalk at Ocean City has an elevation of about 14 feet above mean low water and extends from the inlet to 28th Street. The remainder of the town has an average elevation of approximately 7 feet above mean low water.

19. Tides of the magnitude of the design tide of 15 feet would rush unimpeded over the barrier beach north and south of Ocean City causing inundation of the town. This flooding can be prevented only by construction of protection around the entire community. Prior to preparing an economic analysis, preliminary field investigations indicated that protection from 14th Street to the inlet might be economically justified, but it was highly doubtful that extension of the protection beyond 14th Street could be justified since the increment of preventable damages would not even approach the additional cost that would be involved.

20. Local interests at Ocean City are concerned over the loss of business that results from hurricane warnings and believe that a more accurate and reliable warning system would minimize this loss. Provision of physical protection, however, will do little to prevent this loss of business because people would still be reluctant to visit the resort during hurricanes even if protection from tidal

flooding were provided. At a public hearing held in Salisbury, Maryland, on 23 February 1956, a representative from Worcester County, Maryland, claimed that citizens at Ocean City desired a more accurate forecasting and warning system to eliminate "false" reports of hurricanes, which cause a loss of business. (See Appendix A)

21. A wall encircling Ocean City to protect against hurricane-induced tides of 15 feet would have to be 20 feet above mean low water to protect against tides and overtopping due to runup and wave action. The boardwalk on the ocean side of Ocean City has an elevation of 14 feet above mean low water. From the inlet north to 2nd Street, sand is almost level with the boardwalk. From 2nd Street north, the maximum elevation of the beach decreases gradually to about 8 feet at 15th Street. Protection to 20 feet on the ocean side of Ocean City can be provided with sand fill to an elevation of 14 feet with groins constructed at 400 foot intervals to hold the fill and a wall 6 feet high along the boardwalk. The remainder of protection would consist of a wall, or levee, along the inlet and Sinepuxent Bay. The portion of protection on Sinepuxent Bay would require a top elevation of only 18 feet above mean low water for protection against the design tide of 15 feet, since the restricted fetch and shallow depths of the Sinepuxent Bay would restrict the generation of large wind waves. The three feet of protection above the design tide still water level is considered sufficient to protect against wave action and runup. This wall would be constructed on land and have an average height of 12 feet above existing ground and a length of about 9,000 feet. It would tie in with the beach fill along the boardwalk at the inlet and in the vicinity of 14th Street. Stop-log structures would be required at Baltimore and Philadelphia Avenues in the vicinity of 14th Street and at pier heads at six locations along the Isle of Wight Bay to allow access to the existing docking facilities.

22. With a protective system completely surrounding Ocean City, a pumping station and collector system would be required to collect and discharge runoff from behind the barrier into the bay during heavy rainfall. At present, the storm drainage system at Ocean City is combined with the sanitary sewer system, but plans have been made for separate systems. When this is accomplished, the present storm drainage system could be utilized as a collector and the pumping station would operate only when high tides make gravity discharge impossible. To prevent underseepage, the wall along the bay would be constructed with a sheet pile cutoff to intercept a layer of impervious material underlying Ocean City at a depth of about 11 feet below ground surface. Drill logs obtained from the Department of Geology, Mines and Water Resources, State of Maryland, for three wells drilled in Ocean City show that a 20-foot thick layer of clay exists at a depth of 11 feet below the surface. Three drill logs were obtained from wells located at Baltimore Avenue and South Division Street, Worcester Street and Philadelphia Avenue, and Philadelphia Avenue near 14th Street.

23. Harbors of refuge. At the public hearing held in Salisbury, Maryland, on 23 February 1956, interested parties expressed a desire for various harbors of refuge and consideration was given to location of harbors of refuge along the survey area. A harbor of refuge has since been constructed at Chincoteague, Virginia, 35 miles south of Ocean City. Ocean City with an inlet to Sinepuxent Bay is already an excellent harbor of refuge. Due to the topography and remote location of Assateague Island, there are no locations along the stretch of island from Ocean City to Chincoteague which would be feasible for the location of a harbor of refuge. With no connection to the mainland and the threat of the island being flooded, boat owners would be understandably reluctant to seek a haven on Assateague Island during a hurricane. With the construction of a harbor of refuge at Chincoteague, there are two harbors of refuge along the 55 miles from the Delaware-Maryland line to Gargathy Inlet, Virginia.

24. The proposed plans of improvement for Ocean City and Chincoteague are shown on Plate 2.

V. ECONOMIC ANALYSIS

25. Chincoteague, Virginia. Complete protection against hurricane-induced tides at Chincoteague can be provided by a wall, with a top elevation of 13 feet above mean low water, around the entire town. This would require a wall about 45,000 feet long, with stop-log structures provided at 8 points where the wall would cross roads and highways. On the west side of Chincoteague, along Chincoteague Channel, a timber bulkhead would be required because of limited available space but on the east side of the town as earth levee could be constructed. The timber bulkhead would be approximately 15,000 feet long, and the dike about 30,000 feet long. The estimated cost of the structure is approximately $3,000,000 with annual charges of $110,000. There would be little damage before the tide reached an elevation of five feet. Since the frequency of storms causing tides above five feet is low, it is highly doubtful that average annual benefits would exceed the annual charges associated with the improvement. In this regard, a damage survey was not conducted. Local interests would be required to contribute at least 30 percent of the cost of the project, or about $1,000,000, and they have indicated that they can make no financial contribution.

26. Ocean City, Maryland. The estimated cost of the plan of improvement outlined in paragraph 15 for Ocean City, Maryland, exclusive of $6,000 for preauthorization studies, is based on price levels existing on August 1963.

01 Lands and damages	$ 500,000	
11 Levees and floodwalls		
Beach fill	1,072,000	
Groins	120,000	
Concrete wall	2,415,000	
Stop log structures		
6 at 2,500	15,000	
2 at 3,000	6,000	
13 Pumping plant	1,000,000	
Sub-total	$ 5,128,000	
Contingencies 15%±	769,000	
Construction cost	$ 5,897,000	
Engineering and design	$ 390,000	
Supervision and administration	588,000	
Total cost	$ 6,875,000	

Annual charges

Federal

Federal cost 70% of $6,875,000	$ 4,812,500	
Total Federal cost	$ 4,812,500	
Interest at 3%	$ 144,375	
Amortization 50 years at 3%	42,690	
Federal annual charges		$ 187,065

Non-Federal

Total Non-Federal Cost 30% of $6,875,000	$ 2,062,500	
Interest at 4%	82,500	
Amortization 50 years at 4%	13,500	
Maintenance and operation	25,000	
Non-Federal charges		$ 121,000
Total annual charges		$ 308,065
	Say	$ 308,000

27. Benefits to be derived from the construction of protective structures for Ocean City would be derived principally from the reduction of damage due to tidal flooding. The considered plan of improvement would provide complete protection against flooding, but wind damage, which cannot be reduced by the protective works, would still occur. Ocean City is located on a flat peninsula with an average elevation of 7 feet above mean low water, and for the purpose of the stage-damage relationships, the first floor level of each establishment was assumed to be at 7 feet above mean low water.

An estimate of the number of structures was made and standard procedures were used to evaluate average annual damages. Average annual damages for Ocean City were thus computed to be $250,000 at August 1963 price levels.

28. With annual charges of $295,200 and average annual benefits of $275,000, the benefit-cost ratio for the planned protection at Ocean City, Maryland, is 0.89 to 1.

VI. COORDINATION AND LOCAL COOPERATION

29. During the course of this study, information and assistance were received from various agencies. The United States Weather Bureau furnished information on the behavior and characteristics of hurricanes that would affect the survey area, including data on wind velocities and durations that were used to determine tides that could be generated by these hurricanes. Tidal records were furnished by the United States Coast and Geodetic Survey. Plans of improvement were discussed with the Mayor of Ocean City and the Mayor and Council of Chincoteague.

30. At a public hearing held at Salisbury, Maryland, on 23 February 1956, a commissioner from Worcester County stated that local interests at Ocean City believe that more accurate reporting of hurricanes would minimize the loss of business that occurs when inaccurate reports and forecasts are released. Local interests at Ocean City and Chincoteague did not present any plans or requests for protection against high tides and wave action.

31. Local Cooperation. In the event protection should be provided at either Ocean City or Chincoteague, or both, local interests in each community should be required to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project.

b. Hold and save the United States free from damages due to the construction works.

c. Assume maintenance, operation, replacement and repair of the project after completion as may be required to serve the intended purpose in accordance with regulations prescribed by the Secretary of the Army.

d. Provide a cash contribution for hurrican tidal protection. This contribution is 30 percent of the first cost of the project (exclusive of the cost of navigation aids and preauthorization studies, which are Federal costs) with such share reduced by an

amount equivalent to the fair market value of lands, easements and rights-of-way and local cost of relocations required by the project.

32. The Mayor and Council of Chincoteague, at an informal meeting with district representatives, stated that the town of Chincoteague is financially unable to contribute to the cost of providing hurricane protective works for the town of Chincoteague.

33. The Mayor of Ocean City expressed an interest in providing hurricane protection for the town and requested information on the plan of protection being considered and the estimated cost of constructing such protection. The Mayor and Council reviewed the tentative plan of improvement and the terms of local cooperation, but did not furnish assurance that the Town of Ocean City would fulfill the requirements of local interests incidental to an approved project. Copies of correspondence with the Mayor and Council are inclosed in Appendix C.

VII. REGULATION OF FLOOD PLAIN DEVELOPMENT

34. In areas where hurricane protective structures cannot be justified, other flood damage reduction measures should be considered to alleviate the hazard to human lives and to prevent property damage. These measures would be introduced and carried out by the local governments in the potential flood zones. The following regulatory measures would be necessary:

a. Zoning ordinances.

b. Building codes.

c. Evacuation planning.

The adoption of measures to regulate development and land use in the potential flood zone would help to decrease loss of life and property. Local interests are encouraged to apply for "flood plain information studies" as authorized by Section 206 of Public Law 86-645. The application of a state or local agency for Flood Plain Information Studies should be in a letter to the District Engineer, prepared with his assistance, if necessary, signed by an authorized officer of the sponsoring agency, and containing the following information:

a. The authority, law, character, or resolution clearly establishing the local agency by the state or subdivision thereof, its interest and jurisdiction in flood plain regulation and planning, and its relation to other local agencies having responsibility therefor should be cited or attached. The identity of the state agency designated by the Governor to cooperate in this program should be cited.

b. The geographic area to be studied should be described together with the nature of present flood plain use and any contemplated flood plain development. The time available before local planning decisions can be made should be stated. The type and extent of descriptive and statistical data that are available and that will be furnished to supplement the study by the Corps of Engineers, without cost to the United States, should be described. Any local cooperation in gathering data, mapping, or other services that can be provided should be stated.

c. The letter of cooperation should give assurances that:

(1) Available information and data will be furnished for the study.

(2) The applicant will publicize the information report in the community and make copies available for use or inspection by responsible interested parties.

(3) Zoning and other regulatory, development and planning agencies and public information media will be provided with the flood plain information for their guidance and appropriate action.

(4) Survey markers, monuments, etc. established in any survey for Section 206 studies or in any regular surveys will be preserved and safeguarded.

35. In order to arrive at suitable and appropriate zoning ordinances, the level to which flooding may be expected must be determined with consideration given to the probable frequency of various levels of flooding. A level could then be established below which the zoning ordinance would not allow construction of improvements that would be damaged by high tides.

36. Map. Effective flood zone planning requires large scale topographic maps with contour intervals of one or two feet in the areas subject to flooding. There are no available maps of this type for either Ocean City or Chincoteague. Since complete protection by means of construction of a tidal flood control project is unlikely at this time, it would appear advisable for the Towns of Ocean City and Chincoteague to have necessary maps prepared as a first step to formulating a plan to regulate development in the flood zones.

37. In addition to an adequate map of the potential flood plain effective planning requires a tide-frequency relationship to determine the probability of low-lying areas becoming inundated. Such a relationship can be established only from continuous tide records over a period of at least ten years. The accuracy of the results will, of course, depend upon the length of time for which

records are available. Such records do not exist for either Chincoteague, Virginia, or Ocean City, Maryland. With the tide frequency relationship and a suitable map, action toward definite legislature for zoning and building restrictions could be initiated to minimize future damages from high tides. Planning could include utilization of areas that would be subjected to periodic flooding for parking lots, playgrounds, or other types of open use.

38. Building codes can be utilized to designate standards of construction of individual homes and buildings in the flood zone. The building code could specify a minimum elevation for the first floor of structure built in the flood zone and could require the buildings be located at a minimum distance from the mean high water shore line. The codes could also require business establishments located in the flood zone to have water-tight construction on the first floor and in cases where business establishments already exist in the flood zone, owners could be informed of the potential flood threat and could locate perishable items and equipment above the first floor level to minimize damage from high tides.

39. Since some development now exists in flood zones and it is not feasible to relocate these structures, an adequate warning system and evacuation plan is necessary to prevent loss of life during high tides. The main step in evacuation planning is in educating the public to the potential danger and presenting them with a definite plan for evacuation. It is the responsibility of local authorities to develop an effective evacuation plan for people located in the flood zones since they possess the detailed knowledge of the local area and are immediately responsible for the welfare of the people within their community. Appendix B is a reproduction of a National Hurricane Research Project Report, "A Model Hurricane Plan for a Coastal Community," prepared by the United States Weather Bureau. This report outlines the provisions for a good hurricane preparedness plan and could be used by local authorities in organizing an appropriate planning agency.

VIII. CONCLUSIONS

40. Conclusions. Protection for Ocean City does not appear to be economically justified. Detailed studies to prepare a final design were not undertaken since the project did not appear economically feasible and local interests did not indicate a willingness to fulfill the terms of local cooperation. At Chincoteague, Virginia, protection against hurricane-induced tides and wave action could be provided but preliminary analysis shows that it is highly doubtful that more exhaustive studies would result in a justifiable project. For this reason and because local participation in the project seemed improbable, a complete economic analysis was not conducted. Along the remaining portions of the Atlantic Coast, Sinepuxent Bay and

Chincoteague Bay, there were no other locations at which protection from hurricane-induced tides were considered to be economically justifiable.

IX. RECOMMENDATIONS

41. Recommendation. The District Engineer recommends that no further planning or investigation for the provision of hurricane protective works within the study area be undertaken at this time. The District Engineer recommends, however, that this report be published and distributed to appropriate officials in the area who may find the information contained therein of use in the establishment of flood plain regulatory measures and evacuation procedures.

ROY S. KELLEY
Colonel, Corps of Engineers
District Engineer

ACKNOWLEDGEMENTS AND IDENTIFICATION OF PERSONNEL

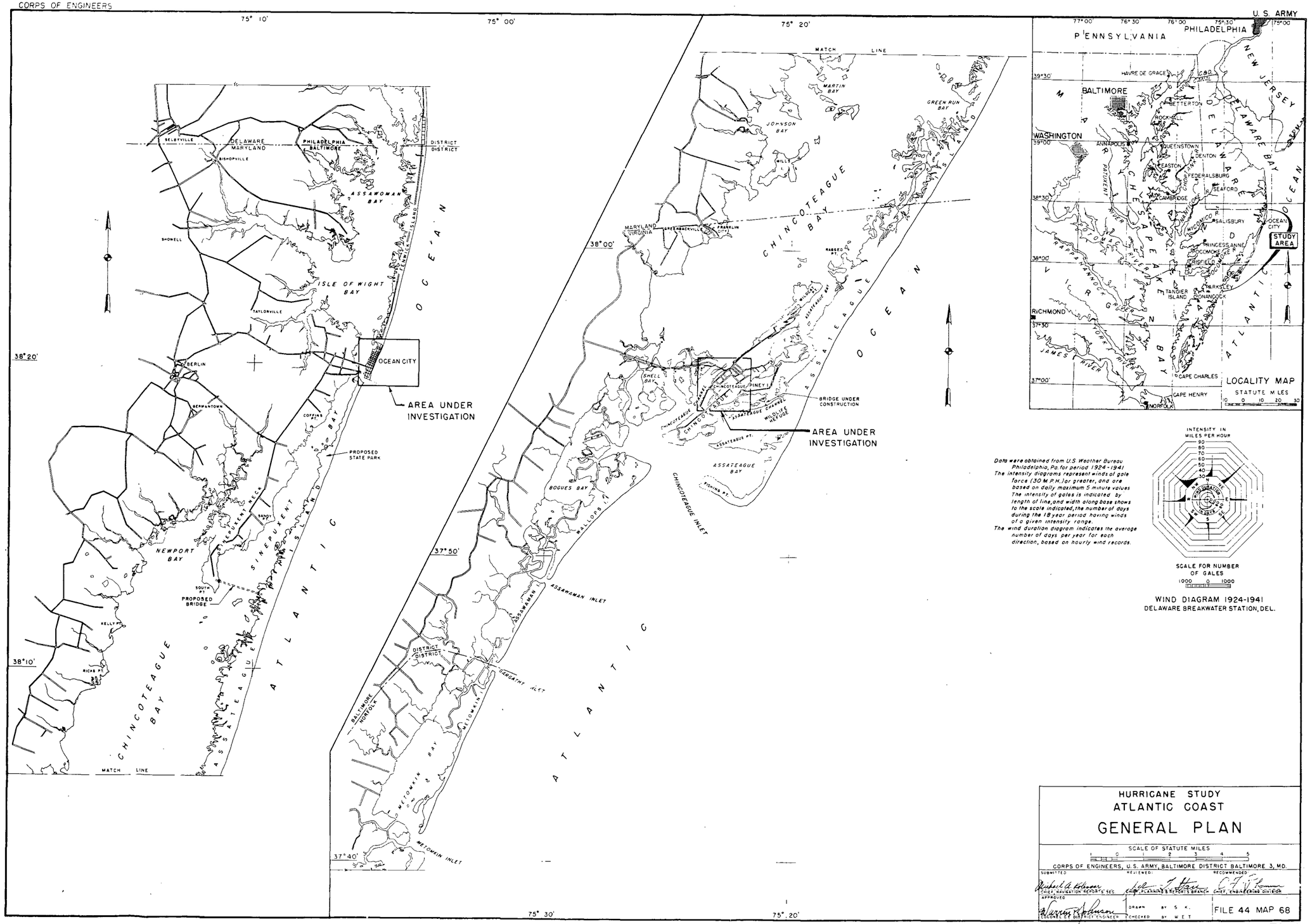
1. The preparation of this report was administered by:

Colonel Roy S. Kelley, C. E., District Engineer
C. F. Pfrommer, Chief, Engineering Division
John T. Starr, Chief, Planning and Reports Branch

2. This report was prepared in the Navigation Reports Section under the direction of Michael A. Kolessar and was written by William E. Trieschman, Jr.

3. The United States Army Engineer District, Baltimore, acknowledges with appreciation the cooperation and assistance rendered in connection with these studies by personnel of a number of other offices and agencies, particularly the following:

The Beach Erosion Board
United States Army Engineer Division, North Atlantic
United States Weather Bureau
United States Coast and Geodetic Survey



Data were obtained from U.S. Weather Bureau Philadelphia, Pa. for period 1924-1941
The intensity diagrams represent winds of gale force (30 M.P.H.) or greater, and are based on daily maximum 5 minute values
The intensity of gales is indicated by length of line, and width along base shows to the scale indicated, the number of days during the 18 year period having winds of a given intensity range.
The wind duration diagram indicates the average number of days per year for each direction, based on hourly wind records.

WIND DIAGRAM 1924-1941
DELAWARE BREAKWATER STATION, DEL.

HURRICANE STUDY
ATLANTIC COAST

GENERAL PLAN

SCALE OF STATUTE MILES
1 0 1 2 3 4 5

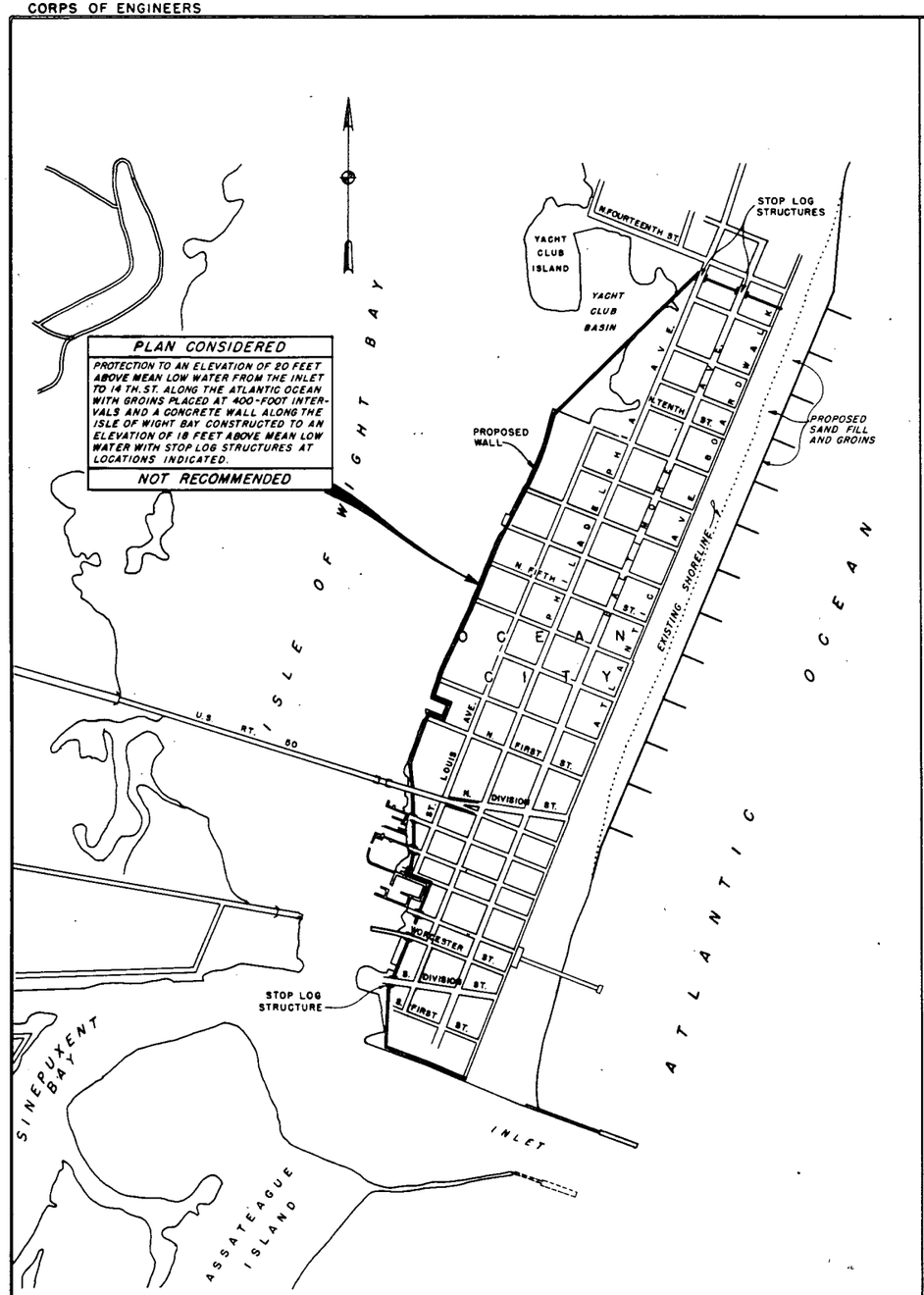
CORPS OF ENGINEERS, U.S. ARMY, BALTIMORE DISTRICT BALTIMORE 3, MD.

SUBMITTED	REVIEWED	RECOMMENDED
CHIEF, NAVIGATION REPORTS SEC.	CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION

APPROVED
COLONEL, C.E. DISTRICT ENGINEER

DRAWN BY S. K.
CHECKED BY W.E.T.

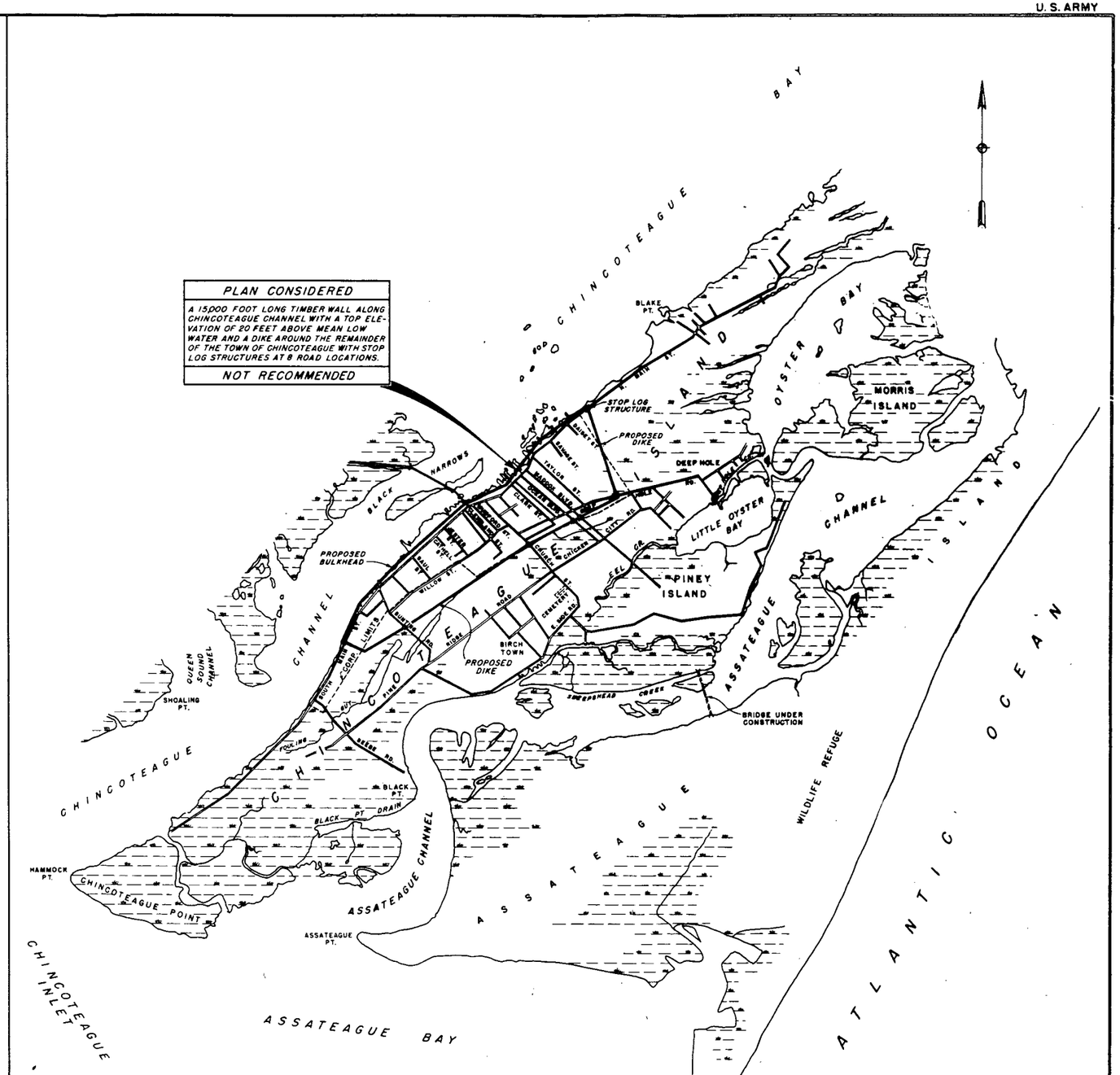
FILE 44 MAP 68



OCEAN CITY, MD.

SCALE OF FEET

500 0 500 1000



CHINCOTEAGUE, VA.

SCALE OF FEET

1600 0 1600 3200

HURRICANE STUDY
ATLANTIC COAST

PLAN OF IMPROVEMENT

SCALE AS SHOWN

CORPS OF ENGINEERS, U.S. ARMY, BALTIMORE DISTRICT BALTIMORE 3, MD.

SUBMITTED:	REVIEWED:	RECOMMENDED:
CHIEF, NAVIGATION REPORTS SEC.	CHIEF, F. CONTROL & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C.E. DISTRICT ENGINEER	DRAWN BY: S. K. CHECKED BY: W. E. T.	FILE 44 MAP 69

SUPPLEMENT #1

HURRICANE STUDY

ATLANTIC COAST DELAWARE-MARYLAND LINE

TO

GARGATHY INLET VIRGINIA

Information called for by

Senate Resolution 148, 85th Congress

Adopted 28 January 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE.

a. Investigation of the survey area indicated that only two locations on the Atlantic Coast warranted consideration of constructing protective works. Protection at these locations, Ocean City, Maryland and Chincoteague, Virginia, could only be accomplished by construction of a circumjacent wall. At each location the protection was designed to prevent flooding from the design tide of 14 feet. The economic life of the project is 50 years.

b. Terms of local cooperation require that local interests:

(1) Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project;

(2) Hold and save the United States free from damages due to the construction works;

(3) Assume the cost of maintenance, operation, and replacement or repair of the project after completion as may be required to serve the intended purpose in accordance with regulations prescribed by the Secretary of the Army.

(4) Provide a cash contribution for the hurricane tidal protection. This contribution is 30 per cent of the first cost of the project (exclusive of the cost of navigation aids and preauthorization studies which are Federal costs) with such share reduced by an amount equivalent to the fair market value of lands, easements, and rights-of-way and local costs of relocations required by the project.

2. PROJECT COSTS.

Construction of protective structures at Ocean City, Maryland is estimated to cost $6,875,000 and at Chincoteague, Virginia, $3,000.000.

3. BENEFIT COST RATIO.

The benefit-cost ratio for the plans of improvement considered are 0.89 to 1 at Ocean City, Maryland and 0.5 to 1 at Chincoteague, Virginia.

4. EXTENT OF INTEREST IN PROJECT.

Local interests have shown no organized support for protection against hurricane-induced tides at either Ocean City or Chincoteague. Correspondence with the Mayor of Ocean City, Maryland is contained in Appendix C. Local interests at Chincoteague indicated at a meeting with District representatives that they could not participate financially in construction of protective works. Due to lack of local support for these projects, application of the alternative standards of Senate Resolution 148 would not result in the change of recommendation.

APPENDIX A

P U B L I C H E A R I N G

PUBLIC HEARING

HELD BY

THE DISTRICT ENGINEER

BALTIMORE, MD.

AT

SALISBURY, MD.

REGARDING
HURRICANE DAMAGES

23 FEBRUARY 1956

REPORT of PUBLIC Hearing held in Maryland National Guard Armory at Salisbury, Maryland, at 1:00 p.m., Thursday, 23 February 1956.

PURPOSE: Discussion of the character and extent of the hurricane problem affecting Salisbury, Maryland and the Eastern Shore of Maryland and Virginia.

RECORD OF ATTENDANCE:

Representing:
U. S. Government:

Baltimore District, Corps of Engineer, U. S. Army:

Colonel Stephen E. Smith
District Engineer, Presiding

Mr. Christopher F. Pfrommer, Chief, Engineering Division
Mr. John T. Starr, Chief, Planning & Reports Branch, Engineering Division
Mr. Michael A. Kolessar, Chief, Navigation Reports Section, Planning & Reports Branch, Engineering Division
Mr. Herbert H. Linthicum, Engineer Technician, Navigation Reports Section, Planning & Reports Branch, Engineering Division
Mr. John L. Reynolds, Chief, Navigation Branch, Operation Division

Reporters: Mrs. Ida E. Kemp and Miss Lillian Chorakjian

Representing:
North Atlantic Division, Corps of Engineers, U. S. Army:

Mr. James R. Johnston, Engineer Advisor, New York

U. S. Weather Bureau:

Mr. H. L. Alkire, In Charge, U. S. Weather Bureau, Friendship Airport, Md.
Mr. Robert A. Hoover, Meteorologist, U. S. Weather Bureau, Washington National Airport

State of Maryland:

Mr. John C. Ahlers, Executive Secretary to U. S. Senator J. Glenn Beall
Mr. John C. Cotton, Engineering Special, Soil Conservation Service, Salisbury, Md.
Mr. W. F. Hastings, Hwy. Engr., Bur. of Public Roads, Balto., Md.
Mr. Henry B. Hegerfield, Assoc. Engr. - Bridges, Md. St. Roads Comm., Balto., Md.

Representing:

State of Maryland: (cont'd)

Mr. James R. McComas, Public Health Engineer, Md. State Dept. of Health, Baltimore, Md.
Mr. Clifton S. Mister, Industrial Examiner, Dept. Labor & Industry, Balto., Md.
Mr. Harry T. Phoebus, Jr., Rep. of State Senator H.T. Phoebus, Princess Anne, Md.
Mr. James F. Wallace, Jr., Rep. Congr. E. T. Miller, Easton, Md.
Mrs. James F. Wallace, Jr., Rep. Congr. E. T. Miller, Easton, Md.
Mr. William F. Waller, Asst. Dist. Engr., State Roads Comm., Salisbury, Md.

City of Cambridge, Maryland:

Hon. Russell P. Smith, Jr., Mayor
Mr. Henry Wier, County Engr., Dorchester County, Cambridge, Md.

Town of Crisfield, Maryland:

Mr. Calvin Gibson, Sec-Tres. Better Crisfield Business Assoc., Crisfield, Md.
Mr. Geo. H. Massey, Jr., City Clerk, Crisfield, Md.
Mr. Charles W. Mosher, Secr. Lower Somerset Flood Contr. Assoc., Crisfield, Md.
Mr. Joseph S. McGrath, Rep. of Mayor & City Council, Crisfield, Md.
Mr. Joan L. Nelson, Asst. to Clerk, Crisfield, Md.
Mr. Ralph W. Parks, Lower Somerset County Flood Control Assn., Crisfield, Md.
Mr. Bryce Revelle, Treas. Lower Somerset County Flood Control Assn., Crisfield, Md.
Mr. B. Frank Somers, Greater Crisfield Assoc., Crisfield, Md.
Mr. Philip Tawes, Crisfield Business Assoc., Crisfield, Md.
Mr. Simmons P. Tilghman, Board Member of Lower Somerset County Tidewater Control, Crisfield, Md.

Other Interested Parties:

Mr. L. Albert Anderson II, Lions Club Committee, Chance, Md.
Mr. W. H. Beach, Snowhill, Md.
Mrs. Pauline Bozman, Rumbley, Maryland
Mr. Randall Bozman, Rumbley, Maryland
Mrs. Randall Bozman, Rumbley, Maryland
Mr. Vernon Bozman, Rumbley, Maryland
Mr. W. Boyd Brittingham, Lions Club Committee, Wenona, Md.
Mr. Edward W. Catlin, Farmer, Nanticoke, Md.
Mr. William B. Cocman, Reporter, Princess Anne, Md.

Other Interested Parties: (cont'd)

Rev. W. I. Collins, Methodist Minister, Deal Island, Md.
Mr. Philip C. Cooper, City Engineer, Salisbury, Md.
Mr. C. L. Dail, City Clerk & Treasurer, Cambridge, Md.
Mr. Thomas G. Dean, Wingate, Md.
Mrs. Alice Dize, Rumbley, Md.
Mr. Archie Dize, Rumbley, Md.
Mr. Clayton Dukes, Oyster Dealer, Girdletree, Md.
Mr. L. C. Dukes, Fisherman, Tyaskin, Md.
Mr. Randall Eudell, Waterman, Elliott, Md.
Mr. Corbitt Elliott, Waterman, Elliott, Md.
Mr. Norman W. Evans, Supt. of Vienna Power Plant, Vienna, Md.
Mr. J. M. Fair, Representing Regional Engr. Pennsylvania R.R. Co., Harrington, Del.
Mrs. Harry W. French, Rumbley, Maryland
Mr. Otis W. French, Rumbley, Maryland
Mrs. Otis W. French, Rumbley, Maryland
Mr. C. Nelton Gray, Waterman, Elliott, Md.
Mr. Charles S. Gray, Waterman, Elliott, Md.
Mr. Gilbert D. Gray, Waterman, Elliott, Md.
Mr. James P. Gray, Waterman, Elliott, Md.
Mr. Joseph H. Gray, Waterman, Elliott, Md.
Mr. Joseph G. Harrison, County Commissioners, Worcester County, Berlin, Md.
Mr. Lester E. Hatton, Sr., Fisherman, Mardela, Md.
Lola M. Hoover, Alexandria, Va.
Mr. Brice Hurley, Waterman, Elliott, Md.
Mr. Robert W. Hurley, Waterman, Elliott, Md.
Mr. Oscar Jones, Waterman, Fishing Bay, Md.
Mr. Walter Lankford, Elliott Island, Md.
Mr. Alyn V. Levergood, Jr., Track Supervisor, Pennsylvania, R.R. Co., Salisbury, Md.
Mr. Randall Lewis, Waterman, Elliott, Md.
Mr. Robert C. Long, President Somerset County Commissioners, Princess Anne, Md.
Mr. Ralph V. Mills, Waterman, Wingate, Md.
Mr. Leonard Shorter, Waterman, Elliott, Md.
Mr. Frank Stone, Owner, Bivalve, Md.
Mr. William H. Sutphin, Rumbley, Md.
Mr. Leonard Thomas, Waterman, Elliott, Md.
Mr. Melvin Thomas, Waterman, Elliott, Md.
Mr. L. L. Walter, West Side Lions Club, Nanticoke, Md.
Mr. Harold W. Webb, Oysterman, Girdletree, Md.
Mr. Horace Webster, Chance, Deal Island & Wenona Lions Club, Wenona, Md.
Mr. William Parks Young, Manager Water View Beach, Water View, Md.

P R O C E E D I N G S

I am Colonel Stephen E. Smith, District Engineer, Baltimore District, Corps of Engineers.

Public Law 71 of the 84th Congress, which was approved 15 June 1955, authorized the Secretary of the Army in cooperation with the Secretary of Commerce and other Federal Agencies concerned with hurricanes, to make an examination and survey of the eastern and southern seaboard of the United States with respect to hurricanes with particular reference to areas where severe damages have occurred. Section 2 of the Act states:

> "Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damage to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required."

In accordance with this law I have been directed to make a study of hurricane problems on the tidal shore lines in the Baltimore District. Included in this area is the western shore of Chesapeake Bay from the mouth of the Patuxent River to the head of the bay, the eastern shore from the head of Chesapeake Bay to the mouth of Onancock Creek in Virginia, and that portion of the Atlantic coast line extending from Gargathy Inlet about 16 miles south of Chincoteague, Virginia northward to the Delaware - Maryland boundary.

The purpose of this hearing is to give you an opportunity to express your views concerning the character and extent of the hurricane problem as it affects your interests. Through this hearing and other such hearings to be held at key locations in the Baltimore District we hope to obtain sufficient information to make a general appraisal of the problem and to determine where and how it might be economically feasible to lessen future damages. From the information obtained at these hearings, supplemented by field investigation, we will recommend that more detailed studies be made at selected areas. The detailed studies will be combined with studies made by the other District Engineers of coastal districts. The resulting report will be submitted to the Congress with specific recommendations concerning the construction of protective works.

I am sure that most of the persons in attendance here today realize that the cost of waterfront structures is high. The cost of waterfront structures to protect against tides and waves resulting from storms of hurricane intensity is extraordinarily high. If we are to justify such costly structures it is imperative that we have good and sufficient information on which to base our economic studies. Before I can recommend the construction of any protective works, it must be shown that the benefits obtained from them will at least be equal to the costs.

These costs to which I refer include the costs, if any, to be incurred by local governmental units in compliance with the terms of local cooperation. Let me explain what local cooperation means. A policy which has been developed through Acts of Congress over a long period of years outlines the responsibilities of the Federal Government and local governmental units. On flood control projects the responsibility of the local unit, be it a State, county, or municipality, is threefold. First, it must furnish the necessary rights-of-way, second it must agree to hold and save the United States free from damages that may arise from the work of improvement and third, it must agree to maintain the works after they are constructed.

In the case of navigation improvements, maintenance of the navigation channels and structures are a Federal responsibility but local interests are usually required to furnish, pay for, and maintain appurtenances such as bulkheads, piers, public landings, and approach channels. They are also required to make those facilities public and open to all on equal terms.

The amount of local cooperation that will be required on protective measures which may be recommended by this study will depend largely on the nature of the benefits that will accrue but they will likely be combinations of those that I have described.

The public notice contained a list of six questions to which answers are desired. I will read these questions:

a. What has been the extent and amount in dollars of damages inflicted during hurricanes in each locality affected? What was the amount of damage caused by winds, by flooding during high tides, and by wave action?

b. What indirect losses such as loss of wages, loss of the use of facilities, cessation of business and interruption of traffic were caused by storms?

c. What were the stages of tide, wave heights and estimated wind velocities during the storms?

d. Was there evidence of excessive shoaling of navigation channels during hurricanes?

e. What is the real and assessed valuation of lands and building in the areas directly affected by storms?

f. What particular shore protective works are desired?

The discussion will not be limited to these questions but it should not include problems other than those caused by severe storms. It is desired to have a full and frank expression of all interested parties supporting or opposing the proposals made here today and as complete a statement as possible of all information that bears on the matter.

Full weight will be given to all evidence or arguments presented at this hearing; and all pertinent material which parties considered should be brought out at this time.

Presentation after the hearing, of evidence or arguments is not desired unless those statements or those arguments contain matter that could not be brought out at this time. Any parties intending to present such additional information at a later date, should announce that intention together with the nature of the information at this Hearing, and present the data to my office by not later than 1 April 1956.

All present will please fill out attendance cards, giving name, address, whom they represent, the nature of their interest in the problem, and pass them to the aisle if they have not already been completed and handed in. This is necessary in order to obtain a record of attendance.

In order that the reporters may make all statements a matter of record, I should like to have all speakers give their full names and addresses, the interest they represent, and the functions of that agency, and to speak clearly and slowly so there will no loss of information. Since we are attempting to make a tape recording of these proceedings and since we have only one microphone, I would appreciate each speaker coming to the microphone before he speaks. I would like each speaker to come up to this table, sit in this chair (pointing to witness table and chair) and speak in a tone of voice for all to hear and that will permit a recording on this tape recorder. I take it that all of you present have filled out an attendance card.

INTRODUCTORY REMARKS

District Engineer: I will first call on representatives of the Federal Government who wish to speak, then State,County, and City officials, and representatives of other Federal Agencies who may be present. First, I would like to read a letter I received yesterday from Senator Butler. (EXHIBIT 3) Senator Beall was unable to be here today, but his secretary is here -- Mr. Ahlers. I believe Mr. Ahlers would like to say a few words.

MR. JOHN C. AHLERS, Executive Secretary to Senator Beall: I have a very brief double mission today. The first part is to express the regrets of Senator Beall and your Representative Miller that they can't be here. Senator Beall - As you might have seen, the farm bill just came up on the floor of the Senate...that's taking care of him pretty much; and Representative Miller is also in the midst of one of the busiest times he has had. He asked me to come, and sent Mrs. Wallace also. He talked with me for an hour and a half yesterday about his plans, etc., and I think about one-third of the time he spent fretting about the fact that he couldn't come down in person. He did give me a little bit of an outline which Colonel Smith has also gone over. The fact that this hurricane problem is almost completely new as far as the Federal Government is concerned, they have not been in on it before. The Army Engineers have the traditional duties of taking care of navigation. In later years, they've done exceptional work in flood control, etc., but now this hurricane problem is relatively new, with the result that there is no program right now set up to help people. One thing, I have dealt with the Engineers quite a bit in different sections of the country. I can tell you there is not a solution right now; our problem is really in the hands of the experts. Senator Beall and Representative Miller had a conference on this the other day and they divided it into different parts. The first is whether a private person can be reimbursed for damages done by hurricanes, reimbursed directly by the Federal Government, or whether the Federal Government might probably get into something where they will set up protective works for individual shores, etc. Unfortunately, they are both extremely pessimistic about that. The reason is that it would just cost so many billions; the only thing they can see. Naturally they would like to help the people, but being practical about it, they don't see how anybody could push something through even if they wanted to with the high cost. They said there's one possible answer to this, and that is that maybe on this hurricane thing various communities could do the same thing as they have, to head off other disasters and that is to start their own organization, get some work started themselves, and they would be footing a good part of the bill then, and the Federal Government would cooperate. That is what Colonel Smith was talking about when he was talking about local cooperation. There is one plan that Senator Beall and Representative Miller have been thinking about and they would like to pass it on to you folks today. It might be good or it might be bad, but at least it is worth consideration, I think. That is this: a major part of the damage of a hurricane comes after the hurricane when there are high tides and strong winds following in the path of the eye as it sweeps along.

Frequently, as you know, there might be a finger of a jetty somewhere protecting a great number of small craft and the high tides come up and they go right over that jetty and you have no more harbor and no more protection, and your boats end up miles away if they are still afloat. What the Senator and Representative thought is that it might be good to establish various refuge harbors along the Bay. They were not sure how many would be needed nor what size or anything. There again, it is up to the Engineers, but the idea would be that with the advanced warnings of hurricanes, and incidentally that will improve--they both backed legislation which is now law--to try to improve the Weather Bureau. There are two sides to this: If you have a better warning system and knew hurricanes were coming up in eight, ten or twelve hours, or something, you can then get the small craft into these refuge harbors, that would save property, lives, and everything. These, with the knowledge of the Engineers, would be built so that the high tides and the winds that follow along after the hurricane passes would be a protection for the ships. Now, in talking about this, they said it was a constructive plan. While I do not think it has been outlined as such yet, they think it would be within the province of the Engineers, once work like this would be authorized, and they also had hoped that the plan was not so extreme they could not get approval on something like that. It is not very easy getting money over there, but in worthy causes like this, and if they fight hard enough, they had fairly high hopes for it. That was the only thing they asked me to pass along, also to again express regrets they could not be here in person and say that it will help the Engineers and our office if you have any plans here or later, to let us know and we will try to do everything possible. Thank you very much.

District Engineer: Thank you very much. Mr. Miller has his secretary here also. Do you care to say anything, Mrs. Wallace?

MRS. WALLACE: No, thank you very much.

District Engineer: I believe we have a State Senator here, Senator Phoebus, would he care to say anything, Sir?

ANSWER: I am his son, HARRY PHOEBUS. He asked me to represent him here. Colonel, Ladies, and Gentlemen, my father is somewhat in the same position as Senator Butler and Congressman Miller. He is unfortunately unable to be here. The State Senate is in session. The Finance Committee is meeting today. They are trying to get the budget out and the auxiliary budget, I understand, is coming down from the Governor's office. It is absolutely impossible for him to get away from Annapolis. He did ask that I come up here in one sense, represent some of the people from Somerset County, or at least represent his ideas. There are quite a few groups from Somerset County I see here, who not only are here in person, but are ably represented by spokesmen of their own. I know the group from Crisfield has Mr. Joe McGrath, who will give you some of the details relating to the damage down there. I see the group from Deal Island has Doctor Collins. I am sure he will be able to present some of the damage done there. Specifically, I would like to point out one phase of

damage that perhaps will not be covered by these other groups. Mrs. French and many other persons from down in Frenchtown and Romley which is a western part of Somerset County on the Chesapeake Bay have asked that we call your attention to the peculiar type of damage in their particular area in that they lost the service of all their wells. In other words, the lost their entire water supply as a result of Hurricane Hazel. Because of the nature of the area, it being right on the Chesapeake Bay and being very low, the people either have to take advantage of the surface water or the water immediately below the surface, or drive their pumps very, very deep. Most of these wells in that area were of a more shallow nature and the hurricane has completely wiped out those as a source of supply for water. I have a copy of the Somerset County Health Department's report on these wells which will in greater detail reflect the actual bacteriological studies which were made and will present their particular problem to you. I know it was unusual and I don't think it was suffered in too many parts of the County but nonetheless in those areas in which it is suffered, it is a grave problem. I believe the larger areas of Somerset County will be represented here. Mr. Joe McGrath I know is here and Doctor Collins is here. The damage done in Somerset County was tremendous, particularly for a small county like ours, and a county away from the municipal services which you might find in other towns. Mr Ahlers' suggestion, or rather Senator Beall's suggestion about the possibility of protective harbors certainly for our watermen would be a God-send. In addition, to that I know a lot of damage was done on Smith Island by the boats that were washed ashore. They actually did damage to other buildings and the like. In addition, of course if those boats could be protected, that naturally is one of our main sources of income in Somerset County. My father again extends his regrets in not being here. He thanks you gentlemen for coming down here and hopes you can offer some solution to our problems as a result of these hurricane losses. (Mr. Phoebus handed a paper (EXHIBIT 2) to Colonel Smith.)

DISTRICT ENGINEER: Thank you. We will call on those who are farthest away so they can speak and then leave if they like. Is there anyone from Virginia to contribute anything? We will come back to Somerset County ...

VOICE: I am W. I. COLLINS, Methodist minister in Deal Island. We have prepared a one-page bit of data double spaced. I would like to submit a copy and read it for the record if I may. Gentlemen we are a committee from the Deals Island-Chance Lions Club. We are speaking in behalf of communities of Chance, Deal Island, and Wenona in Somerset County. We are confining this to Hurricane Hazel. As a result of Hurricane Hazel alone, insurance companies paid claims amounting to not less than $27,000 on damage resulting from wind and tide in our three communities. The American Red Cross at Arlington, Virginia, advised me by wire that in our communities, 345 families were sufferers from this hurricane and the Red Cross paid out in aid the sum of $23,152. Additionally, many work-boats which were uncovered by insurance were lost or badly damaged. Some were partially salvaged only through the aid of the military services. Wells were contaminated by tide water to such an extent that the army sent in water in tanks for use.

Some of these wells today are useless. Question 2: Seafood houses were closed down with heavy losses; this closing brought loss of wages to employees and wage losses to watermen which extended into thousands of dollars. One seafood packer was compelled to borrow $2,000 from the small business administration to repair walls. Question 3: During this hurricane, wind velocity reached a point well over 100 miles per hour. The tide was 5 feet above normal; the wave height was 8 to 10 feet. Question 4: There is concrete evidence of shoaling. Our harbor channels filled in considerably and some cannot be used by our oyster and crab dredge boats at low water. Question 5: We are not prepared to answer. We would like to reserve the right to submit that data. It has to do with property evaluation. Question 6: Our community is suggesting and urging a series of jetties from Haines Point to the channel at the Lower Thoroughfare off Wenona, Maryland, for the protection of Wenona Harbor. A jetty should be constructed from Big Ditch Bar to the No. 8 beacon light. Unless some protective measures are taken at once these communities will in the not too distant future cease to exist. This report is signed by a committee of four representing the local Lions Club which is the only civic group we have. (EXHIBIT 5) I would like these gentlemen if they so desire to add to what I have said. (NO ANSWER)

DISTRICT ENGINEER: Thank you. Is there anyone else from Somerset County?

VOICE: Colonel Smith, ladies and gentlemen, I am JOE MCGRATH from Crisfield. I am representing the Mayor and Council of Crisfield, the Lower Somerset County Flood Control Association, and the Better Crisfield Business Association. I have a brief report which I should like to read, if I may. During the past three years, and on the occasion of visits by Hurricanes Hazel in '54, and Connie in '55, in particular, Crisfield and its environs, along the tidewater streams, have suffered tremendous damages. These damages came from overflooding of tides, waves, winds, and accompanying unprecedented rainfall in this area. Where the valuation of the property is conservative, estimated at $27,000,000. We, representing the Mayor and Council of Crisfield, Maryland, the Better Crisfield Business Association, and the Lower Somerset County Flood Control Association present the following facts and data for consideration by your honorable body with the request that in your wisdom you advise and as far as possible under existing and future legislation, take measures to give us the relief we ask. (1) Normal tides in this area have a rise and fall of from 4 to 5 feet and pose no problem when the normal winds from 10 to 15 miles per hour prevail. However, during Hurricane Hazel in October '54, tides rose as much as 10 feet and wind velocity 110 miles per hour, according to U.S. Coast Guard in Crisfield. Hence property damage therefrom ran into an estimated Two and a Half Million Dollars in the Crisfield, Asbury, Lawsons and Brinkleys election districts. Through emergency relief in Crisfield, the Red Cross distributed $45,080 and insurance companies paid on properties covered something like, $500,000, with only about one-fifth of the damages covered by insurance, according to estimates. This does not

include damages to the soil. Much of the farmland is still out of production, entailing a hardship on many residents of these Districts. (2) Briefly, after considerable study, we present the accompanying 13 photographs that are indicative in part of wave and water damages along the waterfront of Crisfield and Vicinity. They show a condition that drew assistance from the United States Army, United States Navy, the American Red Cross, and Civilian Defense in October 1954. (3) Following Hurricane Hazel and Hurricane Connie in particular, our streams have had channels shifted and filled as evidenced by existing dredging projects and those contemplated in the area. (4) In particular, we desire your consideration on

a. Jetties for the Crisfield Harbor which, in your judgment, will protect our anchorage and dockings during a northwest blow giving a haven to waterborne properties in Apes Hole, Jenkins Creek, and Hospital areas.

b. Dredging of Cove Landing which has been approved, and of Jenkins Creek for adequate mooring of vessels.

c. Diking our tide-banking from Greater Annemessex River to Johnson's Creek. This would reestablish or supplant our old tide bank and diking systems that existed previously. I might add that previous construction was done by slave labor more than 100 years ago.

(5) We believe these projects will help to alleviate or prevent such a condition as prevailed during and following Hurricane Hazel when work on the water by oystermen, crab fishermen, and others were stalled for as much as three weeks holding the entire seafood industry in Crisfield - which is one of the greater producing areas of the Nation - at a standstill and inflicting an economic loss of inestimable value because this hurricane came at a season when the industry should have been and was enjoying its greatest activity.

DISTRICT ENGINEER: That two and a half million dollar damage - do you have any breakdown as to how much was caused by wind and how much by water?

MR. MCGRATH: This was given as an estimate by the insurance people, Colonel Smith. Some of these photographs which I have are indicative. The Civil Defense came along and helped relieve such conditions as those.

DISTRICT ENGINEER: We will study that and go over the insurance company's statistics, but I thought possibly you had some figures. Of course these photographs were taken not in contemplation of such a report but are indicative of things at random that happened. We brought them for you. Is there anyone else from the Crisfield area?

MR. MCGRATH: I have a group of gentlemen with me representing those associations - if you would like to count their noses or if you would like to see them.

DISTRICT ENGINEER: Would any of you gentlemen like to add anything further? NO ANSWER. Anyone else from Somerset County? NO ANSWER. Anyone from Worcester County?

I am JOSEPH G. HARRISON, Chairman, County Commissioners, Worcester County, Berlin. I have no papers to present. I only have a few words to say in reference to Worcester County. We of course, experienced all the hurricanes that have come by the East Coast in the past several years. I recall the first in 1933 which cut a very nice inlet at Ocean City and has done alot of economic good, but in the last two or three years, we experienced one or two bad hurricanes each year. The amount of damage done in Ocean City and other Worcester County points, I am not in a position to state in dollars and cents, however I am sure it runs in the millions. In Ocean City we have about 41% of our total assessable basis located from the Atlantic Coast on the east for a distance of 4 miles inland. 41% of our total assessment basis is real estate. That has not suffered in the last two or three years quite as bad as some other points in the county. As you know there are a large number of broilers grown in Worcester County and they seem to have taken a much worse loss on broiler houses and farm buildings than we really have along the coast. Now the water damage has been considerable along the shores of the Sinepuxent Bay, probably more than along the ocean. The ocean damage has not been quite so bad. However, there is quite a bit of erosion taking place at all points. The Federal Government has been working on a jetty at Ocean City, and there is much local thought that there should be an extension of the south jetty at the Ocean City Inlet or some means of protecting the northern section of what is known as Assateague Island. When we think of farm crops in these hurricanes which does not enter into this thing too much, but actually from a farming standpoint-fruit and vegetables, that total loss was probably as extensive as the personal property damage was. As I have stated before, Worcester County is being more and more dependent on tourists and resort business each year. More and more money is being invested along our ocean front and if there is any way to give more accurate reports as to hurricanes, I believe that is what our people in Ocean City would desire. Now they have thought the reports were inaccurate and exaggerated or at least the press statements were exaggerated but I cannot argue with a highly trained weather man as to the reports. Thank you.

DISTRICT ENGINEER: Thank you. Anyone else from Worcester County? NO ANSWER. Anyone from Wicomico County would like to say anything? NO ANSWER. Anyone from Dorchester County?

Colonel Smith, ladies, and gentlemen, I am Lester E. Hatton, Sr., Mardela, representing the watermen at Elliott's Island. At the time of these last storms they have had considerable damage done to boats due to the fact that they do not have adequate harbor. All they have is a channel dug in to the wharf which with a small basin on the inside, is not adequate enough to take care of a half-dozen boats. That wharf is facing the south winds. If the winds are blowing from 10 to 15 miles an hour, it is unsafe to try

to unload at this wharf. It has been approximately $10,000 damage during this last storm. Of all the boats there, there were only two left in the creek. One of them was capsized and the other seemed to be okay. The rest was washed in the woods or up on high land. It also done quite a bit of damage to drinking water to some of the people's wells which are shallow. They had to carry their water from their neighbors. What we would like, if it could be figured out, would be a proper channel dug in farther with an harbor that we might moor these boats to keep them from in a cove exposed to the south winds which has the whole range of Pocomoke Sound to work in time of any winds or storms. We figure that a channel about 500 to 700 yards with a harbor big enough to take care of 100 to 150 boats with a jetty opposite the wharf running out far enough to protect anyone loading or unloading at this wharf. Now this estimate is only what we could figure roughly is the damage done to boat property and loss of time in getting these boats off. The Government at the time sent the Engineers to other places but it so happens that the Elliotts did not receive any help at all. What they did, they got their boats off and paid for theirselves. We would appreciate anything that could be done by you, the Engineers, to go down there and check with these people for a better and adequate place for more protection during storms. I have a delegation with me if you would like, I would like to ask them to stand. (About 15 delegates stood).

DISTRICT ENGINEER: That is quite a delegation.

(C. NELTON GRAY of Elliott, Maryland) Colonel Smith, and other officials, ladies and gentlemen, I am not here to take issue with anyone or any group but I would like to refer back to Senator Beall's secretary who said that the extent of damage was done AFTER the storm. That may be on farms as far as salt on farms but when Hurricane Hazel came with us, the tide came with the wind and it was all done at once and receded at once. I believe he stated something about having refuge havens for instance dotted about where maybe boats on a certain tributary could all go in there. Was that the case?

MR. AHLERS: Yes, there would be harbors in many cases utilizing harbors that are already there. In your case improvement would be made on the harbors you have and if there are other harbors needed.

MR. GRAY: Well for instance if it's a rescue harbor on the bay and all boats from lower part and upper part and mid bay would have to go to that shelter during a storm. You see that isn't workable, plainly because people would have to go in the storm, when they could not reach there and they would have to leave their homes to carry their boats there. In order to take care of the working boats it must be at the place where they reside.

MR. AHLERS: We were thinking of these harbors in terms of improved weather reports where you would have at least six hours maybe twelve to eighteen hours of safe warning.

MR. GRAY: But if those harbors were dotted about, for instance, one on a bay to take care of that entire bay, it would not be workable. Now if it's where we are, where we reside, good and well that's what we want. In a particular place Colonel known as Apes Island we have a dredged project which is in your office and Mr. Reynolds you can consult him; we know him very well , that is known as McCready's Creek Project, and in fact I am one of the land owners who gave the land what we are seeking - that is inadequate for a harbor . It does not protect our boats; it only lets us in and out. As far as an harbor, we haven't got it. Colonel, I wish you would take this up with Mr. Reynolds. In addition, dig up in the marsh on that McCready's Creek project I would say about one-third of a mile or 4/10 of a mile then we come to a high hill then we dig the harbor, the hole see in the high land. This property can be acquired and access given to the Government to do this work what we have is inadequate; we have no boat protection at all. Our boats go adrift during storms. During August '33 we had the same thing. Losses and damage of boats let adrift same as Hazel. If you would, Colonel, I wish you would make note of that and take it up and see that addition is built on McCready's Creek on what we have and up in this land to take care of this situation where our boats could be protected. You can see how vital the seafood industry might be, vital to the economic stability of our State. I think the people are very deserving of that because it is the only way they have to make a livelihood. Their boats should be protected and what you can do for us in reference to that addition on McCready Creek Project, which you have in your office, we would appreciate very much.

DISTRICT ENGINEER: Thank you. Is there anyone here from Dorchester County?

Colonel Smith, ladies and gentlemen: My name is THOMAS G. DEAN from the Wingate Area which of course you remember was hit awfully hard in Hurricane Hazel and our most complaint is just about the Elliott's complaint- no place to harbor our boats. During that time all our boats went ashore - some cracked up but a lot were in pretty good shape. The Army Engineers came down and stayed approximately two weeks. As Civil Defense Officer in our District, I worked side by side with Lieutenant Jenkins for two weeks, to get those boats overboard and we do need a place we can put our boats so that when these storms come up we can put our boats there and they won't be washed ashore. Fortunately, mine came and wrapped herself neatly around an electric pole and stayed there on the road. But most of them weren't that fortunate . Some cracked up and some went into fields and it took quite some time to get them away. If any way possible, we have some nice places that would really make a nice harbor. It would be really nice if we could have a place dug out and jettied off so we could keep our boats moored. Another thing is communications service in our District, and in our particular district when the tide came the wind came. It all came together. The water was about 4 feet deep in my house and about that time the wind was blowing right along with it. So if any way possible, we would like to have some means

of communication with our neighboring town which is Cambridge, our closest place. I have a tower down there. I was in constant contact with the Air Force. I stay in the tower during hurricanes. Most of the time we lose all contact by telephone. We live in a rural district, the Department of Forestry has a little truck with a radio which is not very powerful. They bring that down. It helps a little but it is not very powerful. They bring that down. It helps a little but it is not very powerful. Between those two things, a place for our boats, and communications - that is just about our worse problem in the Wingate area. So anything that can be done would be deeply appreciated.

DISTRICT ENGINEER: Yes, communications during hurricanes is very important. Anyone else from Dorchester County?

I am MAYOR RUSSELL SMITH at Cambridge. My remarks will be very brief because at the present time we do not have adequate figures as to the amount of damage which the hurricanes have done. As a perfect example of that, approximately two years ago we made an investigation into the possibility of repairing our municipal yacht basin. The figure which we received and the estimate we received was approximately Thirty to Thirty-five Thousand Dollars. Just recently we submitted bids to have that work done and the lowest bid that we received was $66,000 and some; that is an increase of approximately Thirty Thousand Dollars which can be attributed a good amount to damage of hurricanes affecting us in recent years. I do not say that all of it is. Certainly some is due to normal wear and tear. The wind damage done by winds and by the tide in Cambridge; I want to make this clear that my remarks deal strictly with Cambridge and not surrounding areas because we have no way of obtaining those figures. The tide water, the rain water which accompanied the hurricane, and the winds which accompanied the hurricane, did a terrific amount of damage but not nearly so much as it had in other areas. We had a loss during the storm and shortly afterwards of the use of many of the utilities. We will not be able to furnish those figures because we do not own those utilities, water, electric, or telephone company. They would have to be furnished by the particular company. We have tried from time to time to get figures from the utilities but they do not like to let municipalities know what they make so the losses that they incurred will have to be gotten from them. The amount of damage which has been done to our streets, Colonel, is awfully hard to estimate at this time. We are still getting the normal number of potholes, but we are also finding and we are in a particular spot where it is rough on us for streets because many of our sewers are laying in quicksand or almost bottomless earth. The amount of washing we are getting under our streets - will be sometime before we can determine that amount of damage. Uprooting of trees caused a terrific amount of damage in the City of Cambridge. We are still getting affects from that. Trees were loosened, trees were split, but we knew nothing about it. From time to time we do feel the affects of it now. So, to cut my remarks short, my report will have to be of a necessity, speaking generally rather than specifically, and we will try as quickly as we possibly can to get some figures compiled for you.

DISTRICT ENGINEER: We would like to have it. Anyone else from Dorchester County?

NO ANSWER: Anyone from Talbot County? NO ANSWER. Caroline County?

NO ANSWER: Anyone else from Maryland would like to contribute anything?

I am LEVIN WALTER from Nanticoke, representing the West Side Lions Club. Our President called on me late yesterday evening and asked me if I would come here today and represent our Club today since he could not be here himself. As to the extent of our damage, I have no written report, no figures of any kind, but I can state a few facts that I happen to know. I am speaking of the water course. I say we have approximately an 8-mile stretch along the Nanticoke River. Shore erosion from storms Hazel and Connie was terrible. I might say it is pretty much the same thing the whole way along the shore. The whole damage was quite a bit but not as bad maybe as it was in other sections of our State. Speaking for Nanticoke Harbor alone. That was pretty well taken care of by the harbor we have. The only trouble is the harbor is not large enough and we don't have sufficient harbors along the river to take care of the boats we have there and boats that would like to come to us. There was considerable land damage done by tides, etc., as well other property damage. As I say, I don't have any figures. That is all I can give. We will be glad to make a report and will be glad to cooperate with you.

DISTRICT ENGINEER: Thank you. Anyone else?

I am CLAYTON A. DUKES of A. J. DUKES & SON of Girdletree, Maryland. We have had storms down there now ever since I can remember. I have been in business thirty years and the August storm came and took every building from that landing. I think the man who was up here a while ago, the County Commissioner, knows where we live. It took every building left from us. The Hazel storm in '54 took all our buildings and washed them six to seven miles they claim all over Chincoteague Bay. Can't even find them. Government men came down this summer from Washington and they recommended an harbor. I mean they just showed us where we could put one, 400 to 500 yards in shallow water. We just want a refuge harbor for these storms, just somewheres to put them in for just safeguard. We are right open to the Atlantic Ocean. There's 7 miles there. Southeast winds blowing 100 miles an hour, there ain't nothing can stand it. The building goes we just have to put it back that's all. I thought maybe you could do something that would help us. We have the land all picked out for the harbor and the Government men was down this winter from Washington about 2 months ago. They recommended where we could put it. You see we have floats and we have to get so far away from these floats and also they recommended where we could put it at. It would be 40 feet wide up there about 400 yards and it would be just a little harbor up there on the hill and would be a safe harbor for our boats. We lost several boats sunk during the last storm here in August during Connie.

DISTRICT ENGINEER: Thank you. Anyone from Somerset County?

Colonel Smith, ladies and gentlemen, I am Clifton S. Mister of the State Department of Labor and Industry, Asbury District; also a citizen of Somerset County all my life and have taken considerable amount of interest in welfare and conditions in general. During last Hurricane Hazel or even as far back as 1933 we have really suffered in lower Asbury as we border on Pocomoke Sound and Tangier Sound to the west. Either wind to the south or southeast or to the west, we are in for a lot of trouble on every high tide or storm especially hurricanes. Two nights ago I left this short note at a country store, and this will show the interest of the people in that locality: (Mr. Mister produced a paper and proceeded to read it. It contained about 115 or so signatures. (See EXHIBIT 7). (Copy of paper was handed to representative of Cong. Miller.) Now Mr. Joseph McGrath and Mr. Phoebus have gone into it very thoroughly but I feel they have just more or less included I'll say just the lower part of Asbury for protection against tides. In my travels around through the county, I find they have considerable tides from Shelltown which borders on the Pocomoke River which leads out into Pocomoke Sound, and much property has been destroyed from tidewater. Their soil their mainstay of their livelihood and they all seem to feel as I do and of course I'm sure the Corps of Engineers are capable of working out what we need. If we had a wall 10 feet high bordering 10 miles or more beginning at the Pocomoke River, that it would protect us from any inclusion of water from any type of storm and our homes would be more secure, and our future generations would be secure and the livelihood of the farmer would be secure. I would also like to mention the type of basin for the watermen of the Apes Hole Creek. They have no natural protection whatsoever. It's a wide open body of water a mile and a half across approximately 3 miles in length where the wind sweeps right across. Every boat was sunk during the Hurricane Hazel except one and there was much damage done to the boats. I would very much appreciate if that would be all taken into consideration and this work I hope will be carried through to a successful conclusion.

My name is PHILIP COOPER, City Engineer at Salisbury. I am representing the Mayor of Salisbury and I will make just a few very brief remarks that I would like to confine to the city. I am sure the Wicomico County suffered damages which would be entirely out of relation to the damages we suffered in Salisbury. The majority of damage that we had I lay to wind. I don't know what the Department of the Army can do with the wind. I guess we are more concerned really with what may happen than with what has already happened. During Hazel I expect we had our most devastating effects; we had trees on buildings, we had trees in streets. We had a major damage; - we had power lines all over the place. Fortunately we had no power, or we would have had a more dangerous situation. The tide damage was disturbing, disrupted traffic, but it was not financially bad for us as a community; it may have been to certain industries, but certainly not on a city-wide basis. I would not know how to estimate the damage that has been done by the various storms but I know that normally our Department of Public Works assumes the obligation and we clean up as best as we can and we may spend two to three weeks with all our force in cleaning up and if you so desire, we will attempt to estimate the amount and the type of damage. There was loss of life - two or three people I think were killed by collapsing building and wind-blown debris of various kinds and

that is always very serious. It seems to me possibly a service of disseminating information that we may take as good information, and not a great amount of warning that we do not know how to evaluate. I think an evaluating service may be of greater value than any other one thing to us at the moment. I do not know how that can be done. I know that Civil Defense will come into the picture. I also represent them in this area. I know the Weather Bureau turns out many reports, I know that the amateur ratio clubs have reports semi-military nature and public in nature. A composite of all these we can somehow draw a fair estimate of what the situation is a little ahead of time. We can just brace for it a little, but we can't help ourselves very much. That is about the way we see it.

DISTRICT ENGINEER: Thank you very much.

My name is ROBERT CHARLES LONG, President of Somerset County Commissioners of Somerset County. I would like to make a statement to the effect that Somerset County is a very small county. As far as assessable basis is concerned it is about - $20,000,000. The Supervisor of Assessors and myself approximated that $9,000,000 of that twenty was damaged by Hurricane Hazel either by tides or ruination of wells, or erosion, or something of that sort. Our main problem seems to be that the wells of two or three islands in Somerset County have been damaged beyond repair. They cannot seem to get water, they drive for water but can't seem to get it. I understand that's already been brought up. On the other hand I would like to mention especially on Smith Island the erosion there has been a pretty terrible devastating thing, especially on Rhodes Point. The waterfront there was practically washed away. Not on Ewell. Ewell of the three islands was not damaged as badly as Rhodes Point and Tylerton. But at Tylerton the wharves were damaged and torn down and the boats were torn up. I would like to close in saying I think maybe Somerset County is certainly to be watched if we continue to have hurricanes that we have been having.

DISTRICT ENGINEER: Thank you. I notice there are several state agencies represented here. Would they like to contribute anything? NO ANSWER. The Highway Department or the Health Department?

I am a representative of the Maryland State Roads Commission - William F. WALLER. I am sure none of us care too much for hurricanes and as far as the State Roads Commission is concerned, we always have damage when those storms come along. However, as far as washing out - I do not recall too much of that since the storm of 1933. The storm of '54, which was Hazel, I remember distinctly the extra work and the money spent to clear the roads and debris, and to check the erosion, amounted to $15,000 in the four counties down here. I will not agree with Harrison the County Commissioner of Worcester County. I would say that a most critical point or spot along the coast, including Crisfield and the Chesapeake Bay, is Ocean City. Especially in our summer season down there. These storms mostly come in August and anybody that's planning on going to Ocean City and they start hearing about the storms two weeks in advance, they change their plans immediately, and I certainly don't

blame them. The problem of the water down there - we have a road that parallels the beach and the State has constructed sand fences with the idea of trying to keep the ocean from coming over. They have recently put in about 50 jetties, I believe, to try to raise the beach up and check the ocean. So I would say these waterfront properties, Crisfield, on the Chesapeake Bay, and on the Atlantic Ocean, are the spots to be given a great consideration. Speaking about Ocean City, I think about that because I am familiar with it - I know what the conditions are - I know the public's reaction when these storms originate two weeks in advance. As Mr. Cooper said, the type of warning information we get, you don't know whether to pull out and leave, or stay because sometimes it misses and sometimes it doesn't. Anything to be done to clarify these things certainly would be appreciated.

DISTRICT ENGINEER: Thank you. Anyone else? Any other State or Federal Agencies represented?

VOICE: I would like to say something. I am H. L. ALKIRE of the Weather Bureau at Friendship Airport. There have been several references to the type of forecasts and evaluating what they mean. If there are no doctors here - we have a saying among ourselves, we put our mistakes on the front page and they bury theirs! In the past years we have had very much trouble keeping up with what is coming down from upstairs. We have had little money to go out and find out and try to find out what's happening to the water once it gets down, as a result, principally I would say on the damage in Narragansett Bay in the last two years the Weather Bureau has received additional appropriations to carry on extensive tide studies. Mr. Hoover from the Washington National Airport is concerned primarily with the Atlantic Coast and the Friendship Airport Weather Bureau is concerned with the Chesapeake Bay areas. Not the hardest part of giving you the information you want to know is forecasting it. Some of the hardest part is getting out of circulation previous forecasts and previous weather bulletins which come to you on radio. You listen to the radios. You listen to the different stations you tune around and you will find quite a lot of confusing talk. In other words one station is using the up-to-date forecast and another may be using one as much as 10 hours old. We know it happens in Baltimore and I suppose it happens everywhere. The announcer is going on the air and he sees this piece of paper it is a weather bulletin - he picks it up and reads it and pays no attention to how old it is. One of the main things we are working on now is to try to provide a means of eliminating that as much as possible. We have set up what we call a conference hook-up for emergency weather warnings by radio. We expect to do this by blanketing the entire state or a particular part of the state through a conference circuit. There are approximately twenty-four radio stations in the State, twenty-one of which have agreed to come into this conference network. What it will mean is that at certain stated times direct broadcasts from Friendship Airport to all stations will come to you at the same time. We hope that by doing this we will give the people the idea that this is the latest thing this is the official thing and anything to the contrary you

should investigate a little bit farther. We have done some work along the lines of tide forecasting and we are going to try to set up tide marks to give us exact heights of what some of the record tides have been in the past. That will come along later on. We realize there is still some confusion in this business and we are trying to eliminate it and now or later on I would like to talk with anyone who has any suggestions along that line or has any conflicting ideas about it since the last forecast.

DISTRICT ENGINEER: Does Mr. Hoover wish to say anything?

MR. HOOVER: I have nothing to add to Mr. Alkire's statements.

DISTRICT ENGINEER: Any other Federal Agencies? Mr. Johnston?

MR. JOHNSTON: No, I am just an observer.

DISTRICT ENGINEER: Mr. Johnston is from the North Atlantic Division Office of the Corps of Engineers, which covers this survey from New England all the way down through Virginia. Does anyone else have anything to contribute to the hearing? Anyone else?

I am HENRY HEGERFELD, Bureau of Bridges, State Roads Commission. I do not know whether I was authorized to talk for the chief engineer. We got his letter and he directed Mr. Grubb to tell me to come down here to attend the meeting. As you know - you don't know - I am with the Bureau of Bridges with the State Roads Commission. Whenever a bridge goes out it is up to us to get it back into condition and to get the road open, especially the State roads or U.S. highways. That is all we are concerned with. You have numerous roads that belong to the county and they are more under-designed than the state and U.S. highways. We build bridges to accommodate a 25-year storm. That is once every 25 years we expect the bridge to reach capacity as far as waterway area is concerned. Also, in times of depression where we have to build a bridge, a bridge will be built slightly under designed to keep the cost down. Now when it comes to time of flood or serious disaster, like we had in hurricane Hazel or Connie, I do not know what the anticipated flood category you would put Hazel in ... I would consider Hazel about a 100 year storm. I don't know what category it's fallen into and Connie I would consider on the average of about a 50 year storm. As you know, the rain does not fall all in the same place at the same time. When you have a hurricane it all depends on which side of the needle you are on. If you are on the easterly side of the needle your wind intensity is greater than on the westerly side. Also your rainfall will be considerably more probably on the easterly side. Now these are considerations that we - well when we design a bridge we don't figure out if a hurricane is going to hit here more prevalent than that, than it is somewhere else. I mean you never know where a hurricane is going to hit. She can come straight into Salisbury and get about 20 miles out of Salisbury and take a right-angle turn and head out towards the ocean. They are very indeterminate. We had considerable damage last summer at Point Lookout. Point Lookout is just a little spit of

land running out to a Coast Guard Station out there. It has about five or ten, twelve houses I think it is. It is down on the end of St. Mary's County. It washed out completely the causeway. The tides rose, to such an extent that it completely washed out the causeway. That is a state road and therefore it was up to us to go in and return the road to it's original position. I can get the figures for you on what repairing that road cost. We spent considerable time on it; I think we opened it in about three weeks after it washed out but it necessitated a tremendous amount of fill. We placed sandbags along parts of it and had to rebuild the road. The cost of those can be furnished to you. Also in St. Mary's County during the flood of 1933 - that was a tremendous flood - it washed out something like 50% of all the bridges in St. Mary's County, and that was up to the State Roads to put temporary structures in there to reopen the roads. Of course when you put a temporary structure in, you are just throwing money away to get the road open because they automatically have to be replaced by permanent structures. But you've got to weigh the economics of it whether it is worth it to open the road and get it open right away or wait until a decent structure and save that kind of money. Now in Charles County last summer we lost two bridges. They washed out due to underscouring of the abutments... They have both been replaced by temporary structures which in time of flood may go out again. If they do go out again, they probably will be replaced with another temporary structure until we can get around and get them on a schedule to replace them with a permanent bridge. It all depends on the necessity of the road to get it open. It is very hard to forecast where you are going to have to build bulkheads. We go in on numerous bridges. We go in if we know that a stream is subject to corrosion. You've seen it under numerous State bridges where we will actually construct the bulkheads completely around the abutments just to contain the stream in its original course. On the average, a bulkhead under a 2-lane road costs $15,000 to $20,000. We do not do that at every stream - it all depends on the type stream, where the stream is located, and the stream gradient. I will talk to Mr. Grubb and try to get some of these data for you in the form of a report to you. I think that about takes care of it.

DISTRICT ENGINEER: I would like to have it. Thank you. Anyone else have anything to contribute to the hearing? NO ANSWER. We appreciate everyone coming here, and giving views and ideas. We assure you we will follow the investigation through and prosecute it and hope to get you some favorable results.

MEETING ADJOURNED AT 2:30 p.m.

APPENDIX B

"A MODEL HURRICANE PLAN FOR A COASTAL COMMUNITY"

U. S. DEPARTMENT OF COMMERCE
Lewis L. Strauss, Secretary
WEATHER BUREAU
F. W. Reichelderfer, Chief

NATIONAL HURRICANE RESEARCH PROJECT

REPORT NO. 28

A Model Hurricane Plan for a Coastal Community

Prepared by the Weather Bureau in collaboration with the Corps of Engineers, U. S. Army, with the advice of other interested agencies and organizations, and in accordance with the authorization of Public Law 71, 84th Congress, First Session.

Washington, D. C.
April 1959

NATIONAL HURRICANE RESEARCH PROJECT REPORT

Reports by Weather Bureau units, contractors, and cooperators working on the hurricane problem are pre-printed in this series to facilitate immediate distribution of the information among the workers and other interested units. As this limited reproduction and distribution in this form do not constitute formal scientific publication, reference to a paper in the series should identify it as a pre-printed report.

No. 1. Objectives and basic design of the NHRP. March 1956.
No. 2. Numerical weather prediction of hurricane motion. July 1956.
Supplement: Error analysis of prognostic 500-mb. maps made for numerical weather prediction of hurricane motion. March 1957.
No. 3. Rainfall associated with hurricanes. July 1956.
No. 4. Some problems involved in the study of storm surges. December 1956.
No. 5. Survey of meteorological factors pertinent to reduction of loss of life and property in hurricane situations. March 1957.
No. 6. A mean atmosphere for the West Indies area. May 1957.
No. 7. An index of tide gages and tide gage records for the Atlantic and Gulf coasts of the United States. May 1957.
No. 8. Part I. Hurricanes and the sea surface temperature field.
Part II. The exchange of energy between the sea and the atmosphere in relation to hurricane behavior. June 1957.
No. 9. Seasonal variations in the frequency of North Atlantic tropical cyclones related to the general circulation. July 1957.
No. 10. Estimating central pressure of tropical cyclones from aircraft data. August 1957.
No. 11. Instrumentation of National Hurricane Research Project aircraft. August 1957.
No. 12. Studies of hurricane spiral bands as observed on radar. September 1957.
No. 13. Mean soundings for the hurricane eye. September 1957.
No. 14. On the maximum intensity of hurricanes. December 1957.
No. 15. The three-dimensional wind structure around a tropical cyclone. January 1958.
No. 16. Modification of hurricanes through cloud seeding. May 1958.
No. 17. Analysis of tropical storm Frieda, 1957. A preliminary report. June 1958.
No. 18. The use of mean layer winds as a hurricane steering mechanism. June 1958.
No. 19. Further examination of the balance of angular momentum in the mature hurricane. July 1958.
No. 20. On the energetics of the mature hurricane and other rotating wind systems. July 1958.
No. 21. Formation of tropical storms related to anomalies of the long-period mean circulation. September 1958.
No. 22. On production of kinetic energy from condensation heating. October 1958.
No. 23. Hurricane Audrey storm tide. October 1958.
No. 24. Details of circulation in the high energy core of hurricane Carrie. November 1958.
No. 25. Distribution of surface friction in hurricanes. November 1958.
No. 26. A note on the origin of hurricane radar spiral bands and the echoes which form them. February 1959.
No. 27. Proceedings of the Board of Review and conference on research progress. April 1959.

USCOMM-WB-DC

PREFACE

The model community hurricane preparedness plan which follows is intended to offer local authorities in cities and communities along the Gulf of Mexico and Atlantic Coasts vulnerable to hurricanes suggestions as to planning and organization to minimize hurricane losses.

The value of advance planning for effective action in emergencies is widely recognized. Leadership in preparation for hurricane emergencies must come principally from local authorities. They direct municipal and community planning, control most of the facilities which would be used in meeting an emergency, possess the necessary detailed knowledge of the local area, and have the immediate responsibility for the welfare of their community and its residents.

The principal factor that discourages community hurricane preparedness planning has been the difficulty of evaluating the risk of a hurricane disaster. Some coastal cities have not been visited by a severe hurricane within the lifetime of most, if not all, their residents. Statistically the risk to a given locality will be small. On the other hand the destruction wrought by a hurricane, when it does occur, can be tremendous and in many coastal areas the potential for loss of life and property in a severe hurricane continues to increase year by year. It is therefore believed that the time and effort spent in developing and maintaining a realistic community hurricane preparedness plan is definitely worthwhile.

The hurricane preparedness plan presented herein is for a fictitious city, Homeport, in Achilles County, on the Atlantic Coast. The plan is equally applicable elsewhere. The plan deals with real hazards associated with hurricanes and shows what might be done to minimize death and destruction.

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HOMEPORT - GENERAL INFORMATION

Homeport, with a population of about 25,000, is laid out on land ranging from 3 to 20 ft., m.s.l. The eastern edge of the business section is about 500 ft. from the beach and lies in the 5-10 ft. m.s.l. range.

While Homeport is an old city, it is progressive. There are at least six fairly new office and store buildings with two to four floors that have been designed to withstand severe hurricanes and floods. The oldest part of the city is on the beach. Most of the stores and homes are one-story frame buildings constructed long before any stringent building codes were in effect. The most exposed part of the city is the residential section known as Homeport Beach, (pop. about 700), located on a key about one mile from the mainland. A two-lane causeway about 4 ft. above mean high water connects it with the rest of the city. A drawbridge on this causeway has to be raised for almost all boat traffic. The highest elevation on the key is 5 ft. m.s.l. Almost all homes are small one-story wooden buildings of relatively light construction.

The city is well managed. It has adequate police and fire protection and public transportation (busses). It operates a marina, which is in a small lake about 2 miles inland on the northern edge of the city. The inlet to the lake is shallow and at mean tide accommodates boats drawing less than 4 ft. Practically all locally owned smaller pleasure boats are kept at the marina. The larger fishing craft and yachts are usually tied up at the beach piers near the mouth of the inlet.

The electric power (Diesel-operated) and gas plants are in the older section of the city on land 6 ft. m.s.l. The power lines are generally overhead except in the business section and in the newest residential areas. The only radio station (WXYZ) in the city is located in the business section atop one of the most substantial buildings in the city, the four-story Triangle Building. Unfortunately, it has no standby power plant. The local Civil Defense and Red Cross Units are well organized and active.

1. HURRICANE PREPAREDNESS COMMITTEE

1.1.1 A permanent Hurricane Preparedness Committee is hereby set up to provide the city of Homeport and suburban communities with adequate protection to minimize death and property losses usually associated with hurricanes. This Committee consists of the following:

City Director, Civil Defense, Chairman

Mayor
County Director, Civil Defense
Chapter Chairman,
Homeport Chapter, Red Cross
District Chief, State Police
Sheriff, Achilles County
Chief of Police
City Engineer
Supt. Public Works
Supt. Street Dept.
Supt. Schools

Disaster Chairman,
Homeport Chapter, Red Cross
Newspaper official
Telephone Co. official
Power & Gas Co. official
Manager, Public Transit
Local representative of press,
National Assoc. of Broadcasters,
and of American Radio Relay
League

The following state and area officials have agreed to be available for consultation by the Committee and to serve in a liaison capacity to the Committee when requested:

Governor's representative
State Director, Civil Defense

Disaster Service Representative,
Red Cross
Director, State Public Health

The following federal officials have agreed to be available for consultation by the Committee and to act in a liaison capacity when requested:

Meteorologist in Charge,
Weather Bureau Airport Station,
Homeport
Area Engineer, Corps of
Engineers, Homeport

Commanding Officer, U. S. Coast
Guard Station, Homeport
Commanding Officer, Inland
Air Force Base

1.1.2 The Committee has the following responsibilities for the Homeport Hurricane Preparedness District (Chart 1):

(1) To direct a program designed to educate the public on the hazards of hurricanes and the protective measures to be effected.

(2) To keep the city and suburbs continually prepared for a hurricane emergency.

(3) To make recommendations regarding construction projects and changes in building codes required to lessen danger and destruction from

hurricanes.

(4) To effect evacuation when authorized.

(5) To direct rescue work.

1.1.3 The Committee shall meet as often as need indicates until a satisfactory preparedness plan has been completed. Thereafter the Committee shall meet at least once a year just before the beginning of the hurricane season (early June) to review the plan and to make sure each member is well acquainted with the duties his organization is expected to perform in case of emergency. In other words, this meeting is in the nature of a "dry run". Other meetings shall be called as required. The Committee shall convene every time a HURRICANE WATCH indicates a threat to its area of responsibility, or earlier when suggested by the Weather Bureau's local Meteorologist in Charge, and will remain in session or on call until the emergency or threat is ended.

1.1.4 The Chairman of the Committee, the Mayor, and the County Director of Civil Defense will function as an executive group of the Hurricane Preparedness Committee to oversee the execution of evacuation plans and to deal with other emergency matters which may arise and require immediate decision and which are not otherwise provided for in the plan. The final authority for execution of evacuation plans in the City is the Mayor and in the County the County Director of Civil Defense.

2. APPRAISAL OF POTENTIAL DANGER

Introduction

2.1.1 The Homeport area has been particularly fortunate in that it has not been visited by disastrous hurricanes for many years. However, this is no indication that it is immune to hurricane disasters. The Atlantic coast has been visited many times by hurricanes, and the losses in life and property have both been tremendous. These losses would have been much greater had not protective measures been taken. The losses would have been still less had today's hurricane warning facilities been available for tracking and predicting the behavior of all these hurricanes. The best hurricane warning service in the world is of little use, however, unless adequate protective measures are taken. Experience has disclosed the type of information required for the planning of adequate protective measures. This report contains the necessary information for the preparation of such a plan. The large increase of population and property value in the Homeport area during recent years makes a hurricane preparedness plan more important than ever.

Coastal Hurricanes

2.2.1 An opinion of the degree of disaster associated with hurricanes can best be obtained by a review of major coastal hurricanes of recent years.

The hurricane of September 18-20, 1926, is said to have been one of the most destructive hurricanes of the century. The property damage was estimated at $100,000,000. Approximately 4700 homes were destroyed and 9100 damaged. The Red Cross estimated that 15,700 families were homeless. The storm tide was 10.5 ft. m.s.l.

2.2.2 Second only to the Galveston, Texas, hurricane of September 8, 1900, in order of deaths was the hurricane of September 15-17, 1928. The Red Cross estimated 1836 lives lost, 1870 injured, and property damages of $25,000,000. Loss of life and property resulted mainly from waters of Lake Okeechobee overflowing the southeast bank. Winds were in excess of 100 mph.

2.2.3 Hurricane "Carol" crossed Long Island and southeastern New England August 31, 1954 causing enormous destruction to communication and power lines, buildings, automobiles, small craft, marine facilities, and crops. The hurricane moved inland at time of normal high tide resulting in extensive coastal flooding. Property losses were estimated at over $400,000,000.

Hurricanes Affecting Homeport Area

2.3.1 Some residents of the Homeport area believe that the area is immune from hurricanes. This belief has no scientific basis. This area has come under the influence of several hurricanes during the period of record. That none of these hurricanes passed directly over Homeport and that those coming very near were of relatively weak intensity is merely due to chance.

2.3.2 On October 2, 1898 a hurricane entered the coast within 70 miles of Homeport. The resulting high water at Goodhaven, 35 miles north of Homeport, reached 10.8 ft. m.s.l. or 7.8 ft. above mean high water. Luckily, this was not a particularly potent hurricane. Its lowest pressure was only 28.82 inches, as compared with 26.35 inches for the Labor Day Hurricane of September 2, 1935; 27.66 inches for hurricane "Hazel" of October 15, 1954; 27.62 and 27.59 inches for the hurricane of September 15-17, 1928, and September 18-20, 1926, respectively.

2.3.3 Other hurricanes have entered the coast not far from Homeport, but Homeport and vicinity have thus far been particularly fortunate in not having had to bear the brunt of a direct hurricane assult during the period of record.

Storm Tides and Floods

2.4.1 Storm tides and floods, which account for over three-fourths of the deaths and much of the destruction associated with hurricanes, deserve special attention. Much of their destructiveness results from the rapidity of rise in the tide. Studies indicate a relation between the central pressure of the hurricane as it enters the coast and the maximum departure of the tide from its normal value along the open coast. The relation, which indicates a maximum storm tide of 20 ft. for the minimum observed pressure of record, 26.35 inches, is valid only for tides on the open coast. Near the head of an estuary the highest tides may be as much as twice the height of those on the open coast.

2.4.2 The highest tide of record in the Homeport area is the 10.8 ft. m.s.l. observed at Goodhaven during the October 2, 1898 hurricane described above. Homeport, itself, has a fairly short record of tide measurements. The longest record (12 years) is at the Municipal Pier, which recorded a record maximum of 5.0 ft. m.s.l. in connection with the October 18, 1950, hurricane.

2.4.3 It is estimated that a hurricane like "Hazel" which passed over Myrtle Beach, South Carolina, on October 15, 1954, could produce a storm tide of 13 ft. if located directly over Homeport. If this storm tide coincided with the mean high water level, the storm tide would reach 16 ft. m.s.l. While a tide of this magnitude would undoubtedly be a rarity for Homeport, it is possible. Protective measures should be taken with this possibility in mind.

2.4.4 The intense rainfall associated with hurricanes could cause all streams in the county to overflow their banks and swamp water levels could be raised as much as 2 ft.

Wave Heights

2.5.1 The wave heights that might occur along the beach are dependent upon the topography of the ocean bottom near the beach, wave direction, depth of water, and the direction, speed, and duration of the winds. The waves are not limited to the actual vicinity of the hurricane but may be hundreds of miles away. On September 8, 1951, 11-ft. waves were observed at Melbourne Beach, Florida, with the hurricane still 700 miles away. At Homeport Beach the waves would probably break offshore. Studies indicating wave heights to be limited to about three-fourths of the water depth suggest that wave heights of the order of 12 ft. could be expected at the mean shore line with a 16-ft. storm tide.

Wind Speeds

2.6.1 Maximum wind speed to be expected at the shore line is 150 mph -- in an onshore direction. Duration of winds of 60 mph or higher could be as much as 8 hours.

Delineation of Predicted Threatened Areas

2.7.1 The extent of coast line endangered by an approaching hurricane can be estimated on the basis of forecasting experience. The accuracy of Weather Bureau forecasts of Atlantic hurricanes in the period of 1950-56 indicates that protective measures must be initiated over 250 miles of coast line at least 12 hours and over 150 miles at least 6 hours before the hurricane is forecast to cross the coast to insure that the area affected by the hurricane is protected about 90 percent of the time.

Emergency Control Center

2.8.1 The Homeport Hurricane Preparedness Committee has established an Emergency Control Center at Burr High School. Direct underground telephone lines connect the Center with all agencies represented in the committees.

The Center is equipped with several battery-powered radio receivers to receive broadcasts on all assigned wave lengths and with two receivers adapted for CONELRAD monitoring. A monitoring unit will listen to and record on tape all broadcasts from all sources serving the area in order to ascertain that the hurricane information being broadcast is based on the latest official information. Stations broadcasting obsolete information will be immediately informed of the latest releases available. Those broadcasting unofficial hurricane information will be asked to broadcast official releases only. If they persist, they will be asked to announce very clearly that the information is unofficial and to name the source of the information.

2.8.2 The Center has no transmitting equipment of its own, but Commercial Station WXYZ and the police and fire department transmitters have direct line microphones at the Center so direct broadcasts are possible. In emergencies, Civil Defense, police and fire department mobile transmitters will be stationed at the Center to insure against breakdown of communications should other means fail.

2.8.3 Burr High School has set up a meteorological station for instruction purposes. This makes a very convenient auxiliary weather station that can be activated during emergencies.

2.8.4 The Center is also equipped with sufficient portable battery-powered lamps to provide good lighting if power fails.

Emergency Communications Network

2.9.1 Commercial Station WXYZ is the only station in the vicinity. Its management has agreed to broadcast all information provided by the Committee during an emergency. While the station is usually permitted to operate only from 6 a.m. to midnight, broadcasting on a 24-hour basis during emergencies has been approved. The emergency is considered to begin when a HURRICANE WATCH indicates a threat to the Homeport area. Unfortunately, Station WXYZ has no standby power plant. In the event of a power failure, Station WMET at Metropolis has agreed to broadcast all information presented by the Homeport Hurricane Preparedness Committee. The information would be sent to WMET via police teletypewriter and radio and Civil Defense radio. Both stations WXYZ and WMET have agreed to preface emergency weather warnings with the CONELRAD attention signal when so requested by the Weather Bureau.

2.9.2 Tape recordings should be made of all broadcasts and retained for at least two weeks after the emergency has ended. These tape records would be very useful in an investigation of a disaster. Failure to transmit warnings properly is a frequent complaint. More often than otherwise, such a complaint is not justified, and the tape record would help to vindicate the source of the warning and the broadcasting station should they be criticized.

2.9.3 All organizations, offices, and agencies represented in the Homeport

Hurricane Preparedness Committee are equipped with CONELRAD alert receivers. Consequently, they can receive emergency weather warnings broadcast following the CONELRAD attention signal at any hour of the day or night.

2.9.4 Mobile communications equipment, together with operating personnel, is kept in a ready status at Coast Guard District Headquarters and some other Coast Guard units within the District. This equipment varies in size from hand portable type to a completely self-contained communications truck. The Coast Guard District Commander will deploy this equipment to assist Homeport and other communities. Available equipment will be deployed so as to insure maximum effective utilization throughout the threatened area.

2.9.5 The Coast Guard Station maintains a two-way radio station which can be utilized until evacuation becomes necessary. (Many are included in teletypewriter distress net.)

Safe Buildings

2.10.1 The City Engineer has indicated to the Red Cross the following buildings as being suitable for shelter purposes for various degrees of potential danger.

Expected Tide Height (ft., m.s.l.)
(Assuming maximum wind speeds and wave heights consistent with tide)

Section of City	4-8	9-12	13-16
Downtown	Acme Bldg. Apex Bldg. Triangle Bldg. King Hotel Adams Hotel Christ Church	Acme Bldg.* Apex Bldg.* Triangle Bldg.* King Hotel* Adams Hotel* Christ Church	Acme Bldg.* Apex Bldg.* Triangle Bldg.* King Hotel* Adams Hotel*
North End	City High School Masonic Hall Gem Theatre	City High School Masonic Hall Gem Theatre	City High School* Masonic Hall*
South End	City Hall Court House Elementary School Armory	City Hall* Court House* Elementary School Armory	City Hall* Court House*
The Ridge	Burr High School First Church City Hospital City Auditorium Primary School	Burr High School First Church City Hospital City Auditorium Primary School	Burr High School First Church City Hospital City Auditorium Primary School

* Denotes "above first floor."

Evacuation Areas, Shelters, and Routes

2.11.1 The City Engineer has prepared 5 maps showing areas to be evacuated when expected tide height is (a) 4-8, (b) 9-12, and (c) 13-16 ft. m.s.l. Locations of shelters, emergency bus loading points, and routes are also shown. These maps have been printed and distributed to all residents of the Homeport area. Additional supplies of these maps, revised if necessary, will be printed and distributed in early June of each year.

2.11.2 The large number of persons to be evacuated under Plan C necessitated setting up shelters outside Homeport. Arrangements have been made with the officials of the towns of Fairhaven, Mound City, and Crossville for the use of their schools as shelters.

Contamination of Water Supply

2.12.1 The old city water supply plant in the North End would be contaminated if tides exceeded 8 ft. m.s.l. The new plant on The Ridge would retain its normal purity even with the highest possible tides. The temporary elimination of the old plant would necessitate drastic rationing of water, but there would be enough to supply the entire city with enough water for drinking and cooking until the old plant could be reactivated.

2.12.2 Flooding of wells or septic tanks would contaminate well water. Consequently, such water should not be consumed until purified. Care should be exercised as the contamination could occur even though the storm tide might not be high enough to endanger the homes themselves.

3. CONTINUAL PREPAREDNESS

3.1.1 The Emergency Control Center and emergency radio network will be checked in early June and monthly throughout the hurricane season to insure that everything is in readiness for an emergency. The Hurricane Preparedness Committee has also set up a program of public education and precautionary measures for the purpose of minimizing hurricane hazards.

Public Education

3.2.1 Radio Station WXYZ will present in late May and early June of each year a series of at least five 15-minute broadcast interviews with authorities on various phases of hurricane preparedness. The Superintendent of Schools is directed to instruct his teachers to inform their charges of these radio broadcasts and to quiz them on the information broadcast. The Homeport Herald will publicize these broadcasts and publish summarizations of the interviews.

3.2.2 When the Hurricane Preparedness Committee meets in early May, it will hold at least one evening meeting where several members or guest hurricane disaster experts can review the local hurricane problem for the public and answer any questions that might be asked.

3.2.3 The broadcasts and newspaper articles should include mention of continual precautionary measures that not only tend to reduce danger and damage during an emergency but to maintain properties from depreciating through neglect. The public will be asked to take the following precautionary measures:

1. Check homes. Secure loose shingles. Repair window shutters and shaky chimneys.

2. Check yards. Trim or remove dead or dying trees. Anchor removable objects such as dog houses, chicken coops, lumber piles, etc.

3. Maintain supply of boards for boarding up picture and show windows.

4. Always keep at hand at least one flashlight in good condition.

5. Promptly raze condemned buildings.

6. Obtain radio receivers equipped as CONELRAD monitors and battery-powered sets for emergency use.

3.2.4 Also to be broadcast and published are instructions on what should be done when a hurricane is expected to strike the area. These include the following:

1. Keep your radio or television on and listen for latest Weather Bureau warnings and advisories. If power fails, use your car radio or other battery-powered receivers. Keep radio tuned in on WXYZ and observe its instructions. Keep CONELRAD monitors on at all times if not actually listening to broadcasts. Keep your radioless neighbors informed. All persons operating small boats and vessels maintain guard on calling and distress frequency 2182 kc for warnings and advisories. Those without radios maintain lookout for signals or messages from Coast Guard vessels or aircraft. Return to safest mooring available and secure all equipment possible.

2. Avoid being misled by rumors.

3. Get away from low-lying beaches or other locations which may be swept by high tides or storm waves. If passage to high ground is over a road likely to be under water,

leave early. Don't run the risk of being marooned.

4. If your house is out of danger from high tides and is well built then it is probably the best place to weather the storm. However, please act promptly if asked to evacuate.

5. Be alert for high water in areas where streams or rivers may flood after heavy rains.

6. Board up windows or put storm shutters in place. Use good lumber securely fastened. Makeshift boarding may do more damage than none at all. Have strong bracing for outside doors.

7. Get in extra food, especially things which can be eaten without cooking or with very little preparation. Electric power may be off and you may be without refrigeration. Place dry ice in deep freezers and refrigerators to keep food from spoiling.

8. If emergency cooking facilities are necessary, be sure they are in working order.

9. Sterilize the bathtub, jugs, bottles, cooking utensils, and fill with drinking water, as city water service may be interrupted and wells may be polluted.

10. If in one of the evacuation areas, move furniture and other valuables to upper floors to minimize flood damage.

11. Have flashlights and/or other emergency lights in working condition and keep them handy.

12. Be sure to have gasoline in your car. If electric power is off, filling stations may not be able to operate pumps for several days.

13. Check on everything that might blow away or be torn loose. Garbage cans, garden tools, toys, signs, porch furniture, awnings, and other objects become weapons of destruction in hurricane winds. Store them all inside if possible.

14. Be sure that a window or door can be opened on the lee side of the house . . . the side opposite the one facing the wind.

15. Make provisions for children and adults requiring special diets. If anyone in your home has to be removed by ambulance, phone the Emergency Control Center, EM 1-1111.

16. If possible, arrange for the safe keeping of pets and other animals by friends living in quarters that will not have to be evacuated. No pets or animals of any kind will be allowed in evacuation busses or trucks nor in shelters.

17. If the center or "eye" of the storm passes directly over, there will be a lull in the wind lasting from a few minutes to half an hour or more. Stay in a safe place. Make emergency repairs during the lull if necessary, but remember the wind will return suddenly from the opposite direction, frequently with even greater violence.

18. Be calm. Your ability to meet emergencies will inspire and help others.

19. When your Hurricane Preparedness Committee advises evacuation, follow instructions promptly.

    a) Shut off main gas valve and pull main switch before leaving home.

    b) Head for the proper shelters or evacuation points indicated for your area. (These are shown on your Evacuation Maps, but the information will also be broadcast at the time of emergency.) Bring whatever clothing is absolutely necessary but do not try to bring household equipment. Follow routes indicated on maps. Drive right up to shelter entrance, unload, and park car as police instruct. If on foot, proceed to nearest loading station and board busses. No fare will be charged.

c) Evacuated areas will be policed to prevent looting.

d) At shelter, follow instructions of Red Cross personnel in charge. Volunteer your assistance, especially if you are a doctor or nurse.

e) Remain at shelter until informed that you may leave. Re-entry into evacuated areas will not be permitted until Public Health officials and building inspectors have had a chance to make their inspections and have given their approval. Evacuees will then be given passes providing for re-entry into the areas from which they were evacuated.

f) Keep calm at all times. If instructions are observed promptly, there is little personal danger involved. The local hazards from hurricanes have been carefully evaluated, and the measures taken for your protection have been well planned.

Precautionary Measures

3.3.1 The precautionary measures to be taken were mentioned above under Public Education. The city will keep its buildings and trees in good order. The Tree Division of the Street Department will trim or remove privately owned trees at cost. The Fire Department will make a survey of the city in the early part of the year and notify home-owners of trees, chimneys, etc. that need attention. The City Engineer will check to see that all gas and gasoline storage tanks and radio towers are securely anchored to prevent dislocation by wind or flood. The Police Department will enforce City Ordinance No. 492, which obligates owners of condemned buildings to have them razed within 90 days of Condemnation Notice. The Public Works Department will ascertain that all drawbridges and piers are in good condition before the beginning of the hurricane season. The Street Department will schedule its maintenance so that no evacuation route has to undergo extensive repairs during the hurricane season.

Planning and Construction to Minimize Hazards

3.4.1 Until there are enough shelters in the Homeport area to accommodate all its evacuees, future city and county buildings will be built so they can serve as hurricane shelters. The new one-story Junior High in the North

End is useless as a shelter because its floor would be under water with a tide of only 7 ft. m.s.l. Furthermore, the large glass panels, which make up most of the walls, would offer a real hazard in a high wind. New buildings will be limited to ordinary-sized windows with walls to be of solid construction. All buildings on land that might possibly be flooded will have at least one floor above the highest possible tide height. The City Engineer will work with the Planning Commission on a revision of the building codes for all types of buildings including homes.

3.4.2 The new coastal 4-lane highway (Route 17) providing main exits to the north and south of Homeport is bottlenecked on the north end of the city by the 2-lane drawbridge across the inlet to the marina. Steps have been taken to replace this bridge with a raised, fixed 4-lane structure, which will allow most boats to pass underneath. Boats with masts over 20 ft., of which there are no more than six now using the marina, will have to tie up at the ocean piers.

3.4.3 The power plant is in a fairly vulnerable location. If it is ever relocated, it should be built on higher ground well removed from the water front. The Homeport Power and Gas Company estimates that the output of the plant will have to be increased in about two years and has agreed to build the new auxiliary plant on the western edge of the city on land now owned by the city. This plot is about 15 ft. m.s.l. and is 2 miles from the beach. All buildings set aside for shelters, the hospital, Emergency Control Center, and Station WXYZ will be supplied with electricity by underground cable from the new power plant. The possibility of power failure at these important posts during an emergency would be practically eliminated.

3.4.4 New sewers and septic tanks will be designed and located so as to minimize the health hazards associated with their malfunctioning during high storm or hurricane tides. Wells will be designed and located to minimize risks of pollution from malfunctioning sewers or septic tanks.

Military Assistance

3.5.1 Military assistance from any of the branches of the Armed Forces is furnished under the responsibility of the Department of the Army; this responsibility has been delegated to Army Commanders having jurisdiction over continental army areas. Direct assistance from local military installations is authorized when extreme emergency conditions do not permit delay for receipt of instructions from higher authority, and local officials are unable to cope with the situation. The primary objectives in supplementing local resources are to save lives, prevent suffering, and reduce damage to Federal property, without assuming functions which normally are performed locally. Military assistance does not extend to rehabilitation, except as requested and authorized by the Office of Civil And Defense Mobilization. Liaison with military forces will be maintained through the Commanding Officer, Inland Air Force Base, Homeport. Motion pictures and other instructive material regarding military assistance may be made available through request to the State Civil Defense Director.

4. EXECUTION OF EMERGENCY PREPARATIONS

4.1.1 When a HURRICANE WATCH is issued for the Homeport area, the local Weather Bureau Office will immediately notify the chairman of the Hurricane Preparedness Committee. The chairman will call an immediate meeting of the Committee to review preparations for emergency procedures.

> HURRICANE WATCH: An announcement issued by the U. S. Weather Bureau to the public and all other interests via press and radio and television broadcasts whenever a tropical storm or hurricane becomes a threat to a coastal area. The "Hurricane Watch" announcement is not a warning; it indicates that the hurricane is near enough that everyone in the area covered by the "Watch" should listen for subsequent advisories and be ready to take precautionary action in case hurricane warnings are issued.

4.1.2 The Weather Bureau will immediately send emergency assistants to supplement the staff at the local office. No local action is required to effect this. The local office will notify all on its hurricane alert list.

4.1.3 The Fire and Police Departments will place all their personnel on 24-hour on-call duty and recall those who might be on leave outside the area. They will also check all equipment.

4.1.4 All members of the emergency communications network will be notified to prepare for emergency procedures. The Homeport Herald and Station WXYZ will publicize the threat and issue new warnings promptly. Only official Weather Bureau warnings will be publicized.

4.1.5 The disaster representative of the Red Cross will call in reinforcements from cities outside the threatened area.

4.1.6 Both railroad companies operating in the area will move all rolling stock in the yards to inland cities. Both airlines serving the area will give priority on incoming reservations to representatives of the Weather Bureau, Civil Defense, Red Cross, Corps of Engineers, State and local police, local firemen, Florida National Guard (Homeport's Co. G), and Homeport Coast Guard Station.

4.1.7 The Homeport Coast Guard Station, assisted by the Coast Guard Auxiliary, will notify all ships tied up at the piers or anchored offshore of the threat. The Coast Guard District Radio Station, plus any other Coast Guard Radio Station designated by the Commander of the Coast Guard District will broadcast warnings and advisories on standard marine frequencies. Coast Guard aircraft from the nearest Coast Guard air unit will cover coastal and inland waterways and isolated land areas, dropping messages to vessels and persons who may not have received warnings by any other method.

4.1.8 The Homeport Transit Company will ready all its spare busses and alert its spare drivers.

4.1.9 The CAP will patrol the coastal area to ascertain that warnings have been heeded. Any boats that are not headed for Homeport will be reported immediately to the Coast Guard by radio.

4.1.10 State Police will set up check points on main highways leading into threatened area to control entry and re-entry. The Homeport Hurricane Preparedness Committee will issue special passes to persons who have to pass through the police lines in the performance of their emergency duties. Evacuees will receive another type of pass so they can be the first to re-enter the evacuated areas after decontamination forces and building inspectors have indicated that re-occupation is safe. The State Police will also patrol the beaches (outside the city limits) 20 miles north and south of Homeport to warn beach campers to leave.

4.1.11 The County Sheriff will send his force out to alert all exposed settlements and trailer camps to maintain a constant radio watch for further instructions. They should also be told where to go if they are warned to evacuate. The settlements and trailer camps to be alerted are indicated on the evacuation maps, but there is a list posted in the Sheriff's Office of the settlements for which he is responsible. The Sheriff's men should also be on the lookout for temporary settlements or trailer camps of roving fruit-pickers which are not shown on the map.

4.1.12 The highway, street and public works departments will take immediate steps to open all streets and roads where construction or repairs are in progress. Where this is not possible, the street or road will be barricaded at an intersection, so as to avoid a dead-end, and DETOUR signs prominentl posted. Heavy movable equipment, such as bulldozers, rollers, earth movers, etc., will be taken to the city lot on the western edge of the city.

4.1.13 Each of the agencies involved in the emergency preparations has a schedule of the actual duties it is expected to perform. These schedules will be followed to the letter unless countermanded by the Hurricane Preparedness Committee because of some unpredictable development.

5. EXECUTION OF EMERGENCY PROCEDURES

5.1.1 Emergency procedures will be initiated when a HURRICANE WARNING indicates a hurricane will reach the Homeport area within 24 hours.

> <u>HURRICANE WARNING</u>: A warning indicating that hurricane winds of 74 miles per hour (64 knots) or higher or a combination of dangerously high water and very rough seas (with winds as low as 60 miles per hour) are expected in a specified coastal area. When a Hurricane Warning is announced hurricane conditions are considered imminent and may begin immediately or at least within 24 hours. It is of utmost importance that precautionary actions be instituted immediately when a Hurricane Warning is announced.

5.1.2 The radio emergency network will go on emergency schedule and operate continuously until the emergency has ended. Broadcasts will be made directly from the Emergency Center and Weather Bureau Office. The following agencies will each station one mobile broadcast unit in the parking lot at Burr High School: Civil Defense, city police, state police, sheriff's office, fire department, and power company. These mobile units will enable the Emergency Control Center to keep in direct touch with all emergency groups at all times.

5.1.3 The broadcasts should remind the public to remain calm, to remain at home, to stay tuned in continuously, and to begin precautionary measures. The following information will be broadcast:

1. "Hurricane Safety Precautions", U. S. Weather Bureau, 1958

2. "Hurricane Preparedness in Homeport, " Homeport Hurricane Preparedness Committee, 1957

3. "Tornado and Hurricane Tips", American Red Cross (4 1/2 minute tape recording)

5.1.4 The broadcasts will also remind the public to call EM 1-1111 if there are any invalids, aged, or infirm to be moved by ambulance in case of evacuation.

5.1.5 All official Weather Bureau warnings and instructions from the Emergency Control Center will be broadcast as soon as issued.

5.1.6 All agencies and individuals on the hurricane warning lists will be notified immediately. The Weather Bureau has one list and the Emergency Control Center has another.

5.1.7 The Superintendent of Schools will immediately cancel all classes for the duration of the emergency. The announcement will be broadcast from the Emergency Control Center.

5.1.8 The Emergency Control Center will put one of three plans in operation, the plan to be selected depending on the maximum tide height expected. Evacuation from various areas should be authorized by the Homeport Hurricane Preparedness Committee on a schedule that will permit evacuees to reach designated shelters at least 9 hours before time of expected flooding.

6. PLAN A -- EXPECTED TIDE 4-8 FT. M.S.L.
(See Charts 1 and 3)

Areas to be Evacuated and Time Required*	Shelters	Routes
Turtle, King, Barracuda, and Shark Keys (3 hrs.)	Masonic Hall	Boats to Marina then bus via Marina Rd. to 5th St.; E on 5th St.
All settlements east of Route 17 from Northville to Homeport (4 hrs.)	City High School	S on Route 17, E on 7th St.
All settlements east of Route 17 from Southville to Homeport (4 hrs.)	Elementary School	N on Route 17, E on 25th St.
Homeport Beach (3 hrs.)	Armory	Causeway, S on A St., W on 30th St., S on R St.
Area A (3 hrs.)	City Auditorium	W on 15th St.

* Time required to evacuate and reach shelter

6.1.1 Buildings west of D Street need not be evacuated above street floor. Tenants of upper floors are requested to provide refuge for occupants of street-level floors and basements.

6.1.2 First Church, which has a well-equipped kitchen in the attached parish hall, at 17th and Crescent Streets, is the Emergency Hospital. All persons requiring ambulance transportation will be taken there.

Emergency Duty Assignments for Evacuation Plan A

6.2.1 Communications: No unusual troubles expected. Station WXYZ will broadcast hurricane warnings and pertinent information exclusively.

6.2.2 Civil Defense: As soon as warnings to evacuate are broadcast, block wardens will make door-to-door checks in areas to be evacuated to ascertain that everyone is warned. Will immediately phone EM 1-1111 if ambulance service is required. Will also assist police if requested. When evacuation is completed, wardens will take posts in indicated safe buildings in their area and assist National Guardsmen in maintaining guard against fire and looting.

6.2.3 The Civil Defense mobile rescue units will operate as ambulances in taking incapacitated persons to the Emergency Hospital at First Church. Ambulances will get their radioed orders from the Emergency Control Center via the Civil Defense mobile transmitter stationed there.

6.4.2 Red Cross: Will be responsible for care including emergency clothing and feeding at indicated shelters. Ambulances will assist in moving incapacitated persons to the Emergency Hospital at First Church. This emergency hospital will be manned by volunteer doctors and nurses, and the Red Cross will supplement the medical and nursing staff as needed.

6.2.5 Transportation agencies: Airlines have agreed to operate additional trips if necessary to fly in emergency personnel. They will, however, cancel all incoming trips and remove all flying equipment from Homeport to unthreatened airports as soon as the first signs of the hurricane are felt.

6.2.6 The Homeport Transit Company will do the following when instructions are received from the Emergency Control Center:

1. Station 4 busses at the Marina to take evacuees from the Keys to the Masonic Hall.

2. Operate 9 busses at 10-minute intervals from Northville to Homeport on Route 17 with pick-up stops at all villages (three) east of the route. Destination will be City High.

3. Operate 8 busses at 10-minute intervals from Southville and Homeport on Route 17 with pick-up stops at all villages (three) east of the route. Destination will be Elementary School.

4. Operate 10-minute service in Area A in Homeport. Regular routes will be used in the Area but terminal will be City Auditorium and 15th Street will be one-way westward beginning at B Street.

These emergency schedules will operate until the Emergency Control Center advises their cancellation or when instructed by police to seek shelter at protected City Park. Fares will not be collected. Passengers will not be carried on outgoing trips except for police, firemen, and those having Emergency Control Center credentials.

6.2.7 Police: City police will be stationed at every other intersection along approaches to shelters, which will be temporarily one-way during the emergency with no parking permitted. Emergency vehicles will be permitted to travel in the opposite direction on the Causeway. Elsewhere, when entering evacuation areas they should use streets not designated as evacuation routes. The chief duty of the police will be to expedite evacuation traffic to the shelters and to prevent parking on approaches and within two blocks in any direction from a shelter.

6.2.8 In the evacuation areas police and National Guardsmen will be posted to prevent looting. When the storm strikes, all policing forces in the evacuation area will take posts in designated safe buildings and wait out the storm. Some National Guardsmen will be equipped with walkie-talkie radios to report fires or cases of looting.

6.2.9 State Police will set up road blocks on all routes into the Homeport area and will divert tourist and truck traffic to cities outside the threatened area. They will make a final patrol of the beach to ascertain that it is deserted and will also assist the Sheriff's force in warning settlements and supervising the evacuation.

6.2.10 The Sheriff and his men are primarily responsible for seeing to it that all settlements, trailer camps, etc., are duly advised of the evacuation. They will be assisted by the State Police and National Guard. Stranded persons whose cars have been disabled or have missed the evacuation busses will be picked up by National Guard personnel carriers dispatched by radio from the Emergency Control Center.

6.2.11 Fire Department: The equipment at Station No. 1 will be moved to the vicinity of the Field House in City Park. The Station's battery operated receiver will be taken along so men can take shelter in the Field House. The Station will not be abandoned, however, until winds reach about 30 mph., by which time all evacuees should be in shelters.

6.2.12 Each of the Department's three stations will be operating at half strength. The remaining half will be on guard duty (in uniform) in their home neighborhoods to watch for fires and fallen live wires, and to give first aid if required. The Department's two ambulances will be used to evacuate incapacitated persons.

6.2.13 Coast Guard: At the discretion of the Commanding Officer boats will be sent as available to ascertain that the Keys have been evacuated. Only Shark Key requires assistance in the way of additional boats. Boats will be dispatched to evacuate about 40 persons from Shark Key.

6.2.14 In addition to seeing that the Keys have been evacuated, the Coast Guard will stand by to tow any boats that may become disabled during the actual evacuation. The CAP will operate two planes over the water areas under Homeport jurisdiction to make sure all boats have sought protection. The planes will notify the Homeport Coast Guard Station by radioing to the FAA station at Homeport Airport, which will relay the message to the Coast Guard Station.

6.2.15 The Coast Guard Station will be flooded so it will have to be evacuated. When no further need for patrolling is indicated, boats will return to station. Coast Guard personnel, with all appropriate available mobile equipment, will proceed to pre-assigned locations selected for maximum availability for rescue operations during and after the hurricane. Communications equipment will be placed in operation.

6.2.16 National Guard: Will assist policing units as indicated under Police. Assisted by the Red Cross, they will care and feed the evacuees using the Armory as a shelter. Their two ambulances will take part in evacuating incapacitated persons to the emergency hospital.

6.2.17 Civil Air Patrol: Will activate its prearranged warning patrol schedule to look for isolated groups which do not appear to be taking shelter. Will notify either Sheriff's Office or Coast Guard depending on whether it is a land or sea situation. As plane transmitters broadcast only on FAA standard airways communications frequency, contacts will be made through FAA Airways Communication Station at Homeport Airport.

6.2.18 Planes will leave for bases outside threatened area as soon as there appears to be no further need for patrolling or until winds become strong or ceiling or visibility begins to lower.

6.2.19 Public Utilities: Main gas lines to evacuation areas will be shut off. Every attempt will be made to maintain electric service in the central section of the city in which most of the shelters are located. Here the power lines are underground and electrical hazards have been greatly reduced. In other sections of the city, power will be shut off when gusts begin to exceed 60 mph.

7. PLAN B -- EXPECTED TIDE 9-12 FT. M.S.L.
(See Charts 1 and 4)

7.1.1 Same as Plan A plus the following:

Areas to be Evacuated and Time Required	Shelters	Approaches
B (3 hrs.)	Court House	W on 25th St.
C (2 hrs.)	City Hall	W on 24th St.
D (1 hr.)	Adams Hotel	N on H St.
E (2 hrs.)	Christ Church	S on I St.
F (1 hr.)	Gem Theatre	W on 5th St.
G (3 hrs.)	Primary School	W on 10th St.
H (3 hrs.)	Burr High School	W on 18th St., N on Denver St.

7.1.2 Areas are all in the city and there is no specified evacuation route. However, the police will see to it that the approaches to the shelters are one-way in the direction indicated above and on the maps.

7.1.3 Buildings west of G Street need not be evacuated above street floor. Tenants of upper floors are requested to provide refuge for occupants of street-level floors and basements.

7.1.4 The settlements of Sardine Springs, Four Corners, and Sandville lying in the area bounded by Routes 17, 19, 18, and 24 will have to be evacuated, but they have taken this responsibility upon themselves. They do depend on Homeport for warnings, however, and they are on all warning lists. The Sheriff will ascertain that evacuation notices reach these towns when advised by the Emergency Control Center and will assist in their evacuation if requested.

Emergency Duty Assignments for Evacuation

7.2.1 Communications: Power plant will be flooded so Station WXYZ may be forced to suspend sometime before the worst part of the storm. Meteorological warnings and other pertinent instructions will be transmitted via State Police radio and/or teletypewriter to Station WMET, which will then carry on the full emergency schedule intended for Station WXYZ.

7.2.2 Weather Bureau: The airport will be flooded by the tides within the expected range of heights. Furthermore, the operations would be greatly hampered by the eventual power failure. The staff should therefore evacuate to the Emergency Control Center and try to carry on their duties at the emergency meteorological post there.

7.2.3 FAA Airways Communications Station: This office would be in the same predicament as the Weather Bureau. Hence, the staff will also evacuate to the Emergency Control Center and help with the communications activities there.

7.2.4 Civil Defense: Same as for Plan A (Par. 6.2.3) except for additional areas to be evacuated.

7.2.5 Red Cross: Same as for Plan A (Par. 6.2.4) except staffing additional shelters.

7.2.6 Transportation: Same as for Plan A (Par. 6.2.6) except for additional bus service by Homeport Transit Company as required by Emergency Transit Schedule for Plan B. The Company's bus equipment will be supplemented by 10 county school busses and 10 National Guard trucks equipped to carry personnel. This supplementary equipment will operate under instructions of the Company's Chief Dispatcher who will assign enough vehicles to operate the schedules listed in Emergency Transit Schedules for Plan B.

7.2.7 Police: City Police will extend the duties listed in Plan A (Pars. 6.2.7 and 6.2.8) to cover the additional evacuation areas and evacuation routes as shown in Emergency Transit Schedules for Plan B.

7.2.8 State Police will perform same duties listed under Plan A (Par. 6.2.9) and will assign 15 troopers to the Homeport Police to assist in directing traffic and maintaining order.

7.2.9 The Sheriff will operate as under Plan A (Par. 6.2.10) and will ascertain that Sardine Springs, Four Corners, and Sandville receive evacuation warnings and provide assistance for their evacuation if they request it.

7.2.10 Fire Department: In addition to operations stipulated in Plan A (Pars. 6.2.11 and 6.2.12) the equipment at Station 2 will be moved to the Burr High School Athletic Field when wind reaches 40 mph. Personnel will take shelter in the Field House taking radio with them.

7.2.11 Coast Guard: Same as for Plan A (Pars. 2.3.13-6.2.15). In addition, utilize mobile communications equipment previously set up and take over when other units cease to function and to maintain contact with other Coast Guard units. To the extent permitted by weather conditions, other personnel carry out rescue operations.

7.2.12 National Guard: Same as for Plan A (Par. 6.2.16). In addition, will place 10 trucks with drivers at disposal of Homeport Transit Company for evacuation purposes.

7.2.13 Civil Air Patrol: Same as for Plan A (Pars. 6.2.17 and 6.2.18).

7.2.14 Public Utilities: The electric power and gas plant will have to be abandoned. As soon as it is suspected that Plan B will have to be put in effect, notice of the impending plant shutdown will be released by the Emergency Control Center for broadcast to the public. The plant management will phone supervisors of all buildings equipped with standby power plants (lists of persons to be called are already available at the plant, at its city office, and the Emergency Control Center) to notify them of the expected service interruption and to check standby equipment and fuel supplies.

7.2.15 When occupation of the plant is no longer considered safe, valves, switches, and engines will be shut off. Plant personnel will then seek shelter at City High School.

8. PLAN C - EXPECTED TIDE 13-16 FT. M.S.L.
(See Charts 2 and 5)

Areas to be Evacuated and Time Required	Shelters	Routes or Approaches
Turtle, King, Barracuda, and Shark Keys (3 hrs.)	Mound City High School	Boats to Marina, busses via Marina Rd. and N on Route 17, W on Route 18.
All settlements east of Route 17 from Northville to Homeport (5 hrs.)	Mound City High and Elementary School	N on Route 17, W on Route 18.
All settlements east of Route 17 from Southville to Homeport (5 hrs.)	Crossville Grammar School	S on Route 17, W on Route 24, N on Route 19.
Homeport Beach (4 hrs.)	Fairhaven High and Jr. High School	Causeway; N on A St., W on 5th St. and Route 22, S on Route 21.
Area A (3 hrs.)	Triangle Bldg.	W on 15th Street
B (3 hrs.)	Apex Bldg.	W on 13th Street
C (2 hrs.)	Court House	W on 25th Street
D (3 hrs.)	City Hall	W on 24th Street
E (2 hrs.)	Acme Bldg.	W on 20th Street
F (2 hrs.)	Adams Hotel	W on 17th Street
G (2 hrs.)	King Hotel	S on H Street
H (3 hrs.)	City High	W on 7th Street and E on 8th.
I (2 hrs.)	Masonic Hall	S on N Street
J (3 hrs.)	City Auditorium	W on 15th Street
K (3 hrs.)	Burr High	W on 12th Street
L (3 hrs.)	Primary School	W on 10th Street

8.1.1 Buildings west of railroad tracks in Homeport proper need not be evacuated above street floor. This also applies to designated hurricane-safe masonry buildings between G Street and railroad tracks. Tenants of upper floors are requested to provide refuge for occupants of street-level floors and basements.

8.1.2 Sardine Springs, Four Corners, and Sandville will also have to be evacuated, and Homeport's only responsibility is to insure that they are

warned. The Sheriff will ascertain that the warnings reach these settlements and that evacuation is effected.

Emergency Duty Assignments for Evacuation

8.2.1 Communications: Same as Plan B (Par. 7.2.1).

8.2.2 Weather Bureau: Same as Plan B (Par. 7.2.2).

8.2.3 FAA Airways Communications Station: Same as Plan B (Par. 7.2.3).

8.2.4 Civil Defense: Same as Plan A (Par. 6.2.3) except for additional areas to be evacuated.

8.2.5 Red Cross: Same as Plan A (Par. 6.2.4) except for additional shelters to be manned requiring more trained personnel to be brought in.

8.2.6 Transportation: Will place Emergency Transit Schedule for Plan C in operation when notified by Emergency Control Center. Equipment will be supplemented by 10 county school busses and 10 National Guard trucks.

8.2.7 Police: City Police will extend duties to cover additional evacuation areas and routes shown in Emergency Transit Schedules for Plan C.

8.2.8 State Police: Same as Plan B (Par. 7.2.8).

8.2.9 Sheriff: Same as Plan B (Par. 7.2.9).

8.2.10 Fire Department: Same as Plan B (Par. 7.2.10)

8.2.11 Coast Guard: Same as Plan B (Par. 7.1.11).

8.2.12 National Guard: Same as Plan B (Par. 7.2.12) plus evacuating their own Armory.

8.2.13 Civil Air Patrol: Same as Plan A (Pars. 6.2.17 and 6.2.18).

8.2.14 Public Utilities: Same as Plan B (Pars. 7.2.14 and 7.2.15).

9. POST-HURRICANE MEASURES

9.1.1 After passage of the hurricane the public will be advised to take the following safety measures:

1. Remain in shelters until informed by those in charge that you may return to your homes.

2. Seek medical care at Red Cross disaster stations or hospitals for persons injured during the storm.

3. Don't touch loose or dangling wires. Report such damage to the light and power company, or nearest police officer.

4. Report broken sewer or water mains to the water department.

5. Guard against spoiled food in refrigerators if power has been off any appreciable length of time.

6. Unless you are qualified to render valuable emergency assistance, stay away from disaster areas where you may hamper first aid or rescue work. Doctors and nurses will be issued special passes.

7. Drive automobiles cautiously. Debris-filled streets are dangerous, so keep your eyes on the road. Along the coast soil may be washed from beneath the pavement, which may collapse under the weight of vehicles.

8. Be alert to prevent fires. Lowered water pressure makes fire-fighting difficult after storms.

9. Take down shutters and save the lumber. Store in a handy place for future use.

9.1.2 Coast Guard vessels, aircraft, and shore units will carry out patrols as soon as possible after the hurricane passes, prepared to give assistance to vessels or persons in distress. Survivors should be ready to signal these units as they approach.

9.1.3 Information as to assistance available for storm victims will be provided by press, radio, and other means. For family disaster-caused problems involving need for food, clothing, repair or rebuilding of homes, and medical and nursing care free counselling service and grants of financial assistance on an individual family basis based on the family's ability to help itself is available at Red Cross disaster headquarters upon each family's application. Red Cross through its welfare inquiry service and in cooperation with the Post Office Department will have available Safety Notification Cards and Change of Address cards by which affected families may notify relatives of their post-hurricane status and re-establish their promptly receiving their mail.

EVACUATION PLANS A AND B

FOR EXPECTED STORM TIDES OF 4-8 AND 9-12 Ft. MSL

HOMEPORT HURRICANE PREPAREDNESS DISTRICT

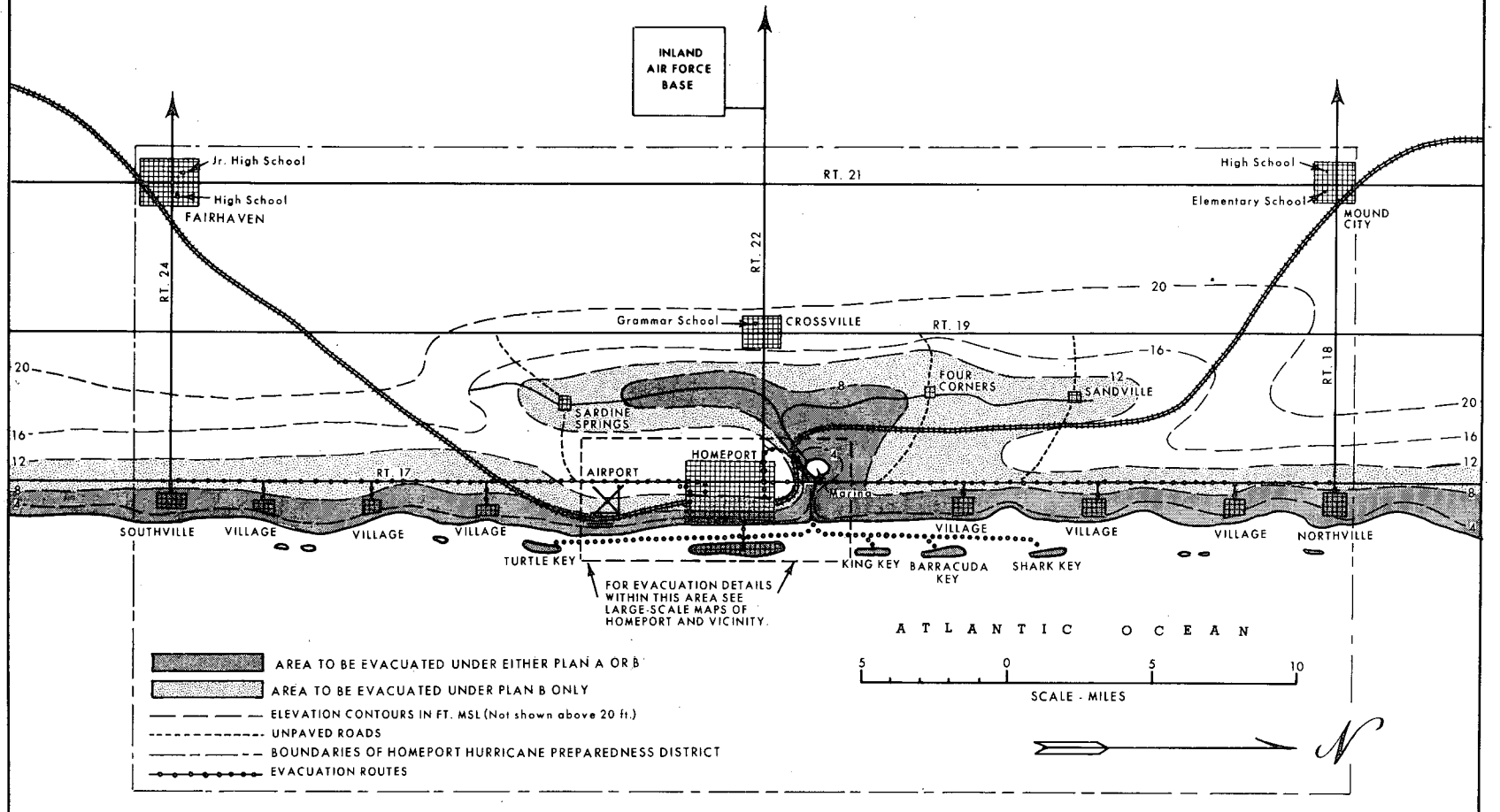


CHART 1

EVACUATION PLAN C

FOR EXPECTED STORM TIDES OF 13 - 16 Ft. MSL

HOMEPORT HURRICANE PREPAREDNESS DISTRICT

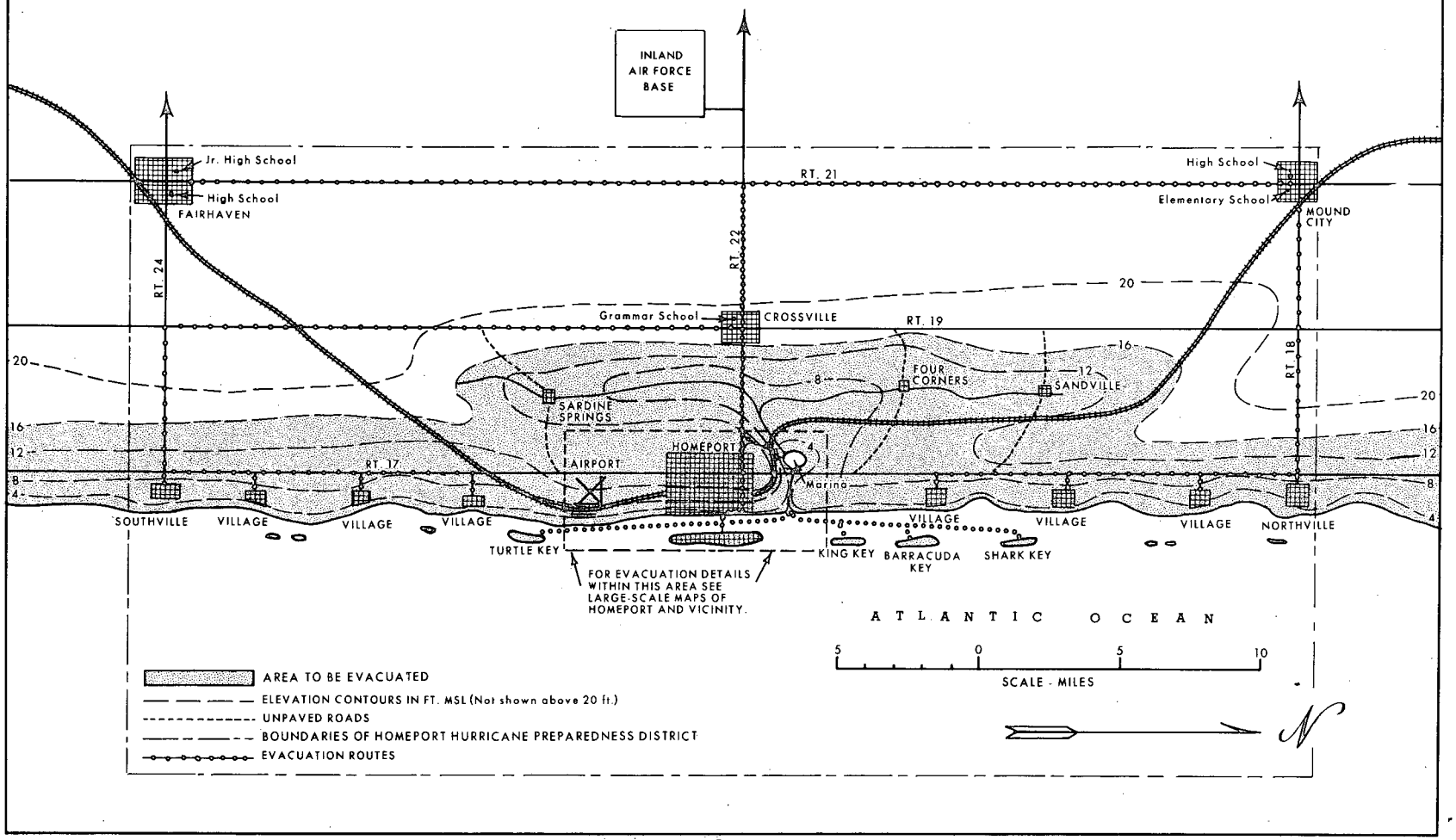


CHART 2

EVACUATION PLAN A

FOR EXPECTED STORM TIDES OF 4 - 8 Ft. MSL

HOMEPORT AND VICINITY

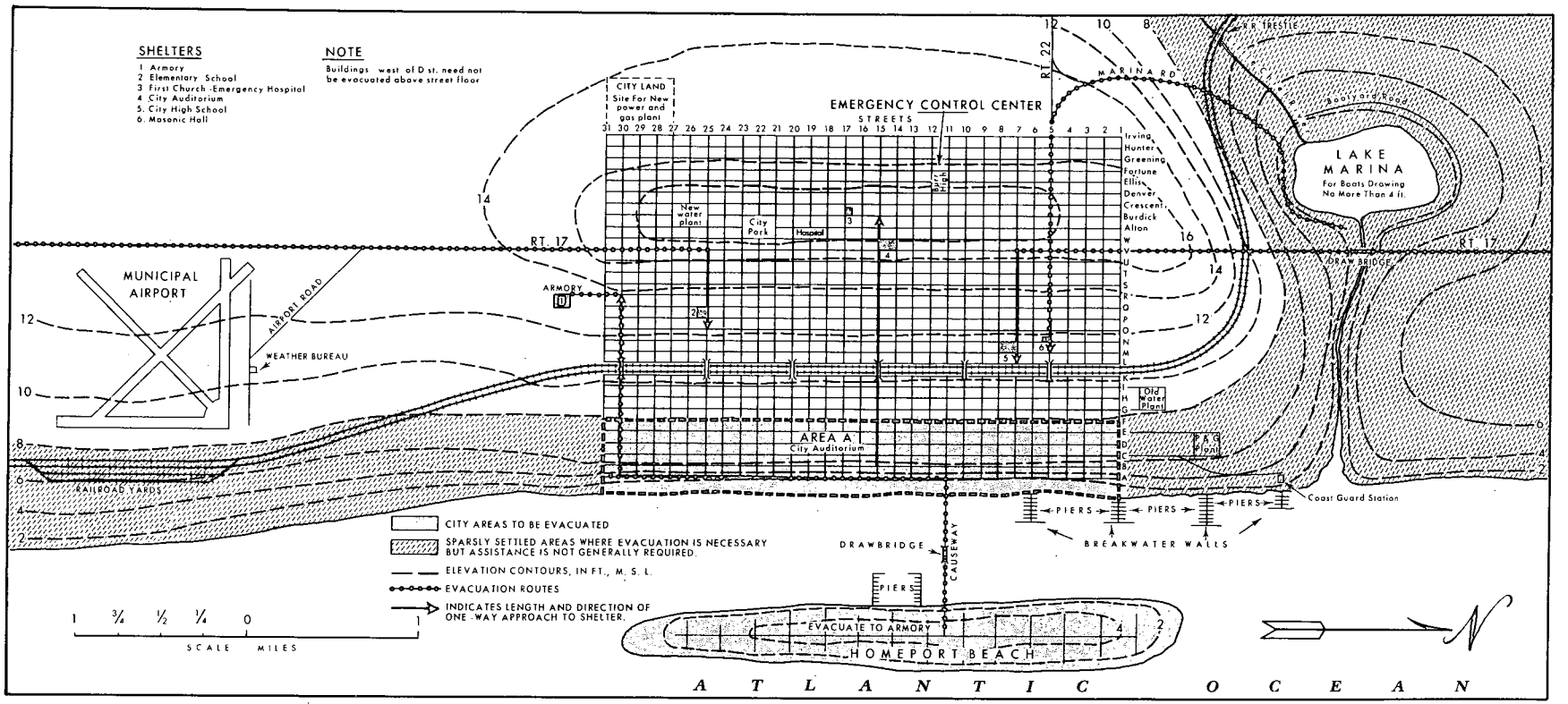


CHART 3

EVACUATION PLAN B

FOR EXPECTED STORM TIDE OF 9 - 12 Ft., MSL

HOMEPORT AND VICINITY

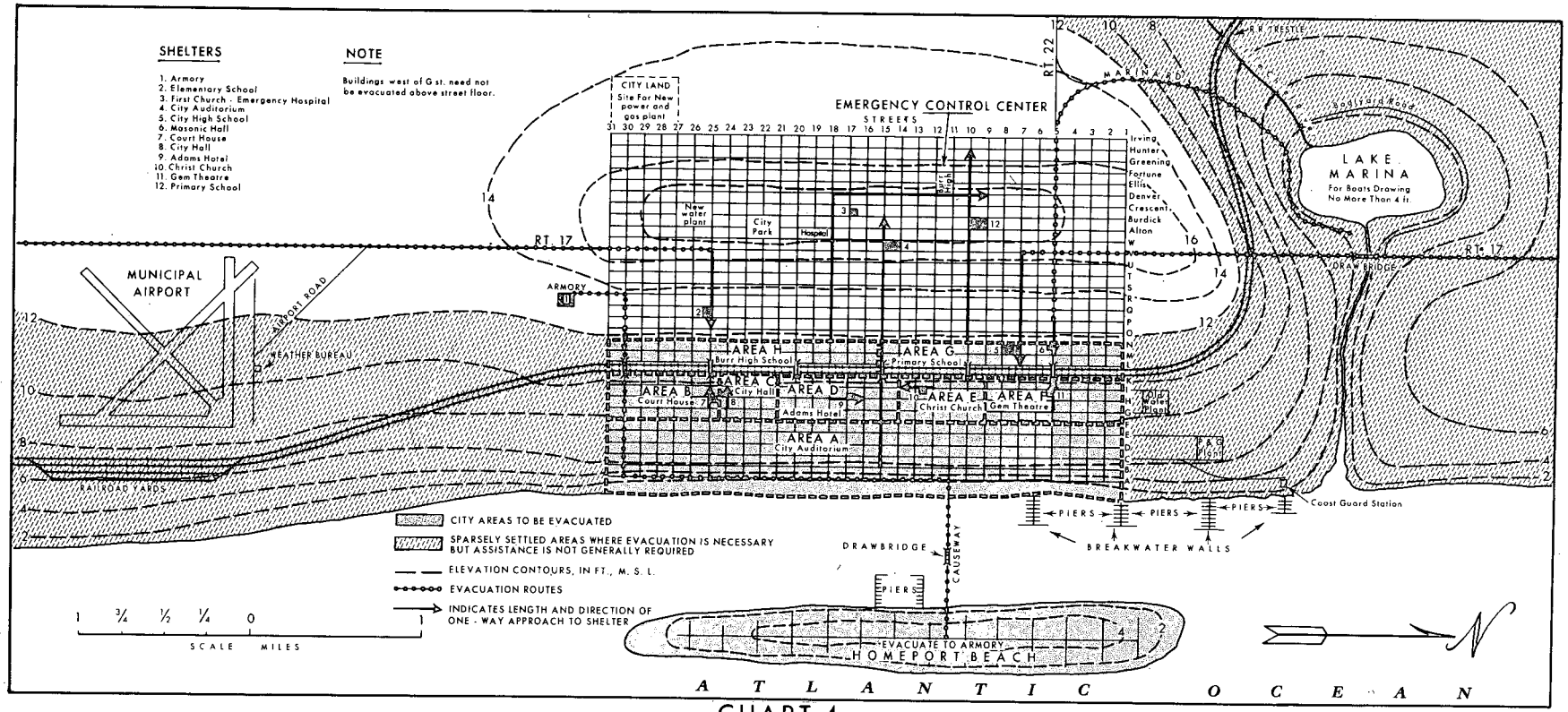


CHART 4

EVACUATION PLAN C
FOR EXPECTED STORM TIDE OF 13-16 FT, MSL
HOMEPORT AND VICINITY

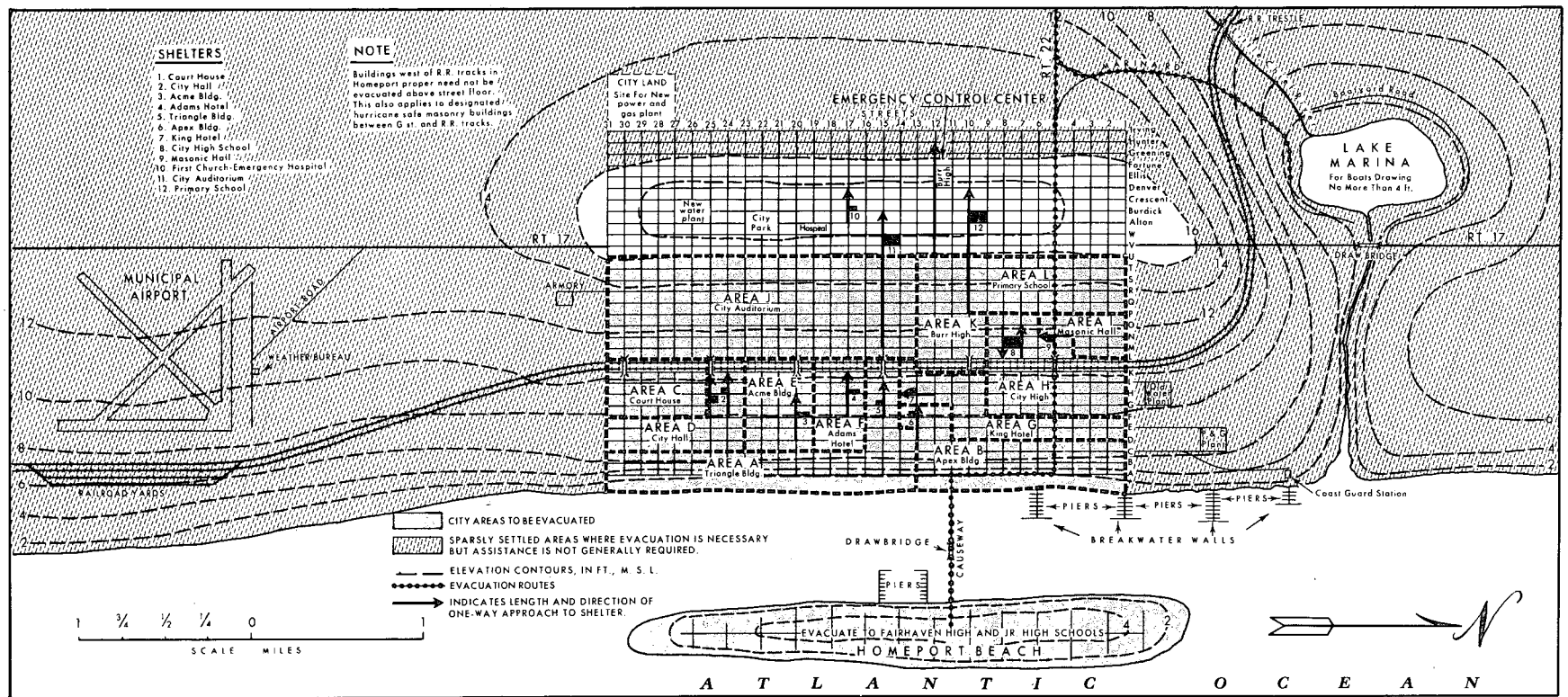


CHART 5

APPENDIX C

C O R R E S P O N D E N C E

C O P Y

U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE 3, MARYLAND

C O P Y

NABGW

11 May 1960

Honorable Hugh T. Cropper
Mayor of Ocean City
Ocean City, Maryland

Dear Mayor Cropper:

This office is currently conducting a preliminary investigation of the Atlantic Coast from the Maryland-Delaware boundary to Gargathy Inlet in Virginia to determine locations along the coast that could be economically protected from hurricane-induced tides. Representatives of this office discussed this investigation with you briefly at Ocean City on 11 April 1960. Our studies indicate that a hurricane-induced tide of 15 feet (not including wave height) is possible at Ocean City and that protection from such tides can only be provided by the construction of a wall or levee around the entire community. Should such a plan of protection be economically feasible and desirable, local interests would be required to furnish the following:

(1) Lands, easements, rights-of-way, and relocation of utilities without cost to the United States.

(2) At least 30 per cent of the total first cost of construction, exclusive of the cost of preauthorization surveys and aids to navigation. Costs involved in connection with item (1) above would be credited to this item.

(3) Maintenance, operation and replacement costs connected with the project.

Before continuing our studies it is necessary to obtain a statement from Ocean City as to the desirability of protection and the city's willingness to provide the terms of local cooperation in the event a project is authorized by the Congress. Will you let me know what the city's views are in this matter?

Please do not hesitate to call on me if you require additional information.

Sincerely yours,

/s/ Stanley T. B. Johnson
STANLEY T. B. JOHNSON
Colonel, Corps of Engineers
District Engineer

8789

TOWN OF OCEAN CITY

MAYOR & CITY COUNCIL
OF OCEAN CITY
MARYLAND

May 19th, 1960

Col. Stanley T. B. Johnson
District Engineer
U. S. Army Engineer District, Baltimore
Corps of Engineers
P. O. Box 1715
Baltimore 3, Maryland

Dear Col. Johnson:-

With reference to your letter of May 11th regarding a preliminary investigation to determine locations along the coast that could be economically protected from hurricane-induced tides, you asked for a statement from Ocean City as to the desirability of protection and the city's willingness to provide the terms of local cooperation in the event a project is authorized by Congress.

When your letter was brought before the members of the Council at our regular meeting last Tuesday evening, they asked so many questions that I was unable to answer that I do not feel that I am in a position at this time to make a statement.

It would seem to me that this is quite an expensive project and we would like to have some idea of costs. We, naturally, feel it our duty to take advantage of any proposed protection for our people and property, however, there is a definite limit as far as our small town is concerned.

I will appreciate it very much if you will write a more descriptive letter so that the members of the council and myself will be more cognizant of just what type of wall or levee is intended, where it will be placed, how high it will be, etc.

Thank you very much for your indulgence.

Very truly yours,

MAYOR AND CITY COUNCIL OF OCEAN CITY

Hugh T. Cropper

Hugh T. Cropper
Mayor

285/66 (Hurricanes)

82866
23 May

C O P Y

U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE 3, MARYLAND

C O P Y

NABGW

31 May 1960

Honorable Hugh T. Cropper
Mayor of Ocean City
Ocean City, Maryland

Dear Mayor Cropper:

I have your letter of 19 May 1960 requesting more definite information about the location and type of protection being considered to protect Ocean City from hurricane-induced tides. As stated in my letter of 11 May 1960, studies indicate that tides 15 feet above mean low water (not including wave height) are possible at Ocean City. Total protection can only be furnished, therefore, by protective works with a top elevation of 18 feet and more above mean low water. Such protection would have to encircle the area to be protected since there is no high ground to which the wall or dike could be tied. Because of the development and topography of the peninsula it appears that the only area, if any, which could be protected economically is the section between 14th Street and the inlet. The benefits to be derived from protection north of 14th Street would probably be less than the cost of the additional protection. In fact, the economic feasibility of protecting the area south of 14th Street is by no means certain.

Should protection be economically feasible, the ocean side of the protection would probably consist of beach fill to an elevation of about 20 feet above mean low water with groins placed to hold the fill between the inlet and 14th Street. The bay side of Ocean City would be probably protected by a concrete wall on shore to an elevation of about 18 feet above average low tide, extending from the inlet to 14th Street and joining the beach fill at the boardwalk at these two locations. Openings, which could be closed quickly during emergencies, would be required at Baltimore and Philadelphia Avenues in the vicinity of 14th Street.

The approximate cost of the tentative plan of improvement outlined above is about $6,000,000 of which at least 30 per cent would have to be borne by local interests. Further work on the determination of economic feasibility and more definite design of the project can not be accomplished until local interests indicate willingness to fulfill the terms of local cooperation.

Sincerely yours,

/s/ Stanley T. B. Johnson
STANLEY T. B. JOHNSON
Colonel, Corps of Engineers
District Engineer

C O P Y

U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE 3, MARYLAND

C O P Y

NABEN-R

12 January 1961

Honorable Hugh T. Cropper
Mayor of Ocean City
Ocean City, Maryland

Dear Mr. Cropper:

In our letters of 11 May 1960 and 31 May 1960, copies of which are inclosed, we outlined the terms of local cooperation and the estimated costs of providing protection for Ocean City from hurricane-induced high tides. We requested that you furnish a statement as to the views of the Mayor and Council of Ocean City regarding the desirability of the proposed protection and the Town's willingness to provide local cooperation in the event that a project should be adopted. In order that we might complete our report, we would appreciate receiving a letter giving the views of the Town on this subject.

If your reply is not received within the next two weeks, we will assume that there is no active interest in this project.

Sincerely yours,

/s/H. B. Barke
H. B. BARKE
Major, Corps of Engineers
Acting District Engineer

2 Inclosures
1. Copy letter, 11 May 60
2. Copy letter, 31 May 60

TOWN OF OCEAN CITY

MAYOR & CITY COUNCIL
OF OCEAN CITY
MARYLAND

January 17th, 1961

HUGH T. CROPPER
Mayor

COUNCILMEN

HARRY W. KELLEY
President

JOHN DALE SHOWELL III
Treasurer

ROBERT B. JACKSON
Secretary

WILLIAM H. McCABE

C. RIDGLEY HARMAN

M[illegible]US J. WILLIAMS
Solicitor

T. EARL PIERCE
City Clerk

Major H. B. Barke
Acting District Engineer
Corps of Engineers
U. S. Army Engineer District
P. O. Box 1715
Baltimore 3, Maryland

Dear Major Barke:-

This will acknowledge receipt of your letter of January 12th pertaining to providing protection for Ocean City from hurricane-induced high tides as outlined in your letters of May 11th and 31st.

Our letter of May 19th addressed to Col. Stanley T. B. Johnson sets forth our feeling in this proposed project. It is extremely hard for us to visualize beach fill to an elevation of about 20 feet above mean low water and a concrete wall to an elevation of about 18 feet above average low tide on the bay side.

Under these circumstances, we feel that although protection is desired, the proposed method would alter the use of our beach detrimentally.

We may have the wrong impression of this and stand to be corrected.

Very truly yours,

MAYOR AND CITY COUNCIL OF
OCEAN CITY

Hugh T. Cropper

Hugh T. Cropper
Mayor

ROBERT N. REED, Mayor

David McCready ~~C. EVERETT JEFFRIES~~, Clerk

TOWN OF CHINCOTEAGUE

INCORPORATED

CHINCOTEAGUE, VIRGINIA

403 S. Main St.

Office of Town

February 11, 1963

Mr. C. J. Robin, Chief, Engineering Division
Corps of Engineers
Foot of Front Street
Norfolk 1, Virginia

Dear Mr. Robin:

The enclosed resolution is self-explanatory, and we will very much appreciate your cooperation in this matter.

We are not fully familiar with Section 107, of the 1960 River and Harbor Act, but understand that same embraces projects as requested in our resolution.

We further understand that in some projects where pleasure or recreational facilities are involved, that counties or municipalities are, in some instances, required to give certain local assistance. It is our understanding, however, that the resolution of The Town of Chincoteague, copy of which is attached hereto, does not within itself commit the Town of Chincoteague to provide any financial assistance.

It should be pointed out that there are apparently no right-of-way problems and we will appreciate it if you will promptly investigate the matter and report back to us at your earliest convenience.

Thanking you, we are

Yours very truly,

TOWN OF CHINCOTEAGUE

By Robert N. Reed, Mayor

RNR/mcs

(5866)

RESOLUTION

At a call meeting of the Town Council of the Town of Chincoteague on Thursday, February 7, 1963, the following resolution was unanimously adopted:

WHEREAS, the Town of Chincoteague originally had a dike on the north side of Lewis Creek, the height of which was reduced by natural erosion; and

WHEREAS, the March storm of 1962 practically eliminated this said dike, with result that wave action from Chincoteague Bay, caused a terrific amount of damage to both boats and property along the waterfront of the Town of Chincoteague, making it necessary for the Town of Chincoteague to be evacuated; and

WHEREAS, the heaviest property losts from the March storm of 1962 could have been prevented had a suitable dike been in existence;

NOW, THEREFORE, BE IT RESOLVED:

That the Council for the Town of Chincoteague, on Thursday, February 7 , 1963, request the Corps of Engineers to construct a suitable dike on the north side of Lewis Creek to prevent wave action on the waterfront of this exposed section of Chincoteague under the authority of Section 107 of the 1960 River and Harbor Act.

BE IT FURTHER RESOLVED:

That the Corps of Engineers be requested to expedite this project in order that same be completed prior to the fall storms of 1963, which normally occur in the months of August and September.

Attest: 2/7/1963 Approved: 2/7/1963

David McCready Clerk Robert M. Rice Mayor

ROBERT N. REED, Mayor

C. EVERETT JEFFRIES, Clerk

TOWN OF CHINCOTEAGUE

INCORPORATED

CHINCOTEAGUE, VIRGINIA

Office of CLERK

August 8, 1963

District Engineer
Corp of Engineers
Baltimore, Maryland

Dear Sir:

I was instructed by the Mayor and Council of the Town of Chincoteague at their Regular Council Meeting, held August 5, 1963, to inform you that action has been taken on the resolution, dated February 7, 1963.

The Lewis Creek project has been started and up to this point, work has been satisfactory.

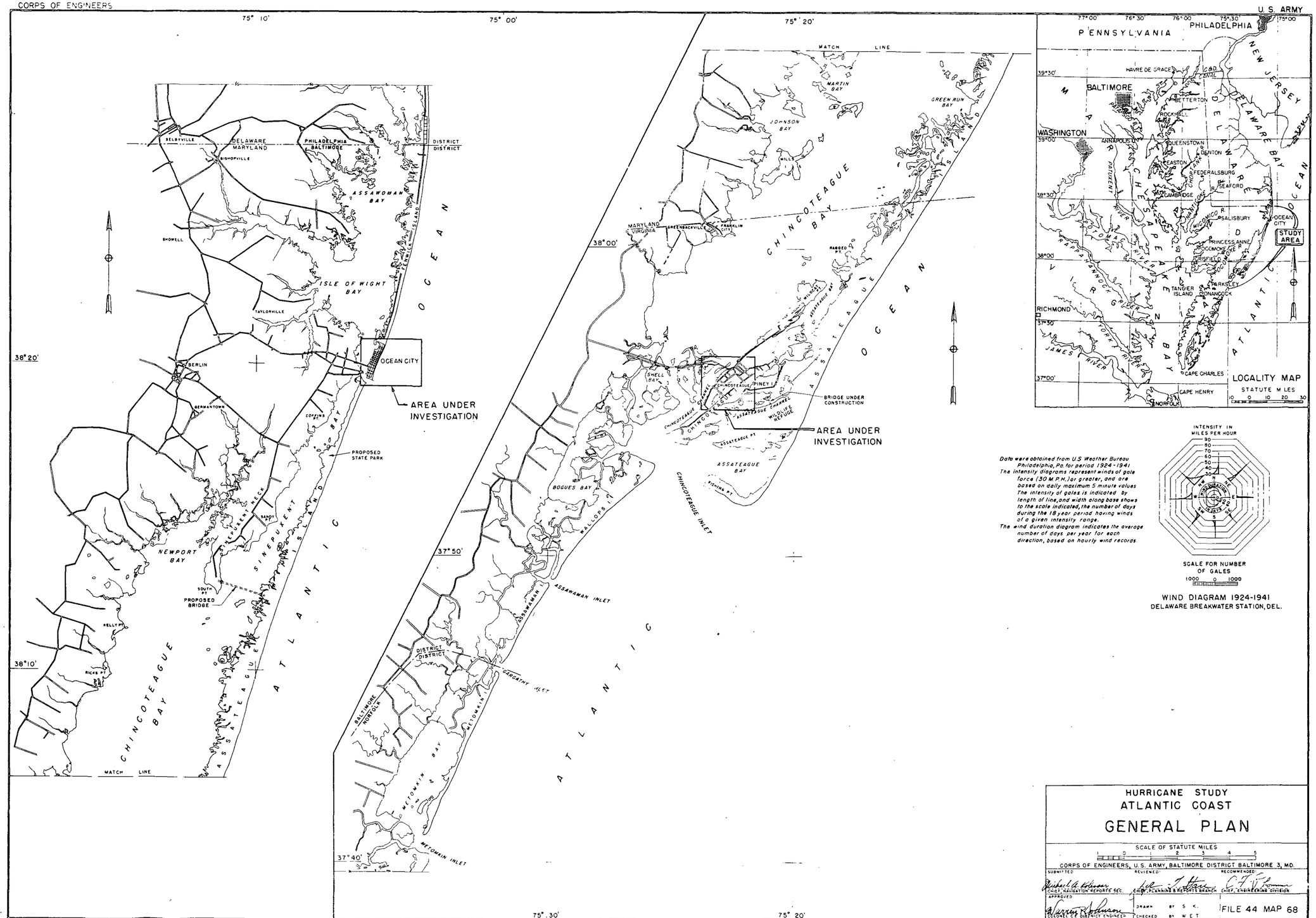
Thank you for your concern in this matter.

Sincerely,

David McCready

David McCready
CLERK
TOWN OF CHINCOTEAGUE

DM/dm



Data were obtained from U.S. Weather Bureau Philadelphia, Pa. for period 1924-1941
The intensity diagrams represent winds of gale force (30 M.P.H.) or greater, and are based on daily maximum 5 minute values. The intensity of gales is indicated by length of line, and width along base shows to the scale indicated, the number of days during the 18 year period having winds of a given intensity range.
The wind duration diagram indicates the average number of days per year for each direction, based on hourly wind records.

WIND DIAGRAM 1924-1941
DELAWARE BREAKWATER STATION, DEL.

HURRICANE STUDY
ATLANTIC COAST

GENERAL PLAN

SCALE OF STATUTE MILES

CORPS OF ENGINEERS, U.S. ARMY, BALTIMORE DISTRICT, BALTIMORE 3, MD.

SUBMITTED: CHIEF, NAVIGATION REPORTS SEC. — REVIEWED: CHIEF, PLANNING & REPORTS BRANCH — RECOMMENDED: CHIEF, ENGINEERING DIVISION

APPROVED: COLONEL, C.E. DISTRICT ENGINEER

DRAWN BY S. K. CHECKED BY W. E. T.

FILE 44 MAP 68