BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

AREA 9

EAST RIVER TO NEW HAVEN HARBOR

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION. BOSTON. MASS.

AUGUST 12, 1955

BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

AREA 9

EAST RIVER TO NEW HAVEN HARBOR

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

AUGUST 12, 1955

BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

Area 9

East River to New Haven Harbor

TABLE OF CONTENTS

PLATES

Plate No.	
1.	Location Map
2.	Hurricanes and Prevailing Winds
3.	Wind Data - Block Island
4.	Wind Data - New Haven
5.	Wind Data - New York
6.	Shore Structures - Typical Construction Details
7.	Shoreline and Offshore Depth Changes - Sheet 1
8.	Shoreline and Offshore Depth Changes - Sheet 2
9.	Shoreline and Offshore Depth Changes - Sheet 3
10.	Comparative Profiles
11.	Survey Map - Sheet 1
12.	Survey Map - Sheet 2
13.	Survey Map - Sheet 3
14.	Survey Map - Sheet 4
15.	Survey Map - Sheet 5
16.	Plans of Improvement
17-28.	Photographs

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
857 COMMONWEALTH AVENUE
BOSTON 15, MASS.

NEDGW August 12, 1955

SUBJECT: Beach Erosion Control Report on Cooperative Study of Connecticut, Area 9, East River to New Haven Harbor

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

SYLLABUS

This report, the eighth of a series to cover the entire coast of Connecticut, includes study of the shore line of the towns of Guilford, Branford and East Haven and the City of New Haven lying between East River in Guilford and Fort Hale Park in New Haven. The purpose of the study is to determine the most suitable methods of stabilizing and improving the shore line.

The Division Engineer finds that a large part of the shore is rocky and therefore naturally resistant to erosion, that sandy beaches along this rocky shore exist generally only in indentations which are comparatively stable, that sandy beaches elsewhere are eroding with consequent exposure of developed areas to storm attack and loss of public beach area, that during storms, damages occur to developed areas located at low beaches and that there is some need for beach improvement for recreational use. The Division Engineer also finds that in general, the most suitable method of protecting developed areas and providing beach improvement for recreational use consists of direct placement of sand fill obtained by hydraulic dredging

from available sources offshore and construction of impermeable groins wherever needed to reduce losses of the fill and that in some locations needed protection of sandy beaches can be effected by groin construction alone. He further finds that the improvement of sandy pocket beaches along the rocky shore, needed for their limited recreational use, can best be effected by trucking in sand for periodic nourishment.

The Division Engineer recommends that local interests consider adoption of projects for protection of privately owned shores at Momauguin, Silver Sands and West Silver Sands Beaches and improvement of the public beach at Guilford Point.

The Division Engineer recommends that the United States adopt a project authorizing Federal participation by the contribution of Federal funds equal to one-third the first cost of protection of the public bathing beach at Lighthouse Point Park by construction of an impermeable groin 380 feet long at Lighthouse Point. The total estimated amount of Federal participation in the above project is $4,000.

Beach Erosion Control Report on Cooperative Study of Connecticut

Area 9

East River to New Haven Harbor

I. General

1. Authority. - This report was prepared by the Corps of Engineers, United States Army, in cooperation with the Connecticut State Flood Control and Water Policy Commission under authority of Section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. The basic agreement for the study of the entire Connecticut shore line was approved by the Chief of Engineers on August 28, 1947 and the detailed program for this area on May 1, 1950.

2. Purpose. - The purpose of the study is to determine (1) the most suitable methods of stabilizing and improving the shore line between East River and New Haven Harbor, (2) which sections of the shore are desirable locations for beach improvements and the most effective measures for accomplishing the improvements, and (3) the economic justification of protective and improvement measures.

3. Prior Reports. - There have been no prior reports on beach erosion control or shore protection in this area. Bulletin No. 46 of the State Geological and Natural History Survey of Connecticut, published in 1929, is a paper by Henry Staats Sharp, A. M., entitled "The Physical History of the Connecticut Shore Line". It described the geological history of Connecticut and the various topographical features of the shore line. The geological history contained in Appendix B is based principally upon this paper.

4. Location . - The study area is located on the north shore of Long Island Sound at and adjacent to New Haven. The shore line is about 29 miles in length and extends from the mouth of East River in Guilford westward to Fort Hale Park in New Haven Harbor. It includes, from east to west, most of the shore of the Town of Guilford, all the shore of the towns of Branford and East Haven and a portion of the shore of the City of New Haven having approximate lengths of 10.7, 13.5, 2.5 and 2.3 miles, respectively. The New York, New Haven and Hartford Railroad runs along the shore within a distance not exceeding 3 miles. United States Route 1 runs generally parallel to the shore 1 to 4 miles inland and it connects with Connecticut Routes 146, 143 and 142 and with town and private roads to provide access to beaches in Guilford and Branford. Access to beaches in East Haven and New Haven is provided from United States Route 1 over city streets and city, town and private roads. The study area is shown on United States Coast and Geodetic Survey Charts 217, 218 and 1212, Army Map Service topographic quadrangles Guilford, Branford, Woodmont and New Haven and on Plates 1 and 11 to 15, inclusive.

5. Population. - The permanent populations according to the 1950 census and the estimated summer increases are listed below:

Location	Permanent Population	Summer Increase
Guilford	5,092	3,000
Branford	10,944	5,000
East Haven	12,212	3,500
New Haven	164,443	Small

6. Description. - The study area is a shore line of submergence. Almost without exception bedrock is exposed at all of the points or irregularities along the shore. Banks and bluffs eroded in unconsolidated material

are almost unknown. Large extents of shore consist of exposed bedrock. This is particularly true between Mulberry Point in Guilford and Mansfield Point in East Haven, an area in which sand beaches exist only in small pockets or indentations. The shore west of Mansfield Point to Lighthouse Point is predominantly a sandy beach fronting marsh. The convex shore north of Lighthouse Point is largely composed of bedrock with sand held in indentations. A sandy beach adjoins this convex shore in the southeast portion of Morris Cove. North of this sand beach the shore is generally composed of gravel, rock fragments, some coarse sand and bedrock. East of Mulberry Point in Guilford marsh forms the shore to West River and narrow sand spits trail in front of marsh west and east from Guilford Point towards West and East Rivers. The geology of the area is described in Appendix B. Detailed descriptions of beaches are included in Part III, Plans of Improvement, Paragraphs 14 to 47 and in Appendix A. Selected photographs of shore areas are included on Plates 17 to 28. Information concerning the condition of shore waters obtained from a sanitary study is included in Appendix J. According to this study none of the shore areas for which plans have been considered were in a questionable category from the standpoint of bathing water safety.

7. Statement of the Problem. - The principal problem consists of erosion and recession of sandy beaches in East Haven resulting in loss of bathing areas and exposure of shore developments to wave attack and damage. This problem has necessitated repeated landward movement of cottages following recession of the beaches on which they were located or the construction of increasingly costly protective works to maintain developments in their present locations. In New Haven erosion has caused loss of sand from the artificially placed bathing beach at Lighthouse Point Park. This is

particularly significant in view of the large expenditures made by the city for construction of a new bath house and other public facilities following placement of the beach fill. Narrow sandy beaches in Branford located in pockets of the irregular rocky shore have been subject to erosion and loss of material at a slow rate. Minor improvement and protection are desired or needed at a number of locations along that portion of Branford including Pine Orchard and the shore to the west which have been intensively developed as a summer resort. Problems in Guilford, with its predominantly rocky coast are localized, generally consisting of tidal flooding of cottage colonies on low beaches at the heads of coves or indentations. Some interest has been expressed by local interests in improvement of a public beach area at Guilford Point for recreational purposes.

II. Factors Pertinent to the Problem

8. Littoral Materials. - a. Characteristics. - The character of littoral material as indicated by mechanical analysis of beach samples taken at mid-tide elevation and by probings in offshore areas is shown in tabular form on Plates 11 to 15, inclusive.

b. Sources. - The principal natural source of supply of beach building materials was the sands and gravels deposited by glaciers. These sources have been depleted by erosion of the mantle of unconsolidated material from the underlying bedrock or they are now protected by structures and can therefor no longer contribute material to the beaches. The minor streams emptying into Long Island Sound in the area contribute little or no beach material.

9. Littoral Forces. - a. Waves. - No wave measurements or statistical wave data are available for this area. Due to the limited fetches across Long Island Sound, waves are short waves generated by local winds. Fetches

vary from 60 miles to the west, 34 southwest, 19 south, 23 southeast and 45 to the east. Swells do not reach the shore because of the shelter afforded by Long Island. The maximum height of waves breaking inside the low water line with tides 3 feet in excess of the mean height of high water is approximately 7 feet but during infrequent higher tides, larger waves can reach the shore. The above maximum wave heights apply to exposed locations only, not to shores of bays and coves.

b. Currents. - Tidal currents in Long Island Sound, about one mile offshore, set to the west during flood and to the east during ebb tides. Maximum currents occur on the ebb. At strength of current, spring velocities are about 1.3 knots and average velocities are 1.1 knots.

c. Winds. - Winds at New Haven are believed to be representative of winds in the study area between New Haven and Branford Harbors. The prevailing direction at New Haven is north or offshore. Onshore winds from the southwest quadrant occur about 27 percent of the time and from the southeast quadrant about 20 percent of the time. The prevailing winds at Block Island which are probably more representative of wind direction east of Branford Harbor occur with a slight predominance from the southwest over the northwest quadrant. Onshore winds from the southwest quadrant occur about 38 percent of the time and from the southeast quadrant 16 percent of the time. Winds throughout the study area from westerly quadrants prevail over those from the east. Wind roses for Block Island and New Haven are shown on Plates 3 and 4.

d. Storms. - Winds equal to or greater than 32 miles per hour blow onshore from southerly quadrants on an average between 2 and 3 times a year at New Haven and 18 times a year at Block Island, predominantly from the southwest. The prevailing storm direction at both locations is northwest

or offshore. Storm frequency at New Haven is probably more representative of that in the study area than that occurring at Block Island. Detailed information concerning hurricanes, storms, storm damages and exposure of the shore is contained in Appendix D.

e. Tides. - Tides are semi-diurnal. The mean range increases from 5.4 feet at East River, Guilford to 6.2 feet at Lighthouse Point and Fort Hale, New Haven. The spring range within the same limits increases from 6.4 to 7.3 feet. The maximum tides of record at Branford and New Haven, both of which occurred during hurricanes, were 11.8 and 13.9 feet above mean low water, respectively. Tides in excess of the mean height of high water occur as follows: 3 feet in excess about once a year, 2 feet in excess about 5 times a year, and 1 foot in excess about 98 times a year. Detailed information concerning tides is contained in Appendix C.

10. Shore History. - a. Shore Line and Offshore Depth Changes. - The principal shore line changes in Guilford and Branford have consisted of recession of low lying marshy shore areas generally located in indentations of an otherwise irregular rocky coast. Shore recession in such areas since 1838 has averaged from 1 to 5 feet per year along portions of the shore in the vicinity of Guilford Point, from Chaffinch Island to Mulberry Point, at the heads of Indian and Joshua Coves and Island Bay, east of Vineyard Point, between Hoadley Neck and Flying Point, between Stony Creek and Juniper Point and at the head of Lindsey Cove. Since 1933 additional recession has occurred, at a generally greater rate, at almost all of the above locations. Recession of some of the sandy pocket beaches located between Pine Orchard and Branford Harbor also occurred between 1838 and 1933 at a comparatively slow rate, probably nowhere averaging more than $1\frac{1}{2}$ feet per year. There appears to have been little or no change in the position of

shore lines in this latter area since 1933. In East Haven, since 1838, portions of Momauguin, Silver Sands, West Silver Sands and Shall Beaches have receded, on an average, 1 to 2 feet per year. Since 1933 recession of portions of the above beaches has occurred at a higher rate, in some places approximating 5 feet per year. The shore line of New Haven during the period of record up to 1949 has been comparatively stable with the greatest average rate of recession probably not exceeding ½ foot per year along a part of Morris Cove. Lighthouse Point Beach was enlarged and its shore moved considerably seaward by direct placement of sand fill during 1949. Loss of some of this fill and recession of the artificially placed beach occurred at a comparatively rapid rate in the vicinity of Lighthouse Point from 1952 to 1955. Offshore depth changes throughout the study area between 1838 and 1872 or 1884 - 1886 have consisted principally of deepening as evidenced by landward movement of the 6, 12 and 18-foot contours. A survey during 1952 indicates that since 1872 or 1884-1886, in the vicinity of the 6-foot depth, there has been deepening at Silver Sands Beach, shoaling at Indian Cove, Limewood Beach and the pocket beach west of and adjacent to it, between Jeffrey and Indian Neck Points, at Momauguin Beach, at Shell Beach near Morris Creek and along the east half of Lighthouse Point Beach and little or no change at other locations at which profiles were run. Detailed descriptions of shore line and offshore depth changes are contained in Appendix E. Comparative changes are shown on Plates 7 to 10, inclusive, Descriptions of the more significant changes are included in Part III, Plans of Improvement, paragraphs 44-47.

b. Existing Protective Structures. - Many structures have been built for protection of the shore. They have generally been for protection of small areas and have had little or no effect on adjacent shore lines.

Structures have consisted of sea walls, revetments or bulkheads, mostly of light construction, built to armor the shore or protect developments located close to the water or short, light groins built to prevent erosion of sandy beaches. Historical information concerning these structures is not readily available. Data about the Pine Orchard and New Haven Harbor breakwaters and a list containing a general description of types of structures and their locations is included in Appendix G. Pertinent descriptions or discussions of existing structures in regard to beach erosion and protection problems are included in Part III, Plans of Improvement, paragraphs 14-47.

c. Profiles. - Beach profiles were run at selected locations as shown on Plates 11 to 15 inclusive. They ranged in length from 800 to 2600 feet and extended seaward from the berms of beaches or from the tops of sea walls to depths of 5 to 15 feet below mean low water. Beach slopes in the foreshore zone and seaward of the foreshore are included in the following tabulation. The foreshore zone slopes, unless otherwise indicated, were measured between the beach berm and mean low water. Slopes are designated as fractions thus: 1/10 (to be read as 1 vertical to 10 horizontal). Slopes of 1/100 or flatter are designated as level.

Beach Slopes

Profile No.	Foreshore (above m.l.w.)	Underwater (below m.l.w.)
1	Ledge	1/32 (to -12.0) then level
2	Ledge	Level
3	Wall near L. W.	Level
4	1/8	1/27 (to -6.0) then level
5	1/10 (above -3.0)	Level (below - 3.0)
6	1/8 (above - 2.5)	1/88 (-2.5 to -6.0), then level
7	1/11	1/87 (L.W. to -6.0), then level

Beach Slopes (Continued)

Profile No.	Foreshore (above m.l.w.)	Underwater (below m.l.w.)
8	1/19 (above - 3.0)	1/80 (-3.0 to -8.0), then level
9	1/8	Level
10	1/6	1/5 (L.W. to -5.0), then level
11	1/13 (above + 1.0)	Irregular (+1.0 to -10.0), then level
12	1/10	1/30 (L.W. to -8.0), then level
13	1/9	Level
14	1/7	Level
14A	1/10	1/50 (L.W. to -8.0), then level
15	1/8 (above -2.0)	Level (some irregularities)
16	1/7 (above -3.0)	Level (some irregularities)
17	1/9 (above +1.0)	1/33 (+1.0 to -2.0), then level (some irregularities)
18	1/10 (above -2.0)	Level (some irregularities)
19	1/8 (above -1.5)	Level
20	Wall near L.W.	1/80 (L.W. to -12.0)
21	1/12	Level
22	1/17 (above -1.0)	1/80 (-1.0 to -10.0)
23	1/8 (above + 2.0)	1/38 (+1.0 to -6.0), then level
24	1/18 (above -4.0)	1/75 (-4.0 to -15.0)
25	1/14 (above -4.0)	1/80 (-4.0 to -10.0), then level
26	1/18 (above -3.0)	Level
27	1/14 (above -2.0)	Level

11. Analysis of the Problem. - The loss of beach material is caused by wave action. The general features of the problem are essentially the same but detailed features vary throughout the area. Ordinary short storm

waves cause littoral drift and offshore loss of beach material. Absence of swells probably precludes the possibility of return of material from offshore by wave action. The prevalence of onshore winds and storms from the southwest quadrant and the longer fetch to the west and southwest result in wave generated littoral currents which move predominantly eastward. The predominant movement of littoral drift along shores which trend generally east and west is therefore eastward while along shores which run generally north and south, littoral drift moves northward. The irregularities in the shore line with the consequent variations in exposure and the shelter afforded by islands, result in movement of littoral drift at localized areas in directions different from the predominant directions. Due to the absence of natural sources of supply of beach building materials, the quantity of littoral drift is small. This is particularly true in Guilford and Branford. Littoral drift in East Haven and New Haven is obtained principally from the sandy beach deposits which constitute so much of this shore. Minor streams contribute little material to the beaches. A listing of the direction and evidence of littoral drift at various locations is included in Appendix F.

12. In general, the rate of supply of beach material cannot be increased except by artificially placing material directly on the beach or in stockpiles to be distributed by wave action. Small amounts of accretion can be effected along portions of the shore of East Haven by construction of groins to intercept and impound littoral drift derived from adjacent sandy beaches. The usefulness of groins elsewhere in the study area would be limited to reduction of losses of existing or artificially placed beaches. Loss of land has been prevented, except during the most severe storms and hurricanes, by armoring the shore against wave attack by bulk-

heads, sea walls and revetments in those areas where supply of material has been inadequate to maintain a protective beach. Such structures have reduced the supply of material available for beaches by protecting former sources of supply. Other methods of protection, such as offshore breakwaters, are not considered applicable in this area.

13. Design Criteria. - Proposed protective measures are designed to provide protection against ordinary conditions of comparatively frequent occurence (at least once a year). They are not intended to provide protection to waterfront structures in the event of hurricanes or exceptional storms of infrequent occurence although even under these conditions some protection will be afforded. Specific design criteria used for protective works are as follows:

a. Design Tide. - The design tide is the maximum elevation of tides which occurs at least once a year. Tide records at New London and Bridgeport indicate that this elevation is 3 feet above the plane of mean high water.

b. Groins. - The horizontal shore section should have a top elevation not lower than the general height of existing berms of beaches or approximately 5 feet above the plane of mean high water and a length equal to that of the berm of the anticipated beach. The intermediate sloped section should be not steeper than the slope of the existing bottom. The top elevation of the outer section should be not lower than 1 foot above the plane of mean low water. For riprap construction, the minimum height of groins should be 3 feet. Groins should be sand tight and firmly anchored at their shore ends to prevent flanking. Groin lengths are generally determined by the toe of the anticipated beach or sand fill. Stone sizes and slopes for groins are computed using the Iribarren method as described

in Technical Report No. 4 of the Beach Erosion Board entitled "Shore Protection Planning and Design". The design wave used is the maximum wave that can break in the depth of water at the groin if the fetch is not a limiting factor. With the fetch available in Long Island Sound, such maximum waves can generally be generated.

c. Sand Fills. - Berm elevations of proposed fills are based on those of existing beach berms. The minimum width of fills is based on widths found to afford protection in the area. Computed volumes of fills are based on slopes similar to existing slopes but fills can be placed initially to a steeper slope and permitted to take a natural slope under wave action. Based on these critira berm elevations are approximately 5 feet above mean high water and beach widths above mean high water are approximately 125 feet with fill slopes of 1 on 20 to 1 on 30. Suitable sand for beach fills would be of size and gradation not finer than that on existing beaches.

III Plans of Improvement

14. Guilford Point and Adjacent Shore. - Guilford Point is a low projecting point of land flanked by marshes (Plate 11). It is privately owned and occupied by a few cottages and residences. Its shore is composed of bedrock, boulders, cobbles, gravel and sand. Low sand spits trail east and west from it in front of marsh towards East and West Rivers. Portions of the spits are owned by the town of Guilford. The one trailing to the east (Plate 17, Fig. 1) is used as a public bathing beach and it is provided with a bathhouse, parking area and sanitary facilities. The westerly spit is undeveloped. The point is protected by riprap revetment, loose stone and rubble masonry walls. In addition, natural protection is provided by the outcrops of bedrock and the coarse material left as a result of former erosion.

The spits and marsh on either side of the point have been subject to erosion which between 1933 and 1948 caused the shore line to recede 25 to 50 feet. This process is continuing. No harmful effects are known to have resulted from this erosion. Improvement of the public bathing beach is desired for recreational use. Since there are no sources supplying beach building materials by natural processes, improvement of the beach can only be effected by artificial nourishment. Probings in East River and opposite the river entrance in Guilford Harbor indicate that suitable material exists offshore within a practicable distance for hydraulic dredging and placement of fill on the bathing beach. A plan of improvement by direct placement of fill to widen the bathing beach and construction of an impermeable groin to retain the fill and reduce losses by eastward drifting has been considered and is shown on Plate 16. A Federal project, adopted in 1945, provides for improvement of Guilford Harbor by dredging a navigation channel into East River. No work has been done on the project. The Town of Guilford has reportedly appropriated and has had its required share of the cost of the improvement available for a number of years and it is attempting to obtain the necessary Federal appropriation for the work. There is an adequate quantity of suitable material required to be dredged for the navigation project within a practicable distance for pumping to the public bathing beach to supply the fill needed for the beach project. In the event the channel is dredged, consideration should therefore be given to disposal of suitable material to enlarge and improve the bathing beach.

15. Chaffinch Island and Adjacent Shore. - The shore between West River and Mulberry Point consists principally of marsh with bedrock exposed at Chaffinch Island (Plate 11 and Plate 17, Fig. 2). The immediate shore area is undeveloped. The shore line has been subject to considerable

erosion and recession since 1838. No harmful effects are known to be resulting from this recession. Protection of the shore is not needed and has not been considered.

16. Mulberry Point. - Mulberry Point is located between Guilford Harbor and Indian Cove (Plate 11 and Plate 17, Fig. 3). Its shore line is composed predominantly of bedrock. There is a marshy indentation on the east side of the point, numerous boulders around the outer tip and small patches of beach composed of finely ground shells in pockets of the rocky shore. Development consists of summer cottages. A road borders a portion of the shore along Indian Cove. Concrete and rubble masonry walls generally protect lawns in front of the cottages. A portion of the shore road is also protected by a sea wall. The only appreciable erosion and recession of the shore since 1933 has occurred along the marsh along the east side of the point. Existing structures appear adequate to provide the type of protection needed. No plan of protection has been considered.

17. The Head and West Shore of Indian Cove. - This area includes the head of Indian Cove and its west shore extending to the first point of land east of Vineyard Point (Plate 11 and Plate 18, Fig. 1). The head of the cove seaward of the road is composed of marsh and a small accumulation of finely ground shells. The west shore is principally composed of bedrock. There is a small pocket beach composed of finely ground shells, in an indentation of this west shore and considerable gravel, cobbles, boulders and some patches of coarse sand along its southerly end. Development is largely concentrated along the north end of the west shore of the cove and it consists of permanent residences and summer cottages. There are a few loose stone and rubble masonry walls in front of lawns along the west shore and some dumped boulders fronting the road at the head of the cove. Except

for the low marshy barrier bar at the head of the cove, there has been little change since 1838 in the position of the high water line. The head of the cove has been subject to continuous recession at a rate of 2 to 3 feet per year. Continued recession will require some form of protection for the road on the bar. Economical protection can be provided by the use of riprap revetment. No specific plan of protection is needed and none has been developed.

18. Vineyard Point and Sachem Head. - This area includes Vineyard Point, the shore indentation east of and adjacent to it and the shore to the west including Sachem Head and most of the southeast shore of Joshua Cove (Plate 11, Plate 18, Figs. 2 & 3, Plate 19, Fig. 1). The shore is irregular and composed largely of exposed bedrock. Unconsolidated material consisting of marsh, sand, gravel or boulders generally exists along the shore line only in pockets in the rock. A considerable extent of the shore of Joshua Cove adjacent to Joshua Point is covered with stone quarry waste while the shore of the cove nearer its head is composed of coarse material ranging from gravel to boulders. Shore ownership is private. Development is residential, both permanent and seasonal. The Sachem Head area possesses many large, widely spaced residences and a small pleasure boat harbor and yacht club. Shore protection consists generally of light sea walls and riprap revetment fronting lawns and low roads except along the east side of Vineyard Point where the residential development is protected by fairly heavy sea walls of rubble masonry and concrete. The only appreciable recession of the high water shore line has occurred in the indentation east of and adjacent to Vineyard Point. This recession has averaged about $2\frac{1}{2}$ feet per year since 1838 and about 5 feet per year since 1933. There has been little or no change in the position of the shore line elsewhere except

for man-made improvements. Existing structures appear to be adequate to provide necessary protection. No plan of protection or improvement has been considered.

19. Head and Northwest Shore of Joshua Cove. - This shore has a length of about 7,000 feet bordering the entire head and north side of Joshua Cove and about 600 feet of the south side adjacent to its head (Plates 11 & 12, Plate 19, Figs. 2 & 3). The south shore is covered with coarse material ranging from gravel to boulders. The south half of the head of the cove, a sand and gravel bar, and the north half, a low earth dam revetted with riprap both front marsh and are separated from each other by a bedrock shore projection. The north shore of the cove consists principally of bedrock, boulders and rock fragments. Development consists of summer cottages located along the south and north shores and the south end of the head of the cove. Ownership is private except for the dam which belongs to the State of Connecticut. A low road on the south half of the bar at the head of the cove is protected by riprap revetment. Rubble masonry walls protect lawns at some of the cottages along the north shore. The principal shore recession since 1838 occurred along the north half of the head of the Cove averaging up to 2 feet per year of which about 50 percent occurred after 1933. The south shore has been developed since 1948 as a cottage colony. A few cottages have also been built on the south end of the adjacent barrier bar at the head of the cove. The bar is low and therefore susceptible to flooding during storms or hurricanes accompanied by exceptionally high tides. The lack of change in the position of the shore line of the south end of the bar shown by shore line comparisons indicates there is no serious erosion problem there. Existing structures if maintained are generally adequate for protection against erosion.

20. East Shore and Head of Island Bay. - The shore line bordering the east side and the head of Island Bay is composed largely of exposed bedrock with marsh along the south end and a sand bar fronting marsh along the north end of a large indentation (Plate 12 and Plate 20, Fig. 1). The head of the bay is a sand bar. Ownership is private. Development consists of summer cottages, most of which are concentrated at the easterly half of the head of the bay and the north end of its east shore. A low shore road on the bar in the shore indentation on the east side of the bay is protected by riprap revetment and a loose stone wall. The cottage colony at the head of the bay is protected by stone filled timber cribs and low sea walls with riprap in front of some of the walls. Riprap revetment borders both sides of the road at the head of the bay west of the cottage colony. The head of Island Bay has been subject to gradual recession. Since 1933 its high water line has receded at a rate between 1 and 2 feet per year. This recession has reportedly resulted in the loss of a road and sandy beach which formerly existed in front of the cottage colony. The high water line is now generally at the line of walls and riprap revetment. These structures if maintained should provide adequate protection against erosion and prevent further shore recession. Due to the low elevation of the bar, the cottage colony area located thereon is subject to flooding during storms or hurricanes accompanied by exceptionally high tides. Existing structures do not provide complete protection against this flooding but protection against flooding is not regarded as being within the scope of this study. The lack of sources of beach building materials close to this area which can be used to build a protective beach eliminates this method as an economical solution. Maintenance and possibly minor enlargement of existing structures appear to be all that is justified.

21. Island Bay, Clark Point, Little Harbor and Harrison Point. - This is an irregular bedrock shore line including the west side of Island Bay and the shore to the west to the Guilford-Branford boundary, (Plate 12 and Plate 20, Fig. 2). Small sandy pocket beaches exist in indentations. The shore is privately owned. Development consists of summer cottages and widely spaced residences. The northerly half of the west shore of Island Bay is covered with large quantities of riprap. There are two shore-connected riprap breakwaters at the entrance to Little Harbor. No erosion or shore protection problem is known to exist in this area and no plan of protection or improvement has been considered.

22. Leetes and Narrows Islands and Hoadley Neck. - The shore line of Leetes and Narrows Islands and Hoadley Neck is composed predominantly of bedrock (Plate 12). The shore of Leetes Island is covered with stone quarry waste. The area is privately owned and sparsely developed for residential use. There are no known beach erosion problems and no plan of protection or improvement has been considered.

23. Flying Point and Stony Creek. - The Flying Point-Stony Creek area is a small residential and fishing community separated by marsh from Hoadley Neck to the east and Pleasant Point to the west (Plate 12, Plate 20, Fig. 3 and Plate 21, Fig. 1). It has a small boat harbor naturally sheltered by a group of islands known as The Thimbles. The shore is composed principally of bedrock with small sandy pocket beaches at scattered locations. Shore ownership is private. There is an almost continuous system of sea walls and a number of piers, boat slips and marine railways along the shore. Existing protective works if maintained should provide the type of protection which is generally needed. No erosion or shore protection problems are known to exist and no plan of protection or improvement has been considered.

24. The Thimbles. - The Thimbles are a group of small rock islands opposite the Leetes Island - Stony Creek area (Plate 12). The shore line of most of the islands consists of bedrock. Development on individual islands ranges from single shacks or small summer houses to colonies of summer homes. There is no known erosion problem and no plan of protection has been considered.

25. Pleasant and Juniper Points. - The shore lines of Pleasant and Juniper Points are irregular and rocky with sand only in indentations (Plate 12 and Plate 21, Fig. 2.). Marsh separates the points from each other and from Stony Creek to the east and Pine Orchard to the west. There is a small group of cottages at Pleasant Point and a mooring area and pier for loading barges with trap rock at Juniper Point. No beach erosion or shore problems are known to exist in this area. No plan of protection or improvement has been considered.

26. Pine Orchard Between Juniper and Brown Points. - The shore line of Pine Orchard between Juniper and Brown Points borders a small dredged pleasure boat harbor sheltered by a riprap breakwater extending southeastward from Brown Point (Plate 13). The shore is characterized by projecting outcrops of bed rock with sandy pocket beaches held between the projections. Development consists of residences, a yacht club, private bathing beach and summer hotels. Light concrete and rubble masonry sea walls front lawns along most of the shore. There is no known beach erosion problem in the area. No plan of protection or improvement has been considered.

27. Pine Orchard West of and Adjacent to Brown Point. - The shore line extending about 2,100 feet westward from Brown Point is a shallow sandy pocket beach between outcrops of bedrock (Plate 13 and Plate 21, Fig. 3). Ownership is private. Development consists of large residences protected

by sea walls, sloped stone revetment and timber groins. Comparative surveys indicate that there has been little or no change in the position of the high water shore line and offshore depths since 1885. Seasonal variations in the elevation and composition of the beach reportedly occur with the height of the west end of the beach rising considerably in the winter months and dropping in the summer, while the beach composition nearer Brown Point is coarse in the winter and finer in the summer. The beach is used for bathing by area residents. Local interests have indicated an interest in eliminating seasonal variations in beach level and preventing losses of beach material. Existing sea walls and revetment, if maintained, should provide adequate protection to the land behind the beach. Reduction of seasonal variations of beach level can probably be achieved but not completely eliminated by construction of impermeable groins similar to those existing along the west end of the area. The groins should, unlike existing structures, be extended landward to the sea walls or bluffs to prevent passage of material around their landward ends. Their effectiveness can also be increased by extending them seaward at least to the mean low water line. Details of typical designs of suitable groins are shown on Plate 6. Design information concerning spacing and other factors is contained in Technical Report No. 4 of the Beach Erosion Board entitled "Shore Protection Planning and Design". The lack of change in the position of the high water line shown by shore line change maps indicates that any loss of beach material must be at a very slow rate. The prevention of such losses would be difficult and costly. There are no natural sources of supply contributing any appreciable amount of beach building material which can be impounded by groins or other structures. Replacement of any beach losses can therefore only be effected by direct placement of material on the

beach. The small quantity of material needed for beach maintenance and the existence of mud and clay in the offshore area make use of the hydraulic dredging process impractical for beach nourishment. A practical method of providing needed maintenance consists of periodically hauling and dumping small quantities of suitable sand at some location along the beach where ordinary wave action can transport the material throughout the area. Construction of groins unless accompanied by artificial filling to the limit of their impounding capacity would interfere with the natural distribution of such beach fill. The need for preventing sand losses or reducing seasonal variations is considered insufficient to warrant development of detailed plans.

28. Pine Orchard, Hotchkiss Grove Beach and Haycock Point. - This area extends westward from the rocky projection, 2,100 feet west of Brown Point, along Hotchkiss Grove Beach to and including Haycock Point (Plate 13 and Plate 22, Figs. 2 and 3). The shore line is irregular and is composed of outcrops of bedrock and small sandy pocket beaches. The shore is privately owned and continuously developed for residential use. It is used for bathing by area residents. Comparative surveys indicate that there has been little change in the position of the high water shore line and offshore depths in recent years. The residential development is in general adequately protected by existing sea walls, revetment and groins. A low shore road closely bordering the central and westerly portions of Hotchkiss Grove Beach is partially protected by a low riprap wall but the road is subject to washouts during storms accompanied by exceptionally high tides. More effective protection could be provided by enlargement of the wall as a rubble mound. Damages would still occur at infrequent intervals due to overtopping of the mound by extreme tides and waves but it would probably be

more economical to make necessary repairs rather than to provide complete protection against all possible conditions.

29. Limewood Beach. - Limewood Beach located west of Haycock Point is a shallow pocket between outcrops of bedrock (Plate 13 and Plate 22, Fig. 3). The easterly half of the beach is sandy with width decreasing to the west. There is generally no width of sand beach above high water along the west half which is characterized by outcrops of bedrock. Development consists of residences and summer hotels. Shore ownership is mostly private. There is a private bathing beach belonging to the Eastern Indian Neck Association adjacent to Haycock Point. There may be some public ownership but this is not clear from town records. About 500 feet of State Highway Route 143 which closely borders the shore has been protected with riprap revetment. Groins front this revetment and the sea walls along the residential development to the west. Existing structures, if maintained, should provide adequate protection against ordinary storm attack. No plan of protection is needed and none has been considered.

30. West of and Adjacent to Limewood Beach. - The shore west of and adjacent to Limewood Beach is a shallow sandy pocket between outcrops of bedrock (Plate 13 and Plate 23, Fig. 1). Shore ownership is private. Development consists of residences and summer hotels. A hotel opposite the west half of the beach maintains bathhouses for its patrons. The beach above high water is narrow. Lawns and a steep bluff bordering a shore highway are protected by sea walls, bulkheads and a few short groins. There are no evident sources of supply contributing beach building materials by natural processes and the groins consequently have little or no effect in impounding a beach. Advice has been requested concerning methods of effecting a limited amount of beach widening fronting a small summer hotel west of an existing riprap groin at the extreme east end of the area. The groin already holds a narrow sand beach which can be enlarged sufficiently by direct placement of a small quantity of sand to provide for the limited recreational needs of the hotel patrons. The small improvement needed and the scarcity of sand in the immediate offshore area precludes the hydraulic dredging process as a practicable method. Periodic trucking of sand to the beach is probably the most economical method which can be used. The comparative stability of the shore as shown by comparison of shore line positions since 1838 indicates that losses of beach material will be at a slow rate and should not constitute a serious problem. Maintenance of the existing riprap groin, which when inspected was in need of repairs, will reduce losses of the beach material. Throughout the shore area, existing walls and bulkheads are adequately protecting the land behind the beach and should continue to do so if adequately maintained. No specific detailed plan of protection is needed and none has been developed.

31. Indian Neck (Linden Point, Maltby Cove, Jeffrey Point). - The shore from the first pocket beach west of Limewood Beach including Linden Point, Maltby Cove and Jeffrey Point is composed almost continuously of outcrops of bedrock with sand and gravel in small indentations (Plate 13). Ownership is private. Development consists of summer cottages and year round residences. Bedrock and the coarse shore material provide natural protection against erosion. Lawns fronting a considerable part of the development are low and protected by walls. Such areas are probably inundated during storms accompanied by exceptionally high tides. No erosion problem is known to exist in the area. No plan of protection against erosion is needed and none has been developed.

32. Jeffrey Point to Indian Neck Point. - This extent of shore is a sandy pocket beach between outcrops of bedrock at Jeffrey and Indian Neck Points (Plate 13 and Plate 23, Fig. 2). Ownership is private. Development is residential with a few large widely spaced residences set well behind the shore along the north half and smaller more closely spaced residences along the south half. There is practically no width of sandy beach above high water along the southerly half and residences in this area are fronted by low sea walls. There has been little or no apparent change in the position of the high water shore line since 1838. Due to its low elevation, the development along the south end of the beach is subject to flooding during infrequent storms accompanied by exceptionally high tides. No erosion problem is known to exist and therefore no plan of protection has been considered.

33. Parker Memorial Park. - Parker Memorial Park is located in Branford Harbor west of and adjacent to Branford Point (Plate 13 and Plate 23, Fig. 3). Its shore is composed largely of bedrock and coarse material.

There is a sandy pocket beach in the indentation adjacent to Branford Point. The park is owned by the Town of Branford. It is provided with dressing rooms for use of the park shore as a public bathing beach. Rubble masonry walls generally provide adequate protection against erosion of the land. Improvement of the bathing beach composition has reportedly been effected by direct placement of sand. Minor periodic improvement of this type, as necessary to maintain the existing bathing beach appears to be all that is necessary. No erosion problem is known to exist and no plan of protection or improvement has been considered.

34. Lindsey Cove to Pages Cove. - The projecting shore west of Parker Memorial Park to Johnson Point and Pages Cove is irregular and composed largely of outcrops of bedrock (Plate 14). Sandy beaches generally exist only in small indentations in the rock. A sandy tombolo, known as Double Beach, connects Lover's Island in Branford Harbor to the mainland. Ownership of the shore is private. Development consists of summer cottages, year round residences and a commercially operated bathing beach, the latter at Double Beach. There is no known beach erosion problem in the area. No plan of protection is needed and none has been considered.

35. Pages Cove and Short Beach. - Pages Cove and the adjoining Short Beach area, located at the head of the large shore indentation between Johnson Point and Kelsey Island, consist of a series of small sandy pocket beaches separated by projecting points of exposed bedrock (Plate 14). The shore is privately owned except for street ends in the pocket beach west of Stanley Point. The shore bordering the road in Pages Cove adjacent to Stanley Point and the pocket beach in which Profile 14 is located may belong to the town but this public ownership is not clearly established.

These latter areas are used for bathing by town residents. They are not provided with any public facilities. The easterly pocket of Pages Cove is a private bathing beach restricted to hotel guests. The general development of the area is residential. Sea walls and riprap revetment protect shore residences and the shore road. The pocket beaches are naturally stable and do not require protection against erosion. Existing structures, if maintained, should generally be adequate for protection of the shore road and residential development although some flooding can occur during infrequent storms accompanied by exceptionally high tides. Due to the absence of natural sources of supply of beach building materials, improvement or enlargement of existing sandy beaches, if desired, can only be effected by artificial placement of sand fill. No structures would be needed to prevent losses of such fill. No detailed plan of protection or improvement is needed and none has been considered.

36. Between Short Beach and Horton Point. - The shore extending southward from the Short Beach area to Horton Point is irregular and almost continuously composed of bedrock (Plate 14). It is privately owned and developed for residential use. There is no erosion problem in the area. No plan of protection has been considered.

37. Kelsey Island. - The shore line of Kelsey Island is characterized by numerous outcrop of bedrock (Plate 14). Small sandy pocket beaches extend between these outcrops along its south side. About one-half the area of the island consists of marsh. There are a few buildings on the higher ground. So far as is known, there is no erosion problem. No plan of protection has been considered.

38. Mansfield Point. - The shore of Mansfield Point located between the East Haven River and Bradford Cove is composed of bedrock outcrops with

sandy beaches held in indentations (Plate 14). The shore is privately owned. Development consists of cottages. The area does not have any known beach erosion problem. No plan of protection has been considered.

39. Momauguin Beach. - Momauguin Beach is a sandy shore with bedrock outcrops at its west end and also about 300 feet west of Bradford Cove, its easterly limit (Plate 14 and Plate 24, Figs. 1-3). Ownership, except for a few town street ends which extend to the shore, is private. Development consists of year round residences, summer cottages, refreshment stands, and a commercially operated bathhouse. Protective structures consisting of sea walls and bulkheads generally exist only along the east and west ends of the beach where the shore line is close to buildings. Comparison of maps of record indicates that between 1885 and 1933 there was shore recession of up to 100 feet along all of the beach except between Bradford Cove and the first outcrop of bedrock to the west where accretion and seaward movement of the shore of about 100 feet occurred and that the shore line in 1952 along the entire beach was practically in the same position it occupied in 1933. Changes determined by field inspections, ground and aerial photographs, not shown by the above comparisons, are known to have occurred along the east end of the beach adjacent to Bradford Cove since 1948 (See Plate 24, Figs. 1 and 2). During the period 1948-1949 a sand beach about 200 feet wide existed in front of residences between Bradford Cove and the first rock outcrop about 300 feet to the west. This beach extended eastward in the form of a sandspit across the mouth of Bradford Cove. Between 1948 and 1952 erosion resulted in the loss of the spit and the entire beach fronting residences thereby endangering their existence. During February 1955, it was observed that considerable width of sand beach again existed in front of residences and this beach

trailed eastward as a sandspit across the mouth of Bradford Cove almost connecting with the south tip of Mansfield Point. It was also noted that a deteriorated groin at the west side of the Bradford Cove entrance had been reconstructed with riprap since 1952 and extended southerly and then westerly as a continuous riprap mound in front of residences. Erosion and recession of the shore line has also been observed between 1948 and 1952 along the beach about 800 feet west of Bradford Cove. The beach area adjacent to Bradford Cove has reportedly been formed artificially by progressively extending a groin at Bradford Cove which impounded littoral drift on its west side. A practicable method of reducing the large fluctuations in the position of the shore line adjacent to Bradford Cove and providing protection for residences consists of additional extension of this groin to intercept and impound beach material which is now lost to the east. Momauguin Beach as a whole is low and the development on it is consequently subject to flooding and wave attack during storms accompanied by exceptionally high tides. Protection against wave attack can be provided by direct placement of a wider sand beach in front of buildings and structures. Reduction of losses of this fill, if excessive, can be effected by construction of impermeable groins. Groins will probably also intercept and impound some beach material but their effectiveness will decrease the farther west they are built since the length of sandy shore on the updrift side which can supply littoral drift will be progressively shorter and the supply of material therefore smaller. It is also likely that the supply of drifting material will decrease following construction of more structures for protection of developed areas to the west. A plan of protection involving beach widening by direct placement of sand fill from available sources offshore and construction of impermeable groins as discussed

above has been considered and it is shown on Plate 16.

40. A large part of Momauguin Beach has been included in a proposed redevelopment plan by the United States Housing and Home Finance Agency. Under this plan much of the shore front would be acquired by the town for a park and bathing beach, and the shore front land area would be redeveloped to eliminate substandard buildings and overcrowding. In the event that this redevelopment materializes an excellent opportunity will arise to provide natural protection to all shore front buildings by requiring that they be at least 125 feet landward of the high water shore line to keep them out of reach of ordinary storm wave attack.

41. Silver Sands Beach. - Silver Sands Beach is a sandy shore (Plates 14 and 15, Plate 25, Figs. 1 and 2). It extends between bedrock outcrops at the point known as South End and the west end of Momauguin Beach. Bedrock is also exposed at a few locations along the shore. The beach is privately owned and occupied by closely spaced, larger than average summer cottages. Protective structures range from occasional low light sea walls along the east half of the shore which possesses a small width of fronting sand beach to an almost continuous irregular line of fairly heavy sea walls and bulkheads and a number of groins along the west half of the beach where the waters edge is generally at the line of buildings or structures. The shore line has a history of erosion and recession. The easterly half of the beach receded at a rate of about one foot per year between 1838 and 1952 while the westerly half which was comparatively unchanged between 1838 and 1933 has receded at a rate of one to four feet per year since 1933, the greater recession having occurred adjacent to South End. The continued erosion of the beach has required the construction of more and heavier sea walls to protect cottages. In some cases, near South

End the shore line has receded landward of the front lines of buildings and sea walls. The bar is low in elevation and the development on it is consequently subject to flooding and wave attack during severe storms or hurricanes accompanied by exceptionally high tides. Restoration of past beach losses to provide a sandy beach in front of cottages and structures is a practicable method of protection against wave attack. Groins along the more severely affected west half of the beach have failed to impound littoral drift. This indicates that beach restoration can be effected only by direct placement of fill on the beach. Probings indicate that suitable beach material exists offshore within a practicable distance for hydraulic dredging and pumping to shore. A plan based on such beach restoration has been considered and it is shown on Plate 16. Maintenance of the beach will be required and can probably be effected most economically by periodic replacement of beach losses. Losses of the beach fill, if excessive, can be reduced by impermeable groins but this method should not be used unless experience with the fill indicates that their construction is economically justified.

42. West Silver Sands Beach. - West Silver Sands Beach is a sandy shore fronting marsh extending westward from South End to Morgan Point (Plate 15, Plate 25, Fig. 3, Plate 26, Figs. 1 and 2). There are rock outcrops at the ends and at several locations along the beach. The shore is privately owned. Development consists of summer cottages and a commercially operated bathing beach provided with cabanas and a bathhouse. A few of the cottages are protected by timber bulkheads. There are timber jetties at South End at the mouth of Caroline Creek and a number of timber groins along the shore. The two longest groins located near South End hold a wider sand beach on their east side while groins farther west hold

material on their west sides. The shore line has been subject to erosion which resulted in a recession averaging 1 to 2 feet per year between 1838 and 1933 and up to 5 feet per year between 1933 and 1952. Cottages have reportedly been moved landward repeatedly following retreat of the shore. The bar is low in elevation and the development is subject to flooding and wave attack during storms or hurricanes accompanied by exceptionally high tides. Restoration of past beach losses to provide a sandy beach in front of cottages and maintenance by periodic replacement of beach losses is a practicable method of protection against wave attack. Existing groins have reduced losses of beach material but they have not resulted in any appreciable widening of the beach. Restoration of the beach can be accomplished only by direct placement of fill along the shore. Probings indicate that suitable material exists offshore within a practicable distance for hydraulic dredging and pumping to the beach. A plan based on beach restoration has been considered and it is shown on Plate 16. Losses of the beach fill, if excessive, can be reduced by impermeable groins but they should not be used unless experience with the fill indicates that their construction is economically justified.

43. Morgan Point. - Morgan Point is a low projecting headland considered in this report to extend about 1500 feet east and 1400 feet west from its outer tip (Plate 15, Plate 26, Fig. 3). The outer tip and east shore are largely composed of bedrock with small extents of sand beach held in indentations. The west shore is coarse, being generally covered with gravel, stone fragments and riprap. The shore is privately owned and developed for residential use. Most of the residences are fronted by sea walls or bulkheads. These structures form a disconnected line of protection along the east face of the point and an irregular continuous

heavier system of protection from the outer tip along the west face of the point. The west side of the point has been subject to erosion which since 1838 has resulted in a shore recession of about 200 feet at its outer tip and 50 to 100 feet elsewhere. During the same period, shore line changes along the east side of the point appear to have been negligible. Due to its low elevation portions of the development are within reach of wave attack during storms or hurricanes accompanied by exceptionally high tides. Residences along the west face of the point are more vulnerable than elsewhere since the sea walls are at the water's edge without benefit of a fronting beach or out-crops of bedrock to dissipate the energy of wave attack. Walls in this area can be undermined by lowering of the beach level. The only practicable method of providing protection consists of maintaining some form of barrier, either bulkheads or sea walls, in front of residences. Existing walls if properly maintained could serve this purpose. Protection against undermining of sea walls can be provided most economically by placement of riprap revetment along their toes.

44. Shell Beach. - Shell Beach is a low sand bar fronting marsh extending westward from Morgan Point to outcrops of bedrock at the mouth of Morris Creek (Plate 15, Plate 27, Fig. 1). The beach is privately owned and it is occupied by a few summer cottages built on piles. There are no shore protection structures. The shore is sheltered by the New Haven Harbor breakwaters from waves from the south and southwest. Use of the beach is restricted to residents. The bar is low and the development is therefore subject to flooding and wave attack during storms accompanied by high tides. Erosion has caused retreat of the shore line since 1933 averaging about 2 feet per year at the east end of the beach and at a progressively

smaller rate to the west with practically no change at the mourh of Morris Creek. A method of protection against wave attack consists of direct placement of sand fill along the shore to create a wider and higher beach in front of cottages. Probings indicate that suitable material exists offshore within a practicable distance for hydraulic dredging and pumping to the beach. Such an improvement would require construction of a jetty or groin at the west end of the beach at Morris Creek to confine the fill. Such a plan has been considered and is shown on Plate 16. Construction of sea walls or bulkheads would be of doubtful value. Such construction could protect cottages from wave attack but it could also accelerate erosion of the fronting beach. There are no apparent natural sources of supply contributing material to the beach which can be impounded by groins so groin construction alone is not considered a practicable solution. Because of the limited development, the physical limitations of the bar which make it unsuitable for extensive development and the high cost of providing adequate protection, it is unlikely that construction of a suitable system of protective works can be justified. It is probably more economical to make periodic expenditures for damages to the existing development than to attempt to eliminate such damages. The beach could be maintained sufficiently for recreational purposes by periodic replacement of sand losses.

45. Lighthouse Point Park. - Lighthouse Point Park is located at the New Haven Harbor entrance (Plate 15, Plate 28, Figs. 1-3). Its shore extending westward from Morris Creek to the tip of Lighthouse Point and a short distance northward therefrom is sandy in composition. The remainder of the shore of the park to the north is composed principally of rock outcrops with small sandy pocket beaches held in irregularities

of the rock. The park belongs to the City of New Haven and is used as a public park and bathing beach. The bathing beach is the south shore of the park east of Lighthouse Point. The park is provided with a large modern bathhouse, parking and picnic areas, playgrounds and amusements. The only significant shore structure is a jetty at the mouth of Morris Creek. The shore is sheltered to the south and southwest by the New Haven Harbor breakwaters. Shore line changes between 1838 and 1933 were irregular and generally small in magnitude. During 1949 about 168,000 cubic yards of sand fill were placed at Lighthouse Point and the adjoining shore to Morris Creek. The fill was material disposed of in connection with hydraulic dredging of a Federal navigation improvement in New Haven Harbor. During 1952, as a result of the placement of fill and subsequent drifting, about 900 feet of shore line extending north from Lighthouse Point was 50 to 100 feet seaward of its 1933 position and the shore line from Lighthouse Point to Morris Creek was 150 to 200 feet seaward of its 1933 position. Between August 1952 and June 1955 the shore line of the bathing beach at and adjacent to Lighthouse Point receded. The recession at Lighthouse Point was 60 feet and it diminished to the east. Continuation of this process could result in a serious reduction in the needed recreational beach area, particularly in view of the large expenditures made by New Haven for construction of a modern bathhouse following enlargement of the bathing beach by the filling operation. Losses of beach material between the tip of Lighthouse Point and Morris Creek, can be reduced by construction of an impermeable groin at Lighthouse Point. Maintenance of this beach area will probably still be necessary and it can be effected by periodic replacement of beach losses. Probings indicate that suitable material for such main-

tenance exists offshore within a practicable distance for hydraulic dredging and pumping to the beach. The jetty at Morris Creek is adequately holding the fill along the east end of the beach. The plan of protection involving construction of a groin at Lighthouse Point is shown on Plate 16.

46. Between Lighthouse Point and Morris Cove Parks. - The shore line of Morris Cove between Lighthouse Point Park and Morris Cove Park varies in composition (Plate 15). Adjacent to Lighthouse Point Park there are a few outcrops of bedrock and the shore for about 2,300 feet to the north is generally covered with gravel with short extents of sandy beach held by structures or in indentations along the shore. This coarse shore merges into a sandy beach with a width above high water of about 100 feet (Plate 27, Fig. 2). The sandy beach is located at the head or most easterly part of Morris Cove and decreases in width to the north so that adjacent to Morris Cove Park there is no beach above high water. Ownership of the shore is private. Development is principally residential. There is a yacht club, boatyard and marine railway for small boats near the south end of the area. The development adjacent to Lighthouse Point Park is protected by various types of low sea walls and bulkheads. Farther to the north, along the wide sandy beach there are generally no protective structures. As the sand beach narrows, residences have been protected by sea walls and bulkheads of increasing size. Adjacent to Morris Cove Park residences located on a low bluff are fronted by high heavy walls at the water's edge. (Plate 27, Fig. 3). Changes in the position of the high water shore line between 1838 and 1933 consisted generally of landward movement at an average rate not exceeding one foot per year except along 300 to 400 feet of shore adjacent to Morris Cove Park

where recession at a rate of about one-half foot per year occurred. Some of the accretion along the coarse southerly portions of shore was probably due to construction. Since 1933, changes in the positions of the shore line have been negligible. Portions of the development are in low areas subject to flooding and wave attack during storms accompanied by exceptionally high tides. Existing structures, if maintained should generally provide adequate protection during ordinary wave attack. During hurricanes or storms of infrequent occurrence damages can occur to buildings. It is unlikely that provision of complete protection against all conditions would be economically justified. No plan of protection is needed and none has been considered.

47. Morris Cove Park to Fort Hale Park. - The shore along Morris Cove Park and the shore to the north possesses little sandy beach above high water (Plate 15). A high sea wall is at the water's edge along most of Morris Cove Park. Coarse material, mostly gravel and rock fragments along the north end of the park wall form a narrow width of beach in that area. The shore extending northward fronting Forbes Bluff, a trap cliff, is also coarse, being composed of angular rock fragments and gravel. The shore north of Forbes Bluff continues coarse being covered with gravel, cobbles and riprap with some coarse sand in the vicinity of Fort Hale Park, the outer tip of which is composed of bedrock outcrops. Except for a short segment of shore occupied by a United States Naval Reserve Station the entire area belongs to the City of New Haven and is used as a park. There are no facilities for public bathing. The area behind the park is residential in character. There is a building near the shore at the Naval Reserve Station fronted by a timber pier. The shore end of the pier and the front of the building are protected by a

rough mound of riprap. The only other protective structures along the entire shore are the Morris Cove Park sea wall and some light riprap scattered along the top of the low earth barrier fronting the moat at Fort Hale. Comparison of shore line positions indicates that between 1838 and 1933 the shore moved landward at a rate averaging less than one foot per year and that since 1933 there has been no apparent change. The coarse nature of the shore and existing structures provide adequate protection for present needs. Due to the low elevation of the land on which the Naval Reserve Station is located, this development is subject to flooding during storms accompanied by extreme high tides. There is no known beach erosion or shore protection problem of concern in the area and no plan of protection has been considered.

IV. ECONOMIC ANALYSIS

48. General. - Detailed estimates of costs are included in Appendix H and detailed estimates of benefits are included in Appendix I. First costs and benefits have been estimated for all projects considered based on price levels prevailing during the Fall of 1954. Projects have been considered as follows:

Area	Ownership	Paragraph Reference	Plate No.
Guilford Point Public Beach, Guilford	Public	14	16
Momauguin Beach, East Haven	Private	39	16
Silver Sands Beach, East Haven	Private	41	16
West Silver Sands Beach, East Haven	Private	42	16
Shell Beach, East Haven	Private	44	16
Lighthouse Point Park, New Haven	Public	45	16

49. First Costs. - The first costs of projects, computed in detail in Appendix H, are as follows:

Project	Work Items	Cost
Guilford Point Public Beach	Beach Fill and 1 Groin	$ 40,000
Momauguin Beach	Beach Fill and 4 Groins	166,000
Silver Sands Beach	Beach Fill and 5 Groins	190,000
West Silver Sands Beach	Beach Fill and 5 Groins	220,000
Shell Beach	Beach Fill and 1 Groin	80,000
Lighthouse Point Park	1 Groin	12,000

50. Benefits. - The estimated benefits are based on direct damages prevented, increased earning power or value of shore lands, and the recreational value of increased public beach space. Benefits from increased value of areas behind and adjacent to improved shore property,

increased business returns and recreational value in improvement of private beaches, although known to exist, have not been estimated. Direct damages prevented have been evaluated as a saving in the maintenance cost of existing protective structures, on the value of annual losses of shore land or beach fill prevented and on the reduction of storm damages to the existing shore development. Benefits from increased earning power or value of shore lands have been evaluated on the basis of increased returns to owners resulting from increased area of shore front property and also on the resulting broadening of the tax base. The recreational benefit has been evaluated for increased public beach area based on probable beach use by assigning a per capita value for beach use estimated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. Estimated annual benefits are as follows:

Project	Direct Damages Prevented	Increased Earning Power	Recreational	Total
Guilford Point Public Beach	$ 0	$ 0	$4,200	$4,200
Momauguin Beach	6,560	3,670	0	10,230
Silver Sands Beach	8,480	3,980	0	12,460
West Silver Sands Beach	7,850	4,810	0	12,660
Shell Beach	550	2,000	0	2,550
Lighthouse Point Park	1,400	0	0	1,400

51. Interests - There is no Federal interest in a shore protection project as none of the shore in the considered area is owned by the United States. Non-Federal public interest is defined as, (a) the benefits accruing to a State or political subdivision thereof as a land owner and, (b) the benefits accruing to the general public, Private interest is defined as

the benefit derived by individuals or non-public groups of individuals on account of ownership of lands and business enterprises affected. The classification of estimated benefits in accordance with the interest involved is as follows:

Project	Federal	Non-Federal Public	Private	Total
Guilford Point Public Beach	0	$4,200	0	$ 4,200
Momauguin Beach	0	1,510	8,720	10,230
Silver Sands Beach	0	1,640	10,820	12,460
West Silver Sands Beach	0	1,980	10,680	12,660
Shell Beach	0	820	1,730	2,550
Lighthouse Point Park	0	1,400	0	1,400

52. Allocation of Costs. - Public Law 727, 79th Congress, 2d Session, established a policy of Federal aid in the protection and improvement of shores owned by states, municipalities and other political subdivisions. In accordance with this policy, the Federal share of the cost can equal but not exceed one-third of the first cost of construction, but not the maintenance, of works for the protection and improvement of publicly-owned shores. No policy has been established for Federal participation in the cost of works for the protection and improvement of privately-owned shores. Factors governing the Federal and non-Federal allocation of costs of contemplated projects are discussed in Section V of this report entitled "Conclusions and Recommendations." The detailed estimates of costs are contained in Appendix H and are summarized below:

Project	Federal Share	Non-Federal Share	Total
Guilford Point Public Beach	0	$ 40,000	$ 40,000
Momauguin Beach	0	166,000	166,000
Silver Sands Beach	0	190,000	190,000

Project	Federal Share	Non-Federal Share	Total
West Silver Sands Beach	0	$220,000	$220,000
Shell Beach	0	80,000	80,000
Lighthouse Point Park	4,000	8,000	12,000

53. Annual Costs. - Interest has been computed at a rate of 2.5 per cent on all funds. A useful life of 50 years has been assumed in determining amortization charges. Maintenance estimates of sand fill are based on maximum rates of loss determined from past shore recession with an assumed minimum rate of one foot per year. Estimated annual costs are summarized below:

Project	Interest	Amortization	Maintenance	Total
Guilford Point Public Beach	$ 1,000	$ 410	$ 380	$ 1,770
Momauguin Beach	4,150	1,700	2,955	8,805
Silver Sands Beach	4,750	1,950	4,170	10,870
West Silver Sands Beach	5,500	2,260	4,025	11,785
Shell Beach	2,000	820	945	3,765
Lighthouse Point Park	300	120	100	520

54. Justification. - The estimated annual benefits and costs and the resulting ratios of benefits to costs are summarized below:

Project	Estimated Annual Benefits	Estimated Annual Costs	Ratio of Benefits to Costs
Guilford Point Public Beach	$ 4,200	$ 1,770	2.3
Momauguin Beach	10,230	8,805	1.1
Silver Sands Beach	12,460	10,870	1.1
West Silver Sands Beach	12,660	11,785	1.07
Shell Beach	2,550	3,765	0.6
Lighthouse Point Park	1,400	520	2.6

55. Coordination with Other Agencies. - Close coordination has been maintained with the Connecticut State Flood Control and Water Policy Commission, the official agency representing the State of Connecticut in this cooperative study. Officials of the towns concerned have been contacted and their views sought. The United States Housing and Home Finance Agency, Connecticut Development Commission, State Park Department, State Highway Department and State Board of Fisheries and Game have been contacted concerning aspects of the study pertaining to their interests. In addition, personal contact has been made with shore residents to ascertain data concerning their problems.

56. Comments by Local Interests. - The cooperating agency, the Connecticut State Flood Control and Water Policy Commission has been informed of the findings and recommendations contained in this report. It considers the report satisfactory and furthermore feels that the proposed plans of protection and improvement are desirable and necessary.

57. Responsibilities of Local Interests. - In regard to the proposed plan for protection of the bathing beach at Lighthouse Point Park, the cooperating agency has informed the Division Engineer it seems certain that the assurances required in connection with the conditions of local cooperation will be furnished when needed. Local interests are required to:

a. Assure maintenance of the protective and improvement measure during its useful life as may be required to serve its intended purpose;

b. Provide, at their own expense, all necessary lands, easements, and rights-of-way.

c. Assure that water pollution that would endanger the health of bathers will not be permitted.

d. Assure continued public ownership of the shore and its administration for public use during the economic life of the project.

The recommendation is further subject to the conditions that the adequacy of the work proposed by local authorities, detailed plans, specifications, assurances that the requirements of local cooperation will be met and arrangements for prosecuting the work be approved by the Chief of Engineers prior to commencement of work.

V. CONCLUSIONS AND RECOMMENDATIONS

58. Conclusions. - The Division Engineer concludes that the following are practicable plans for protection and improvement of shore areas which merit consideration, all as shown on Plate 16.

a. Guilford Point Public Beach, Guilford. - Widening of 125 feet, approximately 400 feet of beach by direct placement of sand fill and construction of an impermeable groin, 300 feet long at the east limit of the fill.

b. Momauguin Beach, East Haven. - Widening to a general width of 125 feet in front of cottages, by direct placement of sand fill, approximately 2,200 feet of Momauguin Beach, construction of a 300-foot extension to an existing groin at Bradford Cove and if necessary to reduce excessive losses of the fill, deferred construction of three additional impermeable groins, 350 feet long.

c. Silver Sands Beach, East Haven. - Widening to a general width of 125 feet in front of cottages by direct placement of sand fill, approximately 2,600 feet of Silver Sands Beach with an added widening of up to 50 feet along the westerly 1,400 feet of shore, construction of an impermeable groin 250 feet long at the mouth of Caroline Creek and, if necessary to reduce excessive losses of the fill, deferred construction of four additional impermeable groins, 350 feet long.

d. West Silver Sands Beach, East Haven. - Widening to a general width of 125 feet in front of cottages by direct placement of sand fill approximately 2,950 feet of West Silver Sands Beach with an added widening of up to 50 feet along the westerly 1,800 feet of shore, construction of an impermeable groin 200 feet long at the mouth of Caroline Creek and, if necessary to reduce excessive losses of the fill, deferred construction

of four additional impermeable groins 350 to 380 feet long.

e. Shell Beach, East Haven. - Widening to a general width of 125 feet in front of cottages by direct placement of sand fill, approximately 1,350 feet of Shell Beach and construction of an impermeable groin 350 feet long at the mouth of Morris Creek.

f. Lighthouse Point Park, New Haven. - Construction of an impermeable groin 380 feet long at Lighthouse Point.

59. Due to the absence of adequate sources of material to supply littoral drift for creation of sandy beaches by natural processes and the apparent lack of suitable material in the offshore areas within a practicable distance for hydraulic dredging and pumping to shore, the limited improvement of the small pocket bathing beaches that may be needed in the town of Branford can best be effected by trucking in sand for periodic nourishment.

60. The project considered for the Guilford Point public beach is justified by evaluated benefits all of which are local recreational benefits. Protection benefits are negligible. In view of the limited public interest, other than recreational, adoption of a Federal project for improvement of the beach is not warranted. In the event the authorized Federal project for improvement of Guilford Harbor is constructed, consideration should be given to use of suitable material which will be available from dredging of the navigation channel for improvement of the town beach.

61. The plans of protection and improvement considered for Momauguin, Silver Sands, and West Silver Sands Beaches, are justified by evaluated benefits. Except for a few street ends, all shore frontages in these areas are privately owned. Inasmuch as no policy has been

established for Federal aid in protection of privately owned shores, no Federal project for this purpose should be adopted.

62. The plan of protection and improvement considered for Shell Beach is not justified by evaluated benefits. Due to the limited development and the physical limitations of the beach which make it unsuitable for extensive development, it appears unlikely that construction of the considered plan can be justified.

63. The project considered for Lighthouse Point Park is justified by evaluated benefits. The nature and amount of public benefits are sufficient to warrant the maximum one-third participation by the United States in the first cost of construction in accordance with the policy established by Public Law 727, 79th Congress, 2d Session. No water pollution exists along the public bathing beach which would endanger the health of bathers. It is advisable for the United States to adopt a project authorizing Federal participation in the proposed construction by contribution of one-third the first cost thereof.

64. Recommendations. - It is recommended that local interests consider adoption of projects for protection and improvement of the Guilford Point public beach, Momauguin Beach, Silver Sands Beach and West Silver Sands Beach as described in Paragraph 58 and shown on Plate 16. It is further recommended that protective measures which may be undertaken by local interests based upon their determination of economic justification, be accomplished in accordance with methods proposed and projects considered in this report.

65. It is recommended that the United States adopt a project authorizing Federal participation by the contribution of Federal funds in an amount equal to one-third the first cost of construction of an

impermeable groin 380 feet long at Lighthouse Point Park generally as shown on Plate 16. The recommended Federal participation is subject to the conditions that local interest will:

a. Assure maintenance of the protective and improvement measure during its useful life as may be required to serve its intended purpose;

b. Provide, at their own expense, all necessary lands, easements, and rights-of-way.

c. Assure that water pollution that would endanger the health of bathers will not be permitted.

d. Assure continued public ownership of the shore and its administration for public use during the economic life of the project. The recommendation is further subject to the conditions that the adequacy of the work proposed by local authorities, detailed plans, specifications, assurances that the requirements of local cooperation will be met and arrangements for prosecuting the work be approved by the Chief of Engineers prior to commencement of work.

66. The estimated amount of Federal participation in accordance with the foregoing recommendation is $4,000.

38 Inclosures
10 Appendices
28 Plates

ROBERT J. FLEMING, JR.
BRIGADIER GENERAL, UNITED STATES ARMY
Division Engineer

APPENDIX A

DESCRIPTION AND COMPOSITION OF BEACHES

1. General. - Detailed descriptive data concerning the entire shoreline of Area 9 was obtained by field inspections. Descriptions of the shore line, divided generally into areas in accordance with the physical character of shore features are given below in geographic sequence from East River in Guilford to Fort Hale Park in New Haven. In addition, samples of surface beach material were obtained at selected locations throughout the area and a mechanical analysis of these samples was made to determine median diameter and classification. Beach sample analysis results and locations are shown on Plates 11 to 15. A complete photographic record was made of the shore. Selected photographs are shown on Plates 17-28.

Guilford

A. Guilford Point and Adjacent Shore (Plate 17, Figs. 1 and 2)

(1) Location. - Between East and West Rivers

(2) Extent. - 4300 feet

(3) Width Beach. - Little or no sand beach above high water.

(4) Ownership. - Portions of the shore east and west of Guilford Point are owned by the town of Guilford. Guilford Point is privately owned.

(5) Beach Use. - The sand bar east of Guilford Point is used as a town bathing beach.

(6) Public Facilities. - Bathhouse, parking area, sanitary facilities.

(7) Composition of Shore. - Bedrock is exposed along the south and east sides of Guilford Point. The shore of the point is coarse in composition consisting generally of gravel, bedrock, cobbles, boulders and patches of sand. A sand bar fronting marsh trails westward from the point to West River and another trails eastward fronting marsh for a short distance towards East River.

(8) Protective Structures. - The point is protected by riprap revetment, loose stone and rubble masonry walls.

(9) Character of Development. - There are a few cottages and residences on Guilford Point.

B. Chaffinch Island and Adjacent Shore

(1) Location. - Between West River and Mulberry Point.

(2) Extent. - 3000 feet

(3) Width Beach. - No sand beach.

(4) Beach Use. - None

(5) Public Facilities. - None

(6) Composition of Shore. - The shore of Chaffinch Island is characterized by exposures of bedrock. It is surrounded by marsh which extends westward to Mulberry Point and northward along the shore of West River.

(7) Protective Structures. - None

(8) Character of Development. - There is a lookout tower and fire department building on the island and piers and boatyards along its West River shore.

C. Mulberry Point (Plate 17, Fig. 3)

(1) Location. - Between Guilford Harbor and Indian Cove.

(2) Extent. - 3900 feet.

(3) Width Beach. - Generally no sandy beach. Small extents of narrow ground shell beaches in indentations of shore.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The shore is predominantly composed of exposed bedrock. An indentation along the east shore of the point is composed of marsh. There are numerous boulders and some marsh grass around the outer tip of the point. There are a number of small sections or patches of beach composed of finely ground shells in indentations of the rocky shore.

(8) Protective Structures. - There are concrete and rubble masonry sea walls fronting lawns along the east and south shore of Mulberry Point. Rubble masonry walls also exist along the shore of Indian Cove fronting lawns, cottages and a shore road.

(9) Character of Development. - Summer cottages.

D. Indian Cove - Head and West Shore (Plate 18, Fig. 1)

(1) Location. - Head of Indian Cove and the intervening shore to the first point of land east of Vineyard Point.

(2) Extent. - 4900 feet

(3) Width Beach. - Generally no sand beach. A small shell pocket beach 15-20 feet wide above high water about 1000 feet south of the head of the cove.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The head of Indian Cove is composed of marsh. A small quantity of finely ground shells has accumulated on the marsh on the seaward side of the road. The remainder of the shore is principally composed of exposed bedrock. There is a pocket beach about 200 feet long composed of finely ground shells in a shore indentation 1000 feet south of the head of the cove and small patches of coarse sand in irregularities of the shore farther south. The rocky shore along the southerly portion of the area contains considerable gravel, cobbles and numerous boulders and some marsh.

(8) Protective Structures. - A few loose stone or rubble masonry walls fronting lawns and cottages along the northerly shore on the west side of the cove.

(9) Character of Development. - Year-round residences and summer cottages with the greatest concentration near the head of Indian Cove and sparse development farther south.

E. Vineyard Point (Plate 18, Figs. 2 and 3)

(1) Location. - East of and adjacent to Sachem Head.

(2) Extent. - 3800 feet

(3) Width Beach. - A sand beach up to 30 feet wide above high water along the southerly face of the point and another up to 20 feet wide above high water at the head of the cove on the west side of the point. Generally no sand beach elsewhere.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The shore is characterized by outcrops of bedrock. Its easterly end in the indentation between Vineyard Point and the first point to the east is composed of marsh, gravel and boulders and some sand. This coarse marshy shore extends to the southeast corner of Vineyard Point in the vicinity of which large areas of bedrock are exposed. There is a medium to coarse sand pocket beach along the south face of Vineyard Point between exposures of bedrock. Bedrock is exposed along the west shore of the point and a medium to coarse sand beach exists at the head of the cove on the west side of the point. The area behind the road is marsh.

(8) Protective Structures. - There are rubble masonry and concrete walls and dumped stone revetment along the east side of the point. Low rubble masonry and concrete walls front lawns along the south face of the point and a rubble masonry wall fronts a lawn along the west side. A shore road across the head of the cove west of Vineyard Point is protected by a rubble masonry wall, a part of which is fronted by dumped riprap revetment.

(9) Character of Development. - Residential

F. Sachem Head. (Plate 19, Fig. 1)

(1) Location. - Between Vineyard Point and Joshua Cove.

(2) Extent. - 16,000 feet

(3) Width Beach. - Generally no sand beach. There is a sandy pocket beach about 250 feet long and up to 20 feet wide along the east shore of Sachem Head.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The shore is almost continuously composed of bedrock with a medium to coarse sand pocket beach on the east side and a small medium sand beach of cuspate form near the southeast tip. The heads of Sachem Head Harbor and other smaller indentations are composed of marsh. A considerable extent of the southwest shore of Sachem Head facing the outer part of Joshua Cove is composed of quarry waste while the shore approaching the head of the cove is composed of coarse material ranging from gravel to boulders.

(8) Protective Structures. - Rubble masonry walls protect lawns at various locations. A road along the pocket beach on the east side of Sachem Head is protected by a low rubble masonry sea wall and a low part of this road farther north is protected by dumped riprap revetment.

(9) Character of Development. - Summer residences.

G. Head and West Shore of Joshua Cove. (Plate 19, Figs. 2 and 3)

(1) Location. - Between a point on the southerly shore of Joshua Cove about 600 feet southwest of its head and the outer tip of the point separating Joshua Cove and Island Bay.

(2) Extent. - 7000 feet.

(3) Width Beach. - A bar about 100 feet wide fronts marsh and a road along the east half of the head of Joshua Cove. No sand beach elsewhere.

(4) Ownership. - Private except for the westerly half of the head of Joshua Cove which belongs to the State of Connecticut.

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The southerly shore of Joshua Cove southwest of its head is covered with coarse material ranging from gravel to boulders. There is a barrier bar halfway across the southerly head of the cove to a shore projection composed of bedrock. This bar is composed of medium sand covered with gravel along its northwestern end. The shore of the head of the cove northwest of the bedrock shore projection is a low earth dam with slopes of riprap revetment. The northerly shore of Joshua Cove is composed principally of bedrock and boulders or rock fragments.

(8) Protective Structures. - The road on the bar at the head of Joshua Cove is protected by riprap revetment. Short rows of boulders act as groins fronting cottages at the southeast end and riprap revetment protects the dam along the northwest half of the head of the cove. Rubble masonry walls protect lawns at some of the cottages along the northerly shore of the cove.

(9) Character of Development. - Summer cottages

H. Island Bay (Plate 20, Fig. 1)

(1) Location. - East shore and head of bay.

(2) Extent. - 3700 feet

(3) Width Beach. - A narrow sandy barrier bar at the head of the bay with walls at the water's edge fronting a cottage colony along its easterly half. Generally no sand beach elsewhere.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - The east shore of the bay is composed largely of bedrock. Marsh borders several hundred feet of the southerly portion of the large indentation along this shore and a medium sand bar fronting marsh exists at the northerly end of this same indentation. The head of the bay is a low sandy barrier bar.

(8) Protective Structures. - There is a low rubble masonry wall protecting a lawn around the outer end of the point between Island Bay and Joshua Cove. Riprap revetment and a loose stone wall protect the road on the sandy barrier bar at the northerly end of the shore indentation on the easterly shore of the bay. The cottage colony at the head of the bay is protected by stone filled timber cribs, concrete and masonry walls with dumped riprap in front of some of the walls. Dumped riprap revetment borders both sides of the road at the head of the bay.

(9) Character of Development. - Summer cottages

I. Island Bay, Clark Point, Little Harbor, Harrison Point (Plate 20, Fig 2)

(1) Location. - Between the northwest end of the head of Island Bay and the Guilford-Branford town line.

(2) Extent. - 9700 feet

(3) Width Beach. - Generally no sand beach.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - An irregular bedrock shore with small sandy pocket beaches in indentations and large boulders along the shore.

(8) Protective Structures. - There are large amounts of dumped riprap along the westerly shore of Island Bay and two shore-connected breakwaters at the entrance to Little Harbor.

(9) Character of Development. - Widely spaced residences and summer cottages.

Branford

J. Leetes and Narrows Island and Hoadley Neck

(1) Location. - Between the Guilford-Branford town line and the creek bordering the west side of Hoadley Neck.

(2) Extent. - 7000 feet.

(3) Width Beach. - No sand beach

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - Predominantly bedrock. The shore of Leetes Island is covered with quarry waste.

(8) Protective Structures. - A loose stone wall fronting residences near the town line. A rubble masonry wall at Narrows Island.

(9) Character of Development. - Residential. Sparsely developed.

K. Flying Point and Stony Creek (Plate 20, Fig. 3 and Plate 21, Fig. 1)

(1) Location. - Between Hoadley Neck and Pleasant Point.

(2) Extent. - 12,000 feet

(3) Width Beach. - Generally no sand beach.

(4) Ownership. - Private

(5) Beach Use. - Bathing by residents at small sandy pocket beaches.

(6) Public Facilities. - None

(7) Composition of Shore. - The shore is composed principally of bedrock. There is about 1600 feet of low marshy shore between Hoadley Neck and Flying Point. Small sandy pocket beaches exist at scattered locations.

(8) Protective Structures. - There is a fairly continuous system of walls of loose stone, rubble masonry and cut stone masonry and a number of piers, boat slips and marine railways along all but the marshy shore at the east end of the area.

(9) Character of Development. - Stony Creek is a small residential community. There is a commercial oyster company wharf east of Flying Point.

L. Pleasant and Juniper Points (Plate 21, Fig. 2)

(1) Location. - Between Stony Creek and west side of Juniper Point.

(2) Extent. - 6,000 feet

(3) Width Beach. - No sand beach

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - An irregular rocky shore with sand only in indentations. Large marsh areas exist between Stony Creek, Pleasant Point and Juniper Point.

(8) Protective Structures. - None

(9) Character of Development. - Small group of cottages at Pleasant Point. Barge loading point for New Haven Trap Rock Co. at Juniper Point.

M. Pine Orchard

(1) Location. - Between Juniper and Brown Points

(2) Extent. - 2200 feet

(3) Width Beach. - Small narrow sandy pocket beaches up to about 50 feet in width at high water.

(4) Ownership. - Private

(5) Beach Use. - Bathing by area residents and hotel patrons.

(6) Public Facilities. - None

(7) Composition of Shore. - Characterized by exposures of bedrock and pocket beaches of fine to medium sand.

(8) Protective Structures. - Riprap breakwater at Brown Point. Concrete and stone masonry walls along most of the shore to the north and east of Brown Point. An open pile timber pier at the yacht club and a rubble masonry wall acting as a jetty and groin on the north side of the inlet north of the yacht club.

(9) Character of Development. - A private small boat harbor area developed for residential, yacht club, private bathing beach and summer hotel use.

N. Pine Orchard (Plate 21, Fig. 3)

(1) Location. - Extending west from Brown Point

(2) Extent. - 2100 feet

(3) Width Beach. - About 20 feet above high water along the easterly two-thirds and generally no sand beach above high water along the westerly third.

(4) Ownership. - Private

(5) Beach Use. - Bathing by residents

(6) Public Facilities. - None

(7) Composition of Shore. - Exposed bedrock at Brown Point and at west end of the area. Fine to medium sand above high water and medium to coarse sand below. Some gravel above and below high water.

(8) Protective Structures. - Curved and vertical faced concrete and rubble masonry sea walls, composite stone and concrete sea walls, timber groins and sloped placed stone revetment.

(9) Character of Development. - Large residences

O. Pine Orchard and Hotchkiss Grove Beach (Plate 22, Fig. 1)

(1) Location. - From first rock outcrop 2100 feet west of Brown Point to west end of Hotchkiss Grove Beach.

(2) Extent. - 3200 feet

(3) Width Beach. - 20 to 50 feet above high water along the westerly three-fourths of Hotchkiss Grove Beach and generally no beach above high water elsewhere.

(4) Ownership. - Private

(5) Beach Use. - Bathing by residents

(6) Public Facilities. - None

(7) Composition of Shore. - Projecting points of bedrock. Coarse sand and fine gravel below high water east of Hotchkiss Grove. Fine sand above high water and medium to coarse sand below high water at Hotchkiss Grove.

(8) Protective Structures. - Loose riprap wall fronting shore road at Hotchkiss Grove. Rubble masonry and concrete sea walls elsewhere with secondary walls and stone slope paving in places above the fronting sea wall.

(9) Character of Development. - Residential

P. Haycock Point (Plate 22, Fig. 2)

(1) Location. - Between Hotchkiss Grove and Limewood Beaches.

(2) Extent. - 2700 feet

(3) Width Beach. - Generally no sand beach above high water except in pockets. The largest pocket just west of the most easterly projection is 20-40 feet wide above high water.

(4) Ownership. - Private

(5) Beach Use. - Limited use by residents

(6) Public Facilities. - None

(7) Composition of Shore. - The shore is largely composed of exposed bedrock with sand or gravel held in indentations. Sand is fine to medium above high water and coarse below.

(8) Protective Structures. - Rubble masonry and concrete sea walls, short rubble masonry groins and dumped riprap revetment.

(9) Character of Development. - Residential

Q. Limewood Beach (Plate 22, Fig. 3)

(1) Location. - West of Haycock Point

(2) Extent. - 2200 feet

(3) Width Beach. - Width above high water decreases westward from about 120 feet adjacent to Haycock Point to little or no high water beach along the westerly half of the area.

(4) Ownership. - Mostly private. Ownership of part of the beach May be public but this ownership is not clear.

(5) Beach Use. - Private bathing (Eastern Indian Neck Association) adjacent to Haycock Point.

(6) Public Facilities. - None

(7) Composition of Shore. - Bedrock exposed at Haycock Point and along the west half of the beach. Beach above high water is fine to medium sand.

(8) Protective Structures. - Timber, concrete and riprap groins along west half of beach. Riprap revetment fronting shore road in central part of beach. Rubble masonry and concrete walls fronting residences along west part of beach.

(9) Character of Development. - Summer hotels and residences.

R. Indian Neck (Plate 23, Fig. 1)

(1) Location. - Pocket beach west of and adjacent to Limewood Beach.

(2) Extent. - 1900 feet

(3) Width Beach. - Above H.W. 0-15 feet.

(4) Ownership. - Private

(5) Beach Use. - Bathing by patrons of hotels and by residents.

(6) Public Facilities. - None. Private bathhouses maintained for hotel patrons.

(7) Composition of Shore. - Medium to fine sand above high water. Considerable gravel, particularly below high water. Bedrock outcrops at both ends of beach.

(8) Protective Structures. - Concrete and masonry sea walls, a steel sheet-pile bulkhead and short timber groins. A timber pier at the bathhouses and a rubble masonry pier with a timber extension at the west end of the area.

(9) Character of Development. - Residences and summer hotels.

S. Indian Neck - Linden Point - Maltby Cove - Jeffrey Point

(1) Location. - Between the west end of the first pocket beach west of Limewood Beach and the southeast end of the pocket beach north of Jeffrey Point.

(2) Extent. - 8600 feet

(3) Width Beach. - Generally no sand beach

(4) Ownership. - Private

(5) Beach Use. - Limited to residents

(6) Public Facilities. - None

(7) Composition of Shore. - Shore composed of numerous, almost continuous outcrops of bedrock with small pockets of sand and gravel in indentations.

(8) Protective Structures. - Lawns along most of the shore protected by rubble masonry or concrete sea walls.

(9) Character of Development. - Summer cottages and year-round residences.

T. Branford Harbor (Plate 23, Fig. 2)

(1) Location. - North of Jeffrey Point to Indian Neck Point.

(2) Extent. - 2,700 feet

(3) Width Beach. - Above H.W. - None along several hundred feet adjacent to Jeffrey Point. Width increases to the north. It is about 60 feet along approximately 600 feet of shore adjacent to Indian Neck Point.

(4) Ownership. - Private

(5) Beach Use. - Limited to residents

(6) Public Facilities. - None. Private bathhouses.

(7) Composition of Shore. - Exposed bedrock at Jeffrey and Indian Neck Points. The beach between the points is sandy. The southeast end is covered with thick gravel deposits or ridges. The beach 600-700 feet east of Indian Neck Point is composed of fine sand and gravel above high water and coarse sand below. Adjacent to Indian Neck Point the beach consists of fine to medium sand above high water and medium to coarse sand below and there is considerable gravel on the beach.

(8) Protective Structures. - Low concrete and masonry sea walls and light timber bulkheads.

(9) Character of Development. - A few large, widely spaced residences along the north half and smaller more closely spaced residences along the south half of the area.

U. Parker Memorial Park (Plate 23, Fig. 3)

(1) Location. - In Branford Harbor west of and adjacent to Branford Point.

(2) Extent. - 1100 feet

(3) Width Beach. - Above H.W. - 30-40 feet along about 200 feet of shore adjacent to Branford Point. Generally no high water beach elsewhere.

(4) Ownership. - Public. Town of Branford.

(5) Beach Use. - Public bathing beach.

(6) Public Facilities. - Dressing rooms, benches and picnic tables.

(7) Composition of Shore. - Fine to medium sand above high water, and medium to coarse sand below in the pocket beach adjacent to Branford Point. Bedrock outcrops at Branford Point and elsewhere along the shore.

(8) Protective Structures. - Low rubble masonry wall behind the sand beach and higher masonry walls around the park to the west.

(9) Character of Development. - A public park and bathing beach.

V. Lamphier Cove to Johnson Point

(1) Location. - The west side of Branford Harbor including Lamphier Cove and the shore to and around Johnson Point.

(2) Extent. - 9500 feet.

(3) Width Beach. - Generally no sand beach above high water.

(4) Ownership. - Private

(5) Beach Use. - Commercial bathing beach at Double Beach. Limited bathing by area residents elsewhere.

(6) Public Facilities. - None. Commercial bathhouse, parking and picnic areas at Double Beach.

(7) Composition of Shore. - An irregular rocky shore with sand in indentations and a sand tombolo at Double Beach. The pocket beach in Lamphier Cove consists of medium to fine sand above high water and medium to coarse sand and gravel below high water. The tombolo at Double Beach consists of fine sand along its ridge and at its ends above high water and medium to coarse sand below high water. The narrow pocket beach in the cove south of Lamphier Cove consists of fine sand above high water and coarse sand below.

(8) Protective Structures. - Rubble masonry sea walls at a few locations.

(9) Character of Development. - Summer cottages and year-round residences. Commercial bathing beach at Double Beach.

W. Between Johnson and Stanley Points.

(1) Location. - North shore of Pages Cove and the shore to the southeast to Johnson Point.

(2) Extent. - 5900 feet

(3) Width Beach. - Above H.W. - Generally no sand beach except in indentations of shore. In Pages Cove, the east pocket beach varies from 0 to 100 feet and the west pocket beach varies from 0 to 40 feet.

(4) Ownership. - Private except for possible public ownership of west pocket beach in Pages Cove (Ownership not clear according to assessor's records).

(5) Beach Use. - East pocket beach at Pages Cove is private and restricted to hotel guests. The west pocket at Pages Cove is used for public bathing.

(6) Public Facilities. - None

(7) Composition of Shore. - Mostly a bedrock shore. Pocket beaches consist of fine sand above high water and medium or coarse sand below high water.

(8) Protective Structures. - Rubble masonry walls, loose stone wall and dumped riprap revetment.

(9) Character of Development. - Residential

X. Short Beach

(1) Location. - Stanley Point from the north shore of Pages Cove and the shore south and west to the south tip of Horton Point.

(2) Extent. - 4500 feet

(3) Width Beach. - Small pocket beaches up to about 30 feet in width above high water.

(4) Ownership. - Private except for street ends in the pocket beach immediately west of Stanley Point and the second pocket beach west of Stanley Point which probably belongs to the town of Branford (Ownership not clear from town assessor's records).

(5) Beach Use. - Bathing restricted to town residents at publicly-owned street ends and pocket beach. Use elsewhere restricted to area residents.

(6) Public Facilities. - None

(7) Composition of Shore. - Shore is composed largely of exposed bedrock. Along the south face of Stanley Point the most westerly pocket beach is composed entirely of finely ground shells and the other pocket beach to the east is composed largely of ground shells with some sand and gravel. Pocket beaches west of Stanley Point consist of fine sand above high water and medium to coarse sand below high water.

(8) Protective Structures. - Low concrete, rubble masonry and loose stone walls front residences and road.

(9) Character of Development. - Residential

East Haven

Y. Mansfield Point

(1) Location. - Southern tip between the East Haven River and Bradford Cove.

(2) Extent. - 800 feet

(3) Width Beach. - Above H.W. - About 60 feet at sandy pocket at south face of point

(4) Ownership. - Private

(5) Beach Use. - Bathing by residents

(6) Public Facilities. - None

(7) Composition of Shore. - Bedrock outcrops throughout with sand held in pockets. Pocket beaches consist of medium to find sand above high water and coarse sand below.

(8) Protective Structures. - None

(9) Character of Development. - Cottages

Z. Momauguin Beach (East) (Plate 24, Figs. 1, 2 and 3)

(1) Location. - West of and adjacent to Bradford Cove

(2) Extent. - 2000 feet

(3) Width Beach. - Above H.W. - Varies from 0 to 100 feet in front of buildings and structures.

(4) Ownership. - Private except for street ends owned by Town of East Haven.

(5) Beach Use. - Bathing by areas residents. Public bathing at publicly-owned street ends.

(6) Public Facilities. - None

(7) Composition of Shore. - Medium to fine sand above high water. Below high water the beach varies from medium sand in the east central portion to coarse sand in the west portion.

(8) Protective Structures. - Generally none. Along the east end of the beach residences are fronted by a riprap mound, a masonry sea wall and a timber bulkhead. There is a riprap mound along the shore of Bradford Cove. To the west structures consist of a timber bulkhead and groin and a riprap groin.

(9) Character of Development. - Residences, summer cottages and refreshment stands.

AA. Momauguin Beach (West)

(1) Location. - Shore projection at west end of Momauguin Beach west from Coe Avenue.

(2) Extent. - 600 feet

(3) Width Beach. - Generally none above high water

(4) Ownership. - Private

(5) Beach Use. - Commercial bathing beach and bathing by residents

(6) Public Facilities. - None. Private bathhouse at east end.

(7) Composition of Shore. - Area characterized by outcrops of bedrock. Medium and some fine sand above high water and coarse sand below high water.

(8) Protective Structures. - Rubble masonry sea walls.

(9) Character of Development. - Residential and commercial bathing beach.

BB. Silver Sands Beach (Plate 25, Figs 1 and 2)

(1) Location. - South End and the adjacent shore to the east.

(2) Extent. - 2800 feet

(3) Width Beach. - Width above high water fronting cottages varies from 0 to 50 feet along the east half. Generally no high water beach fronting cottages along the west half.

(4) Ownership. - Private

(5) Beach Use. - Bathing by area residents

(6) Public Facilities. - None

(7) Composition of Shore. - Medium sand above high water, with some fine sand along the westerly half. Bedrock outcrops at South End and at a few scattered locations along the beach.

(8) Protective Structures. - Along the east half, some cottages are fronted by low concrete and masonry sea walls, others have no protection. Along the west half most cottages are fronted by an irregular line of concrete and masonry sea walls and timber or steel sheet pile bulkheads. There are a number of timber, riprap and concrete groins, mostly along the west half of the beach.

(9) Character of Development. - Larger than average beach cottages.

CC. West Silver Sands Beach (Plate 25, Fig. 1 and Plate 26, Figs. 1 and

(1) Location. - Between Caroline Creek (South End) and Morgan Point.

(2) Extent. - 2900 feet

(3) Width Beach. - Varies. Little or no width of sand beach in front of some cottages and bulkheads during high tide. The high water width of the bar fronting marsh is about 250 to 300 feet.

(4) Ownership. - Private

(5) Beach Use. - Commercial bathing beach and bathing by residents.

(6) Public Facilities. - None. A private beach has a bathhouse and cabanas.

(7) Composition of Shore. - Generally medium sand above high water. A few scattered outcrops of bedrock.

(8) Protective Structures. - A number of cottages fronted by timber bulkheads. A few timber groins along the shore.

(9) Character of Development. - Summer cottages, beach club and commercial bathing beach.

DD. Morgan Point (Plate 26, Fig. 3)

(1) Location. - Shore extending about 1500 feet east and 1400 feet west of the tip of the point.

(2) Extent. - 2900 feet

(3) Width Beach. - Generally no high water beach except in shore indentations.

(4) Ownership. - Private

(5) Beach Use. - Limited to residents

(6) Public Facilities. - None

(7) Composition of Shore. - Numerous outcrops of bedrock at and east of the tip of Morgan Point. Medium to fine sand in indentations above high water.

(8) Protective Structures. - Residences fronted by an irregular line of concrete and rubble masonry sea walls and timber bulkheads.

(9) Character of Development. - Residential

EE. Shell Beach (Plate 27, Fig. 1)

(1) Location. - Between Morgan Point and Morris Creek.

(2) Extent. - 1100 feet

(3) Width Beach. - Width of bar fronting marsh generally 100 to 150 feet at high tide.

(4) Ownership. - Private

(5) Beach Use. - Restricted to residents

(6) Public Facilities. - None

(7) Composition of Shore. - Medium and fine sand above high water. Outcrops of bedrock at Morris Creek.

(8) Protective Structures. - None

(9) Character of Development. - Summer cottages

New Haven

FF. Lighthouse Point Beach (Plate 28, Figs. 1, 2 and 3)

(1) Location. - Between Morris Creek and the tip of Lighthouse Point.

(2) Extent. - 1000 feet

(3) Width Beach. - About 175-250 feet between the high water line and the fence separating the beach area from the building area.

(4) Ownership. - Public. City of New Haven.

(5) Beach Use. - City bathing beach and park.

(6) Public Facilities. - New bathhouse, parking area, picnic grounds, playground and amusements.

(7) Composition of Shore. - Medium sand. Outcrops of bedrock at Lighthouse Point.

(8) Protective Structures. - A stone and timber jetty at the mouth of Morris Creek.

(9) Character of Development. - A public bathing beach and park.

GG. Lighthouse Point Beach (Plate 28, Figs. 1, 2 and 3)

(1) Location. - Between the tip of Lighthouse Point and the north limit of Lighthouse Point Park.

(2) Extent. - 2700 feet

(3) Width Beach. - Varies irregularly with sand beach above high water only in pockets of the rocky shore.

(4) Ownership. - Public. City of New Haven.

(5) Beach Use. - Public bathing beach in the vicinity of Lighthouse Point. No beach use to the north.

(6) Public Facilities. - Park facilities as described in preceding section FF.

(7) Composition of Shore. - Medium sand above high water and medium or coarse sand below high water. Numerous outcrops of bedrock.

(8) Protective Structures. - Riprap walls along edge of gravel road.

(9) Character of Development. - A public park.

HH. Morris Cove.

(1) Location. - North of and adjacent to Lighthouse Point Park.

(2) Extent. - 2300 feet

(3) Width Beach. - Varies. Generally none above high water except in pockets and at solid projecting structures.

(4) Ownership. - Private

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - Generally coarse gravelly shore with sand in indentations or held by structures. Sand is medium above high water and coarse below high water. A few outcrops of bedrock along the southern portion of the shore.

(8) Protective Structures. - A miscellany of low concrete and rubble masonry sea walls and timber bulkheads along the shore.

(9) Character of Development. - Principally residential. A yacht club, boatyard and marine railway for small boats near the south end of the area.

II. Morris Cove (Plate 27, Figs. 2 and 3)

(1) Location. - South of and adjacent to Morris Cove Park

(2) Extent. - 1900 feet

(3) Width Beach. - None above high water along the northerly third of the shore. The high water sand beach then increases southward to about 100 feet in front of buildings.

(4) Ownership. - Private

(5) Beach Use. - Bathing by residents

(6) Public Facilities. - None

(7) Composition of Shore. - Medium sand above high water and coarse sand below.

(8) Protective Structures. - Heavy cut stone masonry or concrete sea walls and timber bulkheads along the north end of the area. The size of walls decreases southward. There are practically no walls along the southern third of the area.

(9) Character of Development. - Residential.

JJ. Morris Cove Park

(1) Location. - Morris Cove

(2) Extent. - 1350 feet

(3) Width Beach. - No beach above high water

(4) Ownership. - Public. City of New Haven.

(5) Beach Use. - None

(6) Public Facilities. - Park benches

(7) Composition of Shore. - A coarse shore composed of gravel and stone fragments at the north end changing to sand to the south.

(8) Protective Structures. - A high continuous curved face cut stone masonry sea wall throughout.

(9) Character of Development. - A public park in a residential neighborhood.

KK. Forbes Bluff

(1) Location. - North of and adjacent to Morris Cove Park

(2) Extent. - 900 feet

(3) Width Beach. - No sand beach

(4) Ownership. - Public. City of New Haven.

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - Gravel and angular fragments of rock fronting a trap rock cliff

(8) Protective Structures. - None

(9) Character of Development. - A public park

LL. Fort Hale Park

(1) Location. - Between Forbes Bluff and the tip of the point at Fort Hale

(2) Extent. - 2200 feet

(3) Width Beach. - Above H.W. - 40 to 50 feet along the south half of the area. Generally no high water beach along the remainder of the shore.

(4) Ownership. - Public, City of New Haven and the United States.

(5) Beach Use. - None

(6) Public Facilities. - None

(7) Composition of Shore. - Generally coarse shore. Coarsest at south end where shore is covered with gravel and cobbles. Some medium and coarse sand farther north. Bedrock outcrop at Fort Hale.

(8) Protective Structures. - Heavy dumped riprap revetment at inshore end of pier and along high water line at United States Naval Reserve Station.

(9) Character of Development. - A public park and a United States Naval Reserve Station.

APPENDIX B

Geology

1. General. - The present shore line is the result of submergence following the lowering of the earth's surface in relation to the surface of the ocean. The study area is predominantly a shore line bordering bedrock. Almost without exception, bedrock is exposed at all of the points or irregularities along the shore. Banks and cliffs eroded in unconsolidated glacial material are almost unknown. Rock cliffs along the shore are common. They are due to partial submergence of precipices originally formed by glacial erosion. This is evident in the Sachem Head - Thimble Islands district which possesses the most intricate hard rock shore line in Connecticut. The country rock is a granite gneiss, often very massive but usually showing well d eveloped foliation. Parallel with this foliation occur pegmatite dikes and banks of basic material which have weathered more readily than the surrounding more resistant gneiss, thereby forming planes of weakness. Preglacial streams followed the weakness of the rock and formed ridges and valleys generally trending parallel with the foliation. The movement of the glacier was directed by these pre-existing irregularities and as a result, its work too was governed by the foliation. When the region was submerged, the tops of former ridges made the islands elongated

in the direction of foliation and terminated by irregular cliffs where the jointed rock had been quarried by ice. A precipitous trap cliff, known as Forbes Bluff, borders the shore of Morris Cove south of Fort Hale Park. The cliff stands in water at high tide, giving the appearance of a sea cliff formed by wave erosion. Actually, postglacial marine erosion has accomplished almost no work on the crystalline rock shore line of Connecticut. Large extents of shore consist of continuous exposed bedrock. This is particularly true between Mulberry Point in Guilford and Mansfield Point in East Haven. Sand beaches in this area are comparatively rare and small and are found only in pockets or indentations in the rocky shore. Some of these beaches are narrow barrier bars fronting marsh at the heads of coves. An unusual feature of some of the pocket beaches is that they are composed entirely or in large part of finely ground sea shells. West of Mansfield Point to Lighthouse Point, the shore is predominantly sandy in composition. Sand beaches here consist principally of barrier bars fronting marsh. The bars connect projecting rock outcrops. The barrier bars extend west of Morgan Point, between Morgan Point and South End and east of South End. The convex shore north of Lighthouse Point is largely composed of bedrock with sand held in indentations. A sand beach exists adjacent to this convex shore in the southeast portion of Morris Cove. North of this sand beach there are practically no sand beaches above high water. The shore of Morris Cove is generally coarse in composition, being composed of gravel, fragments of rock, derived from the trap cliff at Forbes Bluff, and some coarse sand with the point at Fort Hale Park composed of exposed bedrock. East of Mulberry Point in Guilford to West River marsh forms the shore and surrounds Chaffinch Island which is characterized by bedrock outcrops. A narrow sand bar extends westward from Guilford Point with its distal end recurving into West River. This

bar fronts a large marsh area. A shorter sand bar extends eastward from Guilford Point fronting a portion of the marsh which borders East River.

2. Origin of Beaches. - The absence of eroded banks and cliffs of unconsolidated material along the shore indicates that existing sand beaches were formed from sources which no longer exist or are now protected by man-made structures and therefore no longer contribute material to the beaches. A probable source of supply was the unconsolidated glacial material which formerly covered the bedrock which forms so large a part of the shore and the islands near the shore. In the Indian Neck-Pine Orchard region, sandy beaches generally lie at the foot of steeply sloping bluffs which are now protected by sea walls, bulkheads and revetments. These bluffs were probably the principal source of supply for the beaches in this area. In general, it appears that beaches were formed by erosion, drifting and deposition of glacial material from locations not far distant from their present positions. The extreme irregularity of the shore line with its numerous pockets would tend to retard the movement of material from one shore area to another. Some material was probably moved shoreward from offshore areas. This shoreward movement appears to have been small. The existence of small pocket beaches composed entirely of finely ground shells along the east side of Mulberry Point and both sides of Indian Cove in Guilford and at the south side of Stanley Point in Branford indicate that some shoreward movement must have occurred. Judging from the larger size of sand beaches west of Mansfield Point to Lighthouse Point, deposits of glacial material in this region must have been larger than elsewhere in the study area. East of Mansfield Point, the rarity and limited size of sand beaches indicates that erodible glacial deposits near the shore were small.

3. Recent Changes and Future Trends. - In general, the only large changes since 1933 occurred along those shores composed of barrier bars or

marsh. These changes consisted of erosion and recession of the barrier bars between Morris Creek and Bradford Cove, and at the heads of Island bay, Joshua Cove, and Indian Cove. Erosion and recession also occurred along the sand spit extending westward from Guilford Point to West River and along the marshy shore between West River and Mulberry Point. Erosion and recession of the above areas can be expected to continue. The only notable accretion was effected artificially at Lighthouse Point during 1949 by direct placement of sand fill at the point and east thereof to Morris Creek. Since 1949, large quantities of this fill have been eroded and moved by natural forces from the vicinity of the outer tip of Lighthouse Point. Some of this fill has been deposited and held in the rocky indentations of the shore north of the point. This process of erosion and sand movement is still in progress. Shore line changes elsewhere have been small. Rocky shores remain unchanged. Pocket beaches due to their natural protection change very slowly. It is expected that future changes along the sandy pocket beaches will continue to be at a slow rate and that changes will consist generally of erosion and gradual loss of sand to offshore areas.

APPENDIX C

TIDES

1. General Characteristics. - The tides along the shore of the State of Connecticut are of two types. The eastern sector from Watch Hill Point, Rhode Island, to Cornfield Point, Connecticut, is subject to the normal ocean or progressive wave type of tide which causes high water to occur at increasingly later times as it progresses from east to west. The western sector from Cornfield Point, Connecticut, to the entrance to East River, New York, is subject to the stationary wave type of tide which causes high and low waters to occur almost simultaneously at all points within this sector, while the range of tide increases in a fairly uniform manner from east to west.

2. Tidal Range. - Tidal range data for points along the shore of Connecticut are given in tide tables, published by the United States Department of Commerce, Coast and Geodetic Survey. These are as tabulated below:

Location	Mean Range	Spring Range	Reference Station	Time Interval
Stonington, F. Is. Sd.	2.7	3.2	New London	-0 35
Noank, Mystic River Entrance	2.6	3.1	" "	-0 30
New London, State Pier	2.6	3.1	" "	0 00
Millstone Point	2.7	3.2	" "	+0 05
Saybrook Jetty	3.5	4.2	" "	+1 00
Duck Island	4.5	5.3	Bridgeport	-0 35
Madison	4.9	5.8	"	-0 30
Falkner Island	5.4	6.4	"	-0 25
Money Island, The Thimbles	5.6	6.6	"	-0 20
Branford Harbor	5.9	7.0	"	-0 15
New Haven Harbor, Entrance	6.2	7.3	"	-0 15
Milford Harbor	6.6	7.8	"	-0 10
Stratford, Housatonic River	5.5	6.5	"	+0 40
Bridgeport	6.8	8.0	"	0 00
Black Rock Harbor Entrance	6.9	8.1	"	-0 05
Saugatuck River, Entrance	7.0	8.3	"	-0 05
South Norwalk	7.1	8.4	"	+0 10
Greens Ledge	7.2	8.5	"	-0 05
Stamford	7.2	8.5	"	0 00
Cosoob Harbor	7.2	8.5	"	+0 05
Greenwich	7.4	8.7	"	0 00

3. Tidal Observations. - A primary tide station is maintained by the United States Coast and Geodetic Survey east of the study area at New London. Daily tidal observations at New London for a nine-year period, from June 12, 1938 to June 31, 1947, show that tides exceeded the height of the plane of mean high water by one foot or more 880 times, by two feet or more 44 times and by three feet or more 9 times. The average annual frequencies of these tides during the above period were 98, 5 and 1, respectively, for tides 1, 2 and 3 feet or more in excess of the mean high water plane. Daily tidal observations were taken west of the study area in Bridgeport Harbor during the periods January 1911 to June 1915, and July 1932 to October 1935. Analysis of these observations shows that the average annual frequencies of the high tides were 86, 6.5 and 0.7, respectively, for tides 1, 2 and 3 feet or more in excess of the mean high water plane. Comparison of the New London and Bridgeport observations indicates that the frequencies of occurrence and excess heights of extreme high tides are similar. The study area, lying as it does between New London and Bridgeport is assumed to be subject to extreme high tides similar to those occurring at New London and Bridgeport. Observations at New London, for which a longer period of record is available, are considered to be applicable to the study area.

4. Extreme Hurricane and Storm Tides. - Elevations of high water marks referred to the plane of mean low water have occurred as tabulated below:

Location	Hurricanes 21 Sept. 1938	Hurricanes 14-15 Sept. 1944	Southeast Storm of 25 Nov. 1950	Northeast Storm of 7 Nov. 1953	Hurricane of 31 Aug. 1954
	High Water Elevations Above Mean Low Water				
Stonington	11.0	7.7	7.6		
Mystic	10.8				
Noank	10.3				
New London	11.1	7.6	8.1	7.1	10.5
Old Lyme				7.7	
Saybrook	13.4	8.0	8.75	9.5	10.8
Clinton			9.0	9.7	11.1
Branford	11.8		10.9		
New Haven	13.0		10.6	11.7	13.9
Milford			11.3	11.3	12.3
Housatonic R.				12.1	
Bridgeport	13.8		12.0	12.1	12.6
Southport	13.4				
Black Rock Hbr.			12.2		
Saugatuck R.			12.0		
South Norwalk	11.6		12.1	12.8	13.3
Five Mile R.			12.1	12.3	
Rowayton	14.3				
Stamford	15.6		12.9		13.8
Greenwich	15.0		13.5	12.2	11.2

APPENDIX D

STORMS

1. Tropical Storms. - Hurricanes can be defined as tropical cyclones with a central barometric pressure of 29.0 inches or less and winds near the center of more than 60 miles per hour in some points in the path. In the northern hemisphere they are known to consist of winds revolving in a counter-clockwise direction about a calm center or "eye." This calm center has an average diameter of approximately 14 miles. The diameter of hurricanes varies considerably, some being 50 to 75 miles; the majority greater in many instances exceeding 500 miles. Winds at the outer limits are usually light, increasing to moderate and gusty toward the center, and they blow with great fury adjacent to the "eye." Hurricanes move bodily along a path in a motion of translation at an average speed of approximately 12 miles per hour. The greatest damage caused by those tropical cyclones to shore areas is due to the inundation which usually accompanies them. This is especially true where there is a bay to the right of the point where the hurricane center moves inland. The rise of water in Narragansett Bay, Rhode Island, during the hurricane of September 1938, which moved inland west of this bay is an example of the devastating effect which such a condition can engender. The strong currents created by hurricanes is an important factor in the destruction caused by such storms.

2. Severe Hurricanes in New England. - Only a few hurricanes which have passed through the New England area are known to have caused considerable destruction. Ivan Ray Tannehill, in his book "Hurricanes," mentions ten such tropical cyclones as occurring between 1635 and 1944. The paths of several of these are shown on Plate 2. The 1944 hurricane has been described as the most violent in history but it did not cause as much destruction in New England as the one which struck in 1938. A comparison

of these storms indicates certain attendant characteristics which can be expected to result in great damage. The 1938 hurricane struck about normal to the shore line at a time when tides were high. The 1944 hurricane struck obliquely to the shore at low tide. The latter hurricane did not produce the inundation and consequent destruction which occurred during the former. Very little information is available concerning the damage caused by most of the hurricanes which have passed through or near New England. This lack of detailed information makes it difficult, if not impossible, to draw conclusions concerning probable shore damage which can be expected from such storms.

3. Hurricane of September 21, 1938. - On September 21, 1938, the New England area was struck by a devastating hurricane which originated around the Cape Verde Islands. It traveled in a curved path in a northwesterly and then northerly direction, arriving in the New England area during mid-afternoon of the 21st of September. The hurricane entered the State of Connecticut with its center just west of New Haven at 3:30 p.m., E.S.T. and continued its progress northward at the rate of 50 to 60 miles per hour. The eye of the storm was clearly observed at New Haven. Winds that were easterly since noon died down between 3:00 and 4:00 p.m., and were then followed by increasing southwesterly winds. The region of strongest wind lay in the dangerous semi-circle at a distance of about 75 miles to the right of the storm center. Barometric pressures reported indicate the severity of the storm along the Connecticut shore. Minimum pressures were reported as follows: at Bridgeport 28.30 inches, at New Haven 28.11 inches at 3:50 p.m., at Hartford 28.04 inches at 4:17 p.m. Barometric pressures dropped gradually until 12:00 noon, and then dropped rapidly until about 4:00 p.m., when the lowest pressures were reached. Pressures then rose rapidly until 8:00 p.m., when the 12:00 noon pressure was attained; thence rose gradually. Wind velocities were observed as follows: maximum for a

five-minute period, 38 miles per hour at New Haven, 46 miles per hour at Hartford, 70 to 90 miles per hour over an area 80 miles wide from Saybrook, Connecticut, to Martha's Vineyard, Massachusetts; maximum gust velocities, 46 miles per hour at New Haven, 59 miles per hour at Hartford, probably in exeess of 100 miles per hour in the area from Saybrook to Martha's Vineyard. The amount of precipitation directly attributable to the hurricane is difficult to determine due to the fact that it rained for two days prior to the storm. The total precipitation ranged from 2 to 5 inches along the Connecticut shore, the major portion of which was probably directly due to the storm. The hurricane increased tidal heights above their predicted ranges. Its approach was manifested in the higher water levels of the preceding low and high water. During these preceding tides, tidal heights were increased more to the east of the hurricane center than to the west because of the counter-clockwise wind rotation. Reported high tide during the hurricane occurred 2 to 2-3/4 hours before the time of predicted tide. The effect of the hurricane was an addition of about 9 to 10 feet to the predicted high tide at the entrance to Long Island Sound; this addition decreasing to 7 feet at Bridgeport and increasing to 9 feet at the west end of the Sound. Wave action accompanying the storm produced a devastating effect upon the shore line, pounding it mercilessly and resulting in widespread damage. Wave heights ranged from 10 feet at New London to 15 feet at New Haven and Bridgeport.

4. Hurricane of September 14-15, 1944. - On September 14, 1944, the New England Area was struck by a tropical hurricane which originated in the West Indies. This hurricane traveled in a northwesterly then northerly direction to Cape Hatteras, thence swerved north, northeast across Long Island, reaching the mainland in the vicinity of Westerly, Rhode Island. From there, it proceeded northeastward across Providence, Rhode

Island, and thence followed closely along the New England coast and passed over Newfoundland and out to sea. The hurricane reached Westerly, Rhode Island, about 11:00 p.m., E.W.T. The greatest wind intensities occurred to the east of the storm center. The calm during the passage of the "eye" of the storm, with the shift in the wind direction after its passage, was clearly noted at Westerly and Providence, Rhode Island. The following minimum barometric pressures were reported in the Connecticut area on September 14, at New Haven, Connecticut, 28.86 inches at 9:50 p.m.; at Hartford, Connecticut, 28.94 inches at 10:50 p.m.; at Fishers Island, New York, 28.41 inches at 10:45 p.m.; at Groton, Connecticut, 28.40 inches at 11:00 p.m.; at Westerly, Rhode Island, 28.30 inches at 11:00 p.m.; at Block Island, Rhode Island, 28.34 inches at 11:09 p.m. Wind velocities reported for the Connecticut area are as follows: New Haven, maximum five minute wind, N 33 m.p.h. and extreme wind NE 38 m.p.h.; Hartford, maximum five minute wind, N 50 m.p.h. and extreme wind, N 62 m.p.h.; New London, extreme wind 70 m.p.h.; Westerly, Rhode Island, extreme wind, 75 m.p.h.; Block Island, Rhode Island, maximum five minute wind, SE 82 m.p.h. and extreme wind, SE 88 m.p.h. Extreme winds were mostly estimated. Heavy rainfall was reported practically throughout the coastal portion of the Providence District, which extended from New York State to Cape Cod. In Providence, a total of 4.49 inches fell from 5:55 p.m. to midnight on 14 September. The following elevations of high water in feet above mean high water were reported: Saybrook, Connecticut, 4.5; New London, Connecticut, 5.0; Stonington, Connecticut, 5.0; Watch Hill, Rhode Island, 6.9; Providence, Rhode Island, 8.0. The hurricane effect occurred on the ebb tide from about 3 to 5 hours after predicted gravitational high water in the area from Watch Hill, Rhode Island, to Wood's Hole, Massachusetts.

5. Storm of November 25, 1950. - On November 25, 1950, the New England area was struck by an east to southeast storm which moved north northwestward from Virginia, reaching Connecticut during the early hours of the morning and continuing through Massachusetts until the early hours of the 26th. Winds continued in northern Maine until the 27th. Hurricane velocities in the gusts were attained at many points both coastal and inland. Interior Connecticut, nearer to the storm center, recorded gusts up to 100 miles per hour. Sustained five minute winds of 34 miles per hour and greater were recorded at New Haven, Connecticut during each hour of the 25th of November from 4:00 a.m. to 5:00 p.m. The prevailing wind direction was southeast. Maximum velocities recorded at New Haven were as follows: fastest mile, 57 m.p.h. at 1:56 p.m.; maximum gusts, 66 m.p.h. at 1:35 p.m.; 4:20 p.m. and 7:40 p.m. and 77 m.p.h. (5-second gust) at 4:45 p.m. The above maximums were probably exceeded between 8:00 p.m. and 9:00 p.m., a period for which no velocities were recorded. The wind died down suddenly after the above period. Heavy rainfall generally exceeding two inches occurred during the night of the 25th-26th in southern New England and as much as four inches in parts of Maine, New Hampshire and Massachusetts on the following day. The storm increased tidal heights in Long Island Sound above their predicted heights. Flood tides which occurred about midday of the 25th exceeded predicted tides by about 5 feet from Bridgeport eastward along the Connecticut shore and up to 6 feet west of Bridgeport to Greenwich. At 9:18 p.m., on the 25th at New London, the flood tide reached 6.1 feet above its predicted height. The storm subsided before the time of high tide along the western part of Connecticut, and the night tides did not reach the maximum heights which occurred during midday. Shore damage along the Connecticut shore was widespread. The greatest amount of shore damage occurred west of New Haven. Wave action

was exceptionally violent causing considerable destruction to coastal highways, sea walls, cottages and small craft.

6. Hurricane of August 31, 1954. - Hurricane Carol entered southern New England on August 31, 1954. It traveled in a north-northeastward direction from a central position about 100 miles off the Virginia Capes at midnight of August 30th and swept over the extreme eastern end of Long Island nine hours later. Swinging on a northward course, its center moved up the Connecticut-Rhode Island border into east central Massachusetts. Continuing northward through New Hampshire the storm center swept into the St. Lawrence valley early on September 1, maintaining hurricane strength until early afternoon after which its intensity diminished rapidly. Winds in miles per hour were recorded as follows: New Haven, 0930 EST, 40 N sustained, 65 N gust; Block Island, 1005 EST, 100 SE sustained, 135 SE gust; Providence 1030 EST, 90 ESE sustained, 105 gust; Nantucket 0900 EST, 72 SE sustained, 0832 EST, 77 ESE gust; Boston 1126 EST, 86 SE sustained, 100 SE gust; Portland, 1310 EST, 69E sustained, 78 E gust. Minimum barometric pressures and total precipitation respectively, were recorded in inches as follows: New Haven 28.77 (910 EST) and 2.75; Block Island, 28.40 (1000 EST) and 3.31; Providence 28.69 (1045 EST) and 2.79; Nantucket 29.32 (1100 EST) and 1.89; Boston 28.83 (1148 EST) and 2.60; Portland 29.15 (1412 EST) and 2.26. The hurricane was most violent during the morning over the region extending eastward 100 miles from the center line of passage. Sustained hurricane winds ravaged extreme eastern Connecticut, Rhode Island and Massachusetts. Similar but lesser devastation occurred in the strip of Massachusetts and Connecticut west of the hurricane's center line to the Connecticut River. Damages from flooding occurred at low shore areas throughout Connecticut as a result of extremely high tides. Damages from wave attack were particularly severe only east of the Connecticut River, increasing in severity to the east

with the greatest damages in the town of Stonington. Some damages due to wave attack occurred between New Haven and the Connecticut River at shore developments which were particularly vulnerable because of their locations at low beach areas. The greater part of all statewide losses resulted from water damage to industrial plants, business establishments and shorefront residences while east of the Connecticut River heavy losses resulted from damages to fishing and pleasure craft and harbor facilities and physical destruction of shorefront residences and bathing beach establishments.

7. Storm Data. - Summaries of records of winds equal to or greater than 40 miles per hour at New York City, New York, and of winds equal to or greater than 32 miles per hour at New Haven, Connecticut, and Block Island, Rhode Island, compiled from United States Weather Bureau data covering the periods indicated, are tabulated below:

Winds Equal To or Greater Than 40 Miles Per Hour

New York City, N.Y., 1911-1947

Direction	Number	Percent of Total	Probable Number in 100 Years
N	73	5	197
NE	29	2	80
E	15	1	40
SE	44	3	118
S	117	8	316
SW	88	6	236
W	161	11	434
NW	934	64	2527
TOTAL	1461	100	3948

Winds Equal To or Greater Than 32 Miles Per Hour

New Haven, Connecticut, 1905-1947

Direction	Number	Percent of Total	Probable Number in 100 Years
N	38	15	88
NE	41	15	90
E	12	5	28
SE	24	9	56
S	40	15	93
SW	25	10	58
W	34	13	79
NW	46	18	107
TOTAL	260	100	599

Winds Equal To or Greater Than 32 Miles Per Hour

Block Island, Rhode Island, 1936-1945

Direction	Number	Percent of Total	Probable Number in 100 years
N	78	10	789
NE	102	13	1020
E	63	8	630
SE	45	6	450
S	24	3	240
SW	35	4	350
W	117	14	1170
NW	341	42	3410
TOTAL	805	100	8050

8. Analysis of Storm Data. - From the observed data the probable frequency of occurrence of storm winds from various directions has been computed on the basis of a 100-year period and the results are shown in the last column of the above tabulations. It should be noted that the storm winds occurring at New York and Block Island are similar in that they show a high preponderance in a northwest direction. The frequency of occurrence at these stations is not comparable since 40 mile per hour winds are listed for New York and 32 mile per hour winds are listed for Block Island. At New York City during 1947, there were 110 winds of 32 miles per hour or greater, as against only 42 winds equal to or greater than 40 miles per hour. Applying the ratio (110/42 = 2.6) determined between 32 and 40 m.p.h. winds in 1947 to the total number of winds listed in the table above for New York City (2.6 x 3948), it appears that approximately 10,300 winds of intensity equal to or greater than 32 miles per hour can be expected during a 100-year period as against 8050 at Block Island.

9. Due to the location of New Haven about midway between New York City and Block Island, it would be natural to expect the wind frequency and direction at New Haven to be somewhere between those for New York City and Block Island. This is definitely not so. Storm winds occur here

without any marked differences in frequency from the west clockwise around to northeast and from the south. It is the stated opinion of weather bureau officials that winds at New Haven are peculiar to that area alone and do not indicate the winds which can be expected along Long Island Sound. This is because New Haven is located in a lowland which runs generally north and south through Connecticut, the winds in this lowland being directed in a north-south direction creating a condition which is not typical of wind expectancy along Long Island Sound. Records for Block Island and New York City give a more accurate picture of the direction of wind expectancy in Long Island Sound. It should be borne in mind that the Connecticut shore is well sheltered by Long Island, Fishers Island, and other islands extending to the east. Therefore, neither the frequency nor intensity of storms occurring at Block Island and New York City can be expected to occur along the Connecticut shore.

10. Storm Damages. - The following condensed accounts from newspaper reports and field inspections indicate the type of storm damage experienced in the study area.

Location	Account
New Haven	Oct. 1, 1920. - Southwest storms, heavy sea, 40 m.p.h. winds. Thousands of dollars damage to piers, bulkheads and boats.
New Haven	Sept. 15, 1944. - East to southeast storm, gusts 50-60 m.p.h. Many cottages destroyed, lower highways undermined or blocked by tons of sand and rock.
Branford	Sept. 15, 1944. - Same storm as above. Road washed out and pavement destroyed at Indian Neck.
New Haven	Nov. 30, 1944. - Northeast to west storm. High seas and tide batter shore structures. Considerable damage. Lower streets flooded.
New Haven	Nov. 29, 1945. - Northeast storm. Tides greatly above normal. Great seas damage coastal installations and roads.

Location	Account
New Haven	Nov. 12, 1947. - Southwest to northwest storm, heavy seas. Much damage to shore area from high tides and heavy seas.
New Haven	Nov. 25, 1950. - Southeast storm, extreme high tides, exceptionally severe wave action. Principal damages occurred to wharves along the harbor area. Minor damage at Lighthouse Beach. Capstones along inner end of jetty at Morris Creek knocked off and some sand washed out adjacent to west side of jetty.
East Haven	Nov. 25, 1950. - Same storm as above. A few cottages damaged at Silver Sands Beach.
Branford	Nov. 25, 1950. - Same storm as above. Shore roads damaged at Limewood and Hotchkiss Cove Beaches. Walls and cottages damaged at scattered locations. Some damage to harbor structures in Branford Harbor.
New Haven	Aug. 31, 1954. - Hurricane Carol. The Morris Cove section hit hard. Homes and porches smashed, piers ripped, boats beached, shore littered with debris. Houses lost walls and had their cellars flooded.
East Haven	Aug. 31, 1954. - Hurricane Carol. Cottages splintered, roads and walks washed away and low shore areas inundated at Silver Sands, Momauguin and Mansfield Beaches.
Branford	Aug. 31, 1954. - Hurricane Carol. Flooding at Pine Orchard and Stony Creek and damage to a dock at Stony Creek.

11. Exposure of the Shore. - The shore line generally faces open water only to the southerly quadrants. The lengths of fetches over which waves can be generated are limited by the length and width of Long Island Sound. These lengths and the directions from the study area are approximately as follows:

Direction	Length (Miles)
East to Southeast	45 to 23
Southeast to South	23 to 19
South to Southwest	19 to 34
Southwest to West	34 to 60

Records of winds at Block Island located east of the study area indicate that the prevailing winds and the greatest frequency of storms which generate waves that can attack the shore occur from those directions having the longest fetches (southwest to west). Similar records at New Haven located at the west limit of the study area show that prevailing winds occur generally from the north and south and that storms which generate waves that can attack the shore occur with greater frequency from the southwest quadrant than from the southeast quadrant. Winds at New Haven are peculiar to the lowland in which New Haven lies and are not regarded as being typical of winds along the entire shore of Long Island Sound. Wind directions as observed at Block Island are regarded as being more typical of those occurring in Long Island Sound east of New Haven. Since Long Island Sound is sheltered to the south by Long Island, the intensity of winds occurring in the study area is regarded as being more similar to that measured at New Haven rather than that measured at Block Island which is directly exposed to the ocean. All shore areas are not exposed to wave attack from all the directions listed above. Considerable protection is afforded by the New Haven Harbor breakwaters, projecting headlands and numerous islands opposite the shore. The study area is sheltered from the prevailing northwest storm direction, such storms blowing offshore. Storms from southerly quadrants which can cause damage are relatively infrequent.

APPENDIX E

SHORE LINE AND OFFSHORE DEPTH CHANGES

1. Basic Data. - Plans showing the location of the shore line and the 6, 12 and 18-foot depth contours were prepared by the Beach Erosion Board from United States Coast and Geodetic Survey data. This data included shore line locations during the years 1838, 1872, 1885, 1910 and 1933 and locations of 6, 12 and 18-foot depth contours during 1838, 1872 and 1884-1886. The 1910 shore line location was limited to that portion of the study area within the City of New Haven. Since its location, as drawn, appears inconsistent with shore lines located during other years, it has not been used in the shore line change study. For this study, a survey, run during 1952, supplemented by vertical aerial photographs flown during 1948 and 1949, located the entire shore line and a survey during 1955 located a part of the shore line of Lighthouse Point Park. Elevations and depths were determined on selected profiles surveyed throughout the study area during 1952 and 1955. Shore line and offshore depth changes are shown on Plates 7 to 10. Due to the scale (1:10,000) used on available maps, it is obviously difficult to measure small changes with accuracy. Change descriptions contained in the following paragraphs, have therefore been limited to those large enough to permit measurement. Amounts of change when given in feet are necessarily scaled distances and, therefore, approximate. Due to the irregular manner in which many of the changes have occurred, no attempt has been made to describe all changes in minute detail. The changes described can generally be considered accurate in indicating the trend in the area and approximate only in indicating the actual quantitative change.

2. East River to West River (Guilford Point.) This area extends from Sluice Creek at the mouth of East River westward to and around Guilford Point to the mouth of West River. The outer end of Guilford Point

is characterized by bedrock outcrops. The shore extending east and west from Guilford Point consists of marsh fronted by sandy barrier bars or spits. The bar to the east has a length of about 400 feet and the bar to the west continuously fronts the marsh and recurves into West River. The principal shore line changes since 1838 consist of erosion and landward movement of the barrier bars and marsh. The landward movement of the bar east of Guilford Point has been continuous since 1838 and amounted to 150 - 300 feet of which about 50 feet occurred between 1933 and 1948. The landward movement of the bar west of Guilford Point has also been continuous since 1838 and amounted to 200 to 350 feet of which 25 to 50 feet occurred between 1933 and 1948. A continuous landward movement of the shore line along the outer face and sides of Guilford Point occurred between 1838 and 1933, the movement generally averaging less than 100 feet. Between 1933 and 1948 changes around Guilford Point have been small, generally not exceeding a landward shore line movement of 25 feet. The east side and outer end of Guilford Point are now largely protected by sea walls and revetment which reduce further recession of the shore.

3. The principal offshore depth change between 1838 and 1884 consisted of a landward movement of the 6-foot depth contour ranging from 100 to 1500 feet. No data are available to determine more recent changes.

4. West River to Indian Cove (Chaffinch Island and Mulberry Point). This area extends south and west from Chaffinch Island at the mouth of West River to and along the west side of Mulberry Point to the head of Indian Cove. Most of this shore line has been subject to erosion and large landward movement since 1838. This movement between 1838 and 1933 was about 50 to 75 feet along the West River side of Chaffinch Island, 250 feet at the outer tip of the island, 200 to 400 feet along approximately 1700 feet of marshy shore south of Chaffinch Island, no change

along 500 feet of rocky shore south of the marsh, about 300 feet along the next southerly 500 feet of indented shore, 50 feet along the next southerly 600 feet to the outer tip of Mulberry Point, 300 feet at the tip of Mulberry Point, between 0 and 200 feet along 1100 feet of shore from the tip of Mulberry Point into Indian Cove and very little change along the remainder of the shore to the head of Indian Cove. The only appreciable shore line changes between 1933 and 1948 consisted of a landward movement of about 100 to 200 feet along the marshy area south of Chaffinch Island and up to 100 feet in the shore indentation on the east side of Mulberry Point located 600 feet north of its outer end.

5. The principal offshore depth changes between 1838 and 1884 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. The greatest landward movement of over 1,000 feet occurred in the vicinity of the 6-foot contour opposite Indian Cove. Elsewhere contour movements were smaller and irregular, in some places being seaward, in others landward, with the latter movement predominant. The offshore deepening resulted in reduction of the size of shoals and some small changes in their position. No data are available to determine changes after 1884.

6. Indian Cove to Joshua Cove. This area includes the head of Indian Cove and the rocky irregular shore to the south and west around Vineyard Point, Sachem Head and along the shore of Joshua Cove extending about 2,500 feet northeast from the outer end of Sachem Head. Except along the head of Indian Cove and the small indentation located about 1,000 feet northeast of the outer end of Vineyard Point, shore line changes since 1838 have been generally too small to permit of reliable measurement on available plans. There was a continuous landward movement of the barrier bar and marsh at the head of Indian Cove of about 200 feet between 1838 and 1948 of which up to 50 feet occurred after 1933. There

was also a continuous landward movement of the shore of the above-mentioned indentation northeast of Vineyard Point between 1838 and 1952 of up to 250 feet of which up to 100 feet occurred after 1933. In small localized areas, some changes have been effected by man-made improvements. Such a change is indicated along the west side of the outer end of Sachem Head where construction around 1930 moved the shore line seaward.

7. Offshore depth changes between 1838 and 1884 consisted principally of deepening and landward movement of the 6, 12 and 18-foot depth contours. The 6-foot contour moved landward up to 500 feet opposite the west half of Indian Cove, 100 to 900 feet, opposite the shore indentation west of and adjacent to Vineyard Point and about 100 feet opposite the east side of Joshua Cove. Movement of this contour was small and irregular alternately landward and seaward, between Vineyard Point and Indian Cove and was 100 to 500 feet seaward opposite the east half of the outer end of Sachem Head. The 12-foot contour moved landward opposite most of the shore with the movement varying irregularly and generally not exceeding 500 feet except opposite the east half of the outer end of Sachem Head where shoaling and up to 200 feet of seaward movement occurred. Movement of the 18-foot depth contour was generally small and irregular consisting principally of landward movement. Profiles run during 1952 indicate that since 1884 there has been little change in the position of the 6-foot contour in the small shore indentations adjacent to the east and west sides of Vineyard Point.

8. Joshua Cove to Island Bay (Sachem Head to Clark Point). This area extends from a point on the east shore of Joshua Cove located about 2500 feet northeast of the outer end of Sachem Head around the shore of Joshua Cove and Island Bay to Clark Point. Most of this shore line is composed of exposed bedrock. Shore line changes along the rocky shore

have been small since 1838. Except at the heads of Joshua Cove and Island Bay which consist of barrier bars fronting marsh, small differences in the location of shore line positions between 1838 and 1948 or 1952 are believed to represent the topographer's interpretation of the location of the high water shore line or errors inherent in matching maps prepared from different surveys. Shore line changes at the heads of Joshua Cove and Island Bay generally consisted of erosion and landward movement. This movement between 1838 and 1948 was 100 to 200 feet along the west half of the head of Joshua Cove of which up to 100 feet occurred after 1933. There was little change along the east half of the head of Joshua Cove during the above period while the east shore of the cove extending about 1800 feet southwestward from the bar moved up to 100 feet landward, a large part of this latter movement apparently having occurred after 1933. The landward movement of the shore at the head of Island Bay was 50 to 75 feet between 1838 and 1952 about one-half of this movement apparently having occurred after 1933. Shore line changes also occurred along the large indentation on the east side of Island Bay consisting of landward movement of up to 100 feet in the southern half and a small amount of accretion in the northern half.

9. Offshore depth changes between 1838 and 1884 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. These landward movements were as follows: 6-foot contour, 100 to 400 feet opposite Joshua Cove, up to 1100 feet opposite Island Bay diminishing to about 200 feet opposite Clark Point, 12-foot contour, 500 to 1200 feet opposite Joshua Cove and very little change opposite Island Bay and Clark Point; 18-foot contour, irregularly 100 to 500 feet opposite the entire area. A profile run in Island Bay during 1952 indicates that shoaling and seaward movement of the 6-foot contour occurred after 1884.

10. Clark Point to Flying Point. - The shore line of this area is very irregular in shape, and it is largely composed of exposed bedrock. Shore line changes since 1838 have occurred generally only at the heads of coves or indentations in the shore. A small amount of accretion and seaward movement of the shore line has probably occurred in the pockets at the heads of Little Harbor and the similar shore indentation to the west located between Harrison Point and Hoadley Neck. Along approximately 1000 feet of the southeast end of Hoadley Neck opposite Narrows Island the shore moved seaward 50 to 150 feet, between 1838 and 1885 probably as a result of disposal of the quarry waste now existing along this shore. Between 1885 and 1948, shore line changes around Hoadley Neck were small. The head of the larger cove or indentation west of Hoadley Neck is composed of marsh. Large changes in the location of the shore of the marsh are shown as having occurred prior to 1933. Aerial photographs during 1948 indicate that the marshy shore experienced almost no change after 1933. West of the marsh, the shore extending about 2300 feet to the outer tip of Flying Point is characterized by bedrock outcrops, and it is largely protected by sea walls. A seaward movement of the shore line in this latter area has been effected since 1838. This accretion appears to be due to man-made improvements along the shore (filling and wall and pier construction).

11. Offshore depth changes between 1838 and 1884 consisted principally of deepening. The deepening moved the 6-foot depth contour landward along most of the shore. This movement was as follows: about 300 feet opposite Clark Point, 200 feet opposite Harrison Point, 50 to 250 feet opposite Narrows Island and Hoadley Neck and up to about 400 feet opposite Flying Point. The 12-foot depth contour moved over 1000 feet landward opposite Clark Point and Little Harbor and changed very little west of Little Harbor to opposite Hoadley Point.

The 18-foot contour moved 100 to 500 feet landward opposite the shore from Clark Point to Hoadley Neck. The changes in the vicinity of the 12 and 18-foot depth contours around the group of islands known as the Thimbles opposite Flying Point are not clearly shown on available data. No data are available to determine offshore depth changes after 1884.

12. Flying Point to Brown Point. This is an extremely irregular shore line characterized by bedrock outcrops and boulders with marshy areas bordering streams which empty into Long Island Sound at the heads of indentations. The principal shore line changes between 1838 and 1933 consisted of landward movement of the marshy shores adjacent to Pleasant Point. This movement varied from a maximum shore recession of about 200 feet east of Pleasant Point to about 500 feet west of Pleasant Point. A smaller amount of landward movement occurred along the shore of Pleasant Point amounting generally to less than 50 feet except in one small indentation in the south face where the shore moved almost 200 feet landward. Fairly large extents of shore line appear to have moved seaward between 1838 and 1933. This is the case along the shore extending northward from Flying Point and also in the vicinity of Juniper Point. This accretion of the shore was effected largely as the result of man-made improvements (piers, walls, wharves, filling, etc.). Between 1838 and 1885, the shore extending about 600 feet north of the tip of Brown Point moved landward about 50 feet and the 400 feet of adjoining shore to the north receded about 200 feet. Between 1885 and 1952, an accretion or seaward movement of the latter 400 feet of shore was effected equal to its former recession, probably as a result of bulkhead construction around 1915. Aerial photographs flown during 1948 indicate that little change has occurred along this entire shore since 1933.

13. Offshore depth changes consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. The amount of movement varied irregularly. The 6-foot contour moved up to 1000 feet landward between Flying Point and Rogers Island and up 350 feet landward between Rogers Island and Brown Point. Landward movement of the 12-foot contour increased from 200 feet to 2000 feet from The Thimbles to Brown Point. The 18-foot contour moved landward 300 to 600 feet between The Thimbles and Brown Point. Changes of the 12 and 18-foot contours amongst The Thimbles opposite Flying Point are not clearly shown on available data. No data are available to determine offshore depth changes after 1884.

14. Brown Point to Linden Point. The shore line west of Brown Point to Linden Point is characterized by projecting outcrops of bedrock with a series of concave, crescent-shaped pocket beaches between projections. The convex-shaped 2500 feet of shore between the most westerly pocket beach and Linden Point is composed almost continuously of exposed bedrock. Narrow sandy beaches exist along large portions of the pocket beaches. Shore line changes have been comparatively small since 1838. Comparison of shore line positions between 1838 and 1885 indicate the following changes: a seaward movement of about 100 feet at Brown Point diminishing to about 50 feet 1000 feet west of Brown Point and continuing at about 50 feet along the next westerly 1000 feet, a landward movement of 125 feet at the east end of Hotchkiss Grove Beach diminishing to a point of no change 400 feet westward, little change between Hotchkiss Grove Beach and Haycock Point, a landward movement of up to 100 feet along 400 feet of the east end and up to 175 feet along 900 feet of the west end of Limewood Beach with little change in the central portion of the beach, a landward movement of 75 to 100 feet along all but the westerly 250 feet of the pocket beach located west of Limewood Beach and generally only small irregular changes along the remainder of the shore westward to Linden Point.

The location of projecting rocky points between Brown Point and Hotchkiss Grove Beach as shown for 1838 and 1885 do not coincide indicating that shore line changes as shown for this area may be due at least in part to errors inherent in matching old surveys for comparison. Shore line changes between 1885 and 1933 were as follows: practically no change along the 2000 feet of shore west of and adjacent to Brown Point, a landward movement of about 50 feet in the small pocket beach in which Profile 6 is located, a landward movement of about 50 feet along the easterly 800 feet of Hotchkiss Grove Beach, little change between Hotchkiss Grove Beach and Haycock Point, landward movement of 50 to 100 feet in the central 1000 feet of Limewood Beach, a varying landward movement of up to 50 feet along the pocket beach west of Limewood Beach and generally little change along the remainder of the shore westward to Linden Point. Shore line changes between 1933 and 1952 were too small to permit of reliable measurement on available maps. There appears to have been a slight shore recession, generally less than 25 feet, along Limewood Beach and along the westerly 700 feet of shore in the pocket beach immediately west of Limewood Beach.

15. Offshore depth changes between 1838 and 1884 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. The 6-foot depth contour moved about 1000 feet landward opposite the shore midway between Brown and Haycock Points. This movement decreased to the east and west to Brown and Haycock Points where changes were small. Opposite Limewood Beach deepening resulted in the reduction of the size of large offshore shoal areas. Opposite the pocket beach west of Limewood Beach, the 6-foot contour moved up to 650 feet landward. West of this pocket to Linden Point, the 6-foot contour moved about 100 feet landward and a large shoal opposite Linden Point was greatly reduced in size. The

12-foot depth contour is not available opposite the entire area. Opposite Brown Point, this contour moved irregularly landward for distances up to 2000 feet. The 18-foot depth contour moved irregularly landward opposite most of the area for distances ranging from about 200 to 1000 feet. Movements of the 12 and 18-foot contours indicate a large reduction in the size of offshore shoal areas opposite Linden Point. Five profiles surveyed during 1952 indicate that there has been little change in the position of the 6-foot depth contour between Brown and Haycock Points. One profile run at Limewood Beach and another in the pocket beach west of and adjacent to Limewood Beach indicate shoaling and seaward movement of the 6-foot depth contour occurred between 1884 and 1952.

16. Linden Point to Indian Neck Point. The shore from Linden Point to and around Jeffrey Point is irregular in shape with projections composed of exposed bedrock and marsh at the head of Maltby Cove and behind the shore area. North of Jeffrey Point, the shore is a crescent-shaped sandy pocket beach terminating at a bedrock projection at Indian Neck Point. Shore line changes between Jeffrey Point and Indian Neck Point since 1838 have been too small to permit of scaling on available maps. In general the 1952 shore line is at or very close to the position it occupied during 1838 with possibly a slight accretion along the northern half of the beach and a slight recession along the southern half. Shore line changes from Linden Point to and around Jeffrey Point have been larger since 1838. They consisted generally of recession or landward movement in the small shore indentations formed by bedrock projections. The recession up to 1952 amounted to about 200 feet along the marshy shore at the head of Maltby Cove and lesser amounts elsewhere. The largest change in the area was apparently man-made consisting of excavation of an entrance channel and basin into the marsh from a point about 600 feet east of the tip of Jeffrey Point.

17. Offshore depth changes between Linden and Jeffrey Points from 1838 to 1884 as shown by the 6-foot depth contours, consisted of shifting and slight enlargement of an irregular offshore shoal area rather than in any large landward or seaward movement. A small seaward movement of the 12-foot contour and a small landward movement of the 18-foot contour are indicated by incomplete data for the above area. Opposite the west side of Jeffrey Point, for the same period, the position of the 6-foot contour moved irregularly landward and seaward for short distances and the 12-foot contour moved landward 100 to 400 feet. Opposite the pocket beach between Jeffrey and Indian Neck Points, the 6-foot depth contour moved landward up to 300 feet along the southerly 500 feet of shore, moved seaward up to 100 feet along the adjacent northerly 600 feet of shore and moved seaward about 100 feet along the remaining 1000 feet of shore adjacent to Indian Neck Point. Profiles surveyed during 1952 near the north and south ends of the pocket beach, indicate that shoaling and seaward movement of the 6-foot depth contour has occurred since 1884.

18. Indian Neck Point to Mansfield Point. This area includes the shore of Branford Harbor north of Indian Neck Point and west of Branford Point, and the shore extending westward around Johnson Point to Short Beach, Horton Point and Mansfield Point. The shore is almost entirely composed of exposed bedrock. It is irregular in shape. Unconsolidated material exists generally only in pockets formed by the irregularity of the rock outcrops. The only appreciable changes in the position of the shore line since 1838 have occurred in those indentations of the shore composed of marsh. Two such indentations exist in Branford Harbor at the head of Lindsey Cove. Changes shown by comparisons of 1838 and 1885 surveys indicate a landward shore line movement of 400 to 500 feet in the easterly indentation and up to 200 feet in the westerly indentation. After 1885 to 1933, shore line changes are shown as accretion or seaward movement

of 300 to 400 feet in the easterly indentation and additional recession of about 100 feet in the westerly indentation. The accretion in the easterly indentation appears to be due to the effect of artificial filling or the interpretation of the topographer as to what constituted the shore line, rather than to natural processes. The 1885 shore line appears to represent the approximate landward edge of marsh and the 1933 shore line the approximate seaward edge. The position of the 1838 shore line along the west side of Branford Harbor and west thereof to Mansfield Point indicates a large eastward movement of the entire shore line of the area occurred between 1838 and 1885. It is believed that this apparent shore line change is due to errors inherent in matching the map of the 1838 survey to maps of later surveys. If the 1838 shore line position as shown is disregarded and a comparison is made of the 1885 and 1933 shore lines, it becomes evident that there has been little change in the position of most of the shore between Branford Harbor and Mansfield Point since 1885.

19. Offshore depth changes between 1838 and 1884 generally consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. The landward movement of the 6-foot depth contour was about 1500 feet in Branford Harbor, was small and irregular around Johnson Point, varied from about 400 to 800 feet in the large indentation between Johnson and Horton Points and varied irregularly south and west of Horton Point, to Mansfield Point, the irregular changes, generally landward movement, not exceeding about 400 feet. Landward movement of the 12-foot contour was as follows: 0 to 800 feet across the Branford Harbor entrance, practically no change around Johnson Point, irregularly between 100 and 600 feet between Johnson Point and Kelsey Island, 400 to 600 feet south of Kelsey Island and the East Haven River entrance and small and irregular changes opposite Mansfield Point. Landward movement of the 18-foot depth

contour was as follows: 100 to 200 feet opposite Branford Harbor, a generally large movement up to 1200 feet west of Johnson Point to opposite Kelsey Island and about 200 feet opposite the East Haven River and Mansfield Point. A profile run during 1952 indicates that little change has occurred in the position of the 6-foot depth contour opposite Short Beach since 1884.

20. Momauguin Beach. This is a sandy shore characterized by scattered outcrops of bedrock. Shore line changes between 1838 and 1885 consisted of a shore recession of up to 50 feet along 500 feet of shore located 200 to 700 feet east of Profile 16 and accretion and seaward movement of the remainder of the shore to the east. The seaward movement of the shore line in the latter area increased gradually eastward to a point about 400 feet east of Profile 15 where the movement was approximately 225 feet. It thence decreased towards Bradford Cove so that the seaward movement was about 100 feet along the 400 feet of shore adjacent to the cove inlet. The accretion at the east end of the area resulted in an eastward migration of the inlet of 100 feet. Shore line changes between 1885 and 1933 consisted of a landward movement of all but the easterly 400 feet of shore. This landward movement amounted to about 100 feet midway between Profiles 15 and 16 and decreased gradually to less than 50 feet to the rock outcrop located about 400 feet west of Bradford Cove. East of this rock outcrop accretion moved the soundward shore seaward about 100 feet and also caused an additional eastward migration of the cove inlet of 50 feet. The location of the entire shore during 1952 was in approximately the same position which it occupied during 1933. Other changes, not shown by available surveys, are known to have occurred along the easterly 400 feet of shore adjacent to Bradford Cove. Aerial photographs flown during February 1949 show the shore line about 200 feet seaward of existing residences and a sand spit about 100 feet wide trailing

about 500 feet across the cove inlet almost to Mansfield Point. During the period from 1949 to 1952, the sand spit and all of the sand beach fronting the residences was lost so that the 1952 high water shore line was at or under the residences. During a field inspection in February 1955, it was noted that a considerable width of sand beach had again formed in front of residences and a sand spit again trailed eastward from the beach across the Bradford Cove entrance with its outer tip almost attaching itself to the south end of Mansfield Point.

21. Offshore depth changes between 1838 and 1884 as shown by the 6, 12 and 18-foot depth contours were generally small and irregular, resulting in both landward and seaward movement of the contours. Between Profiles 14A and 15, the predominant movement of the 6-foot depth contour was seaward for a maximum distance of about 200 feet, there was practically no change in the vicinity of the 12-foot contour and the 18-foot contour moved landward for an average distance of about 150 feet. Between Profiles 15 and 16, irregular small landward and seaward movements of the 6-foot contour were about equal but shoaling is indicated by existence of two isolated areas during 1884 shallower than 6 feet, located landward of the 1838 6-foot depth contour, the 12-foot depth contour moved up to 500 feet seaward and an isolated area shallower than 12 feet existed during 1884 landward of the 1838 12-foot contour, and there was a seaward movement of the 18-foot contour of not more than 100 feet. Three profiles surveyed during 1952 indicate that shoaling has occurred in the vicinity of the 6-foot depth since 1884. Profile 14A, one of the above profiles, indicates that deepening and landward movement of the 12-foot depth contour occurred between 1884 and 1952.

22. Silver Sands Beach. This extent of shore consists of two shallow concave sections of sandy beach connecting bedrock outcrops. The westerly section, a barrier bar fronting marsh, lies between South End and a point about 200 feet west of Profile 17 and the easterly section extends eastward therefrom to Profile 16. About 600 feet of the west end of the latter section is a barrier bar fronting marsh, the land behind the remainder being higher and occupied by a cottage development. The shore line during 1933 along the westerly concave section was in approximately the same location as during 1838. A shore recession of up to 125 feet, averaging about 100 feet, occurred in the easterly concave section between 1838 and 1933. Between 1933 and 1952, the westerly concave section retreated landward about 75 feet adjacent to South End and progressively lesser distances to the east down to about 25 feet. During this same period shore recession, of about 25 feet, occurred along the westerly third of the easterly concave section, while no measurable change occurred along the remainder of this shore.

23. Offshore depth changes between 1838 and 1872-1886 were generally small and irregular in the vicinity of the 6, 12 and 18-foot depth contours except opposite South End where all contours moved landward about 500 feet. Profile 17 surveyed during 1952 in the center of this area indicates that there has been little change in depth in the vicinity of the 6-foot depth contour since 1872, and there has been some deepening and landward movement of the above contour as located during 1884-1886.

24. West Silver Sands Beach (South End to Morgan Point.) This shore area is a low sandy barrier bar fronting marsh. It extends westward from exposed bedrock outcrops at South End to similar outcrops along the east side of Morgan Point. Shore line changes since 1838 generally indicate erosion and landward movement of the bar. Available surveys show that the

easterly 2600 feet of shore between South End and a point about 700 feet west of Profile 19 moved continuously landward between 1838 and 1933. This shore line retreat was about 100 feet at South End. It increased to almost 150 feet to Profile 18, varied between 125 and 175 feet to Profile 19 and gradually decreased to a point of no change about 700 feet west of Profile 19. The shore retreat along most of this area continued between 1933 and 1952 amounting to a maximum additional movement slightly less than 100 feet in the vicinity of Profile 18. During this latter period little change occurred along approximately 200 feet of shore immediately west of South End and the shore line extending about 300 feet east and 400 feet west of Profile 19 was moved up to 50 feet seaward, apparently as a result of construction of groins and sea walls. The westerly 1200 feet of the shore along the east side of Morgan Point, is characterized by numerous bedrock outcrops and it was subject to smaller irregular changes between 1838 and 1952. The net effect of these changes was that the 1952 shore line was close to its 1838 position, the maximum change in the shore line position not exceeding 50 feet.

25. Offshore depth changes between 1838 and 1872 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours opposite practically all of this area. The contour movements were irregular. The maximum movements were as follows: 6-foot contour, 500 feet; 12-foot contour, 400 feet; 18-foot contour, 1000 feet. Profiles 18 and 19, run during 1952, indicate that there has been little change in depth in the vicinity of the 6-foot depth contour since 1872.

26. Morgan Point and Shell Beach. Shell Beach is a low sandy barrier bar fronting marsh extending from exposed bedrock at the outer end of Morgan Point to exposed bedrock at the mouth of Morris Creek. Only minor changes in the position of the shore line have occurred along the

south face of Morgan Point since 1838. Shore line changes west of Morgan Point between 1838 and 1872 consisted of erosion and landward movement along approximately 1500 feet of shore adjacent to Morgan Point and a slight accretion or westward migration of the Morris Creek inlet. The erosion caused a maximum shore line movement of about 200 feet along the west side of the outer end of Morgan Point. This shore recession decreased rapidly westward and varied from practically no change to a shore line recession of almost 100 feet. The westward migration of the Morris Creek inlet was slightly less than 100 feet. Between 1872 and 1933, the only appreciable shore line change was accretion and up to 50 feet of seaward movement of the shore extending about 600 feet eastward from the rock outcrops adjacent to Morris Creek. Between 1933 and 1952, a landward movement of up to 50 feet occurred along that portion of the barrier bar located between points approximately 300 and 1300 feet east of the rock outcrops at Morris Creek. Minor seaward movements of the shore appear to have been effected by construction of sea walls east of the erosion area and a slight eastward movement, about 25 feet, appears to have occurred along the east shore of the Morris Creek inlet.

27. Offshore depth changes between 1838 and 1872 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. Movement of the 6-foot contour was small and irregular, generally not exceeding 100 feet. Movement of the 12-foot contour varied from about 400 to 900 feet. Movement of the 18-foot contour varied from about 300 to 500 feet. Profiles 20 and 21, run during 1952, indicate that since 1872 there has been little change in the position of the 6 and 12-foot depth contours opposite the shore located 900 feet west of Morgan Point and that shoaling and seaward movement of the 6-foot depth contour occurred opposite the mouth of Morris Creek. This latter shoaling may be

due to sand fill placed on Lighthouse Point Beach adjacent to Morris Creek during 1949.

28. Lighthouse Point Park. The shore of Lighthouse Point Park lies between Morris Creek and a point approximately 400 feet northeast of Profile 25. Changes in the high water line between 1838 and 1933 were irregular, particularly north of the tip of Lighthouse Point. These changes appear to have consisted generally of accretion and seaward movement of the shore line. The movement at the tip of Lighthouse Point was about 100 feet. North of the point, the changes varied irregularly and were smaller. East of and adjacent to the point, there was no change along approximately 500 feet of shore and a seaward movement of 50 to 75 feet along 500 feet of shore adjacent to Morris Creek. The only appreciable change in the position of the shore line between 1933 and 1952 was effected by direct placement of about 168,000 cubic yards of sand fill at Lighthouse Point and the adjoining shore to Morris Creek during January and March 1949. This fill was obtained by hydraulic dredging done in connection with a Federal navigation improvement in New Haven Harbor. As a result of this filling and subsequent drifting, the high water shore line along approximately 900 feet of shore line from Lighthouse Point north along the west shore of Lighthouse Point Park, during 1952 was 50 to 100 feet seaward of its 1933 position, and the south shore of the park between Lighthouse Point and Morris Creek was 150 to 200 feet seaward of its 1933 position. Comparative surveys covering the south shore of the park and the west shore from Lighthouse Point northward about 200 feet north of the Old Light tower were run during August 1952 and June 1955. They showed a 30 to 70-foot recession of the west shore and a recession of the south shore which decreased from 60 feet at Lighthouse Point to no change about 700 feet to the east. They also showed accretion or seaward movement of 10 to 15 feet adjacent to the Morris Creek jetty with the area of accretion extending about 300 feet to the west.

29. Offshore depth changes between 1838 and 1872 consisted of deepening and landward movement of the 6, 12 and 18-foot depth contours. The movement of the 6-foot contour was 400 to 500 feet between Morris Creek and the outer tip of Lighthouse Point, decreased to a point of practically no change opposite the west side of the outer tip of Lighthouse Point and varied between 100 and 300 feet opposite the west shore of Lighthouse Point Park. The movement of the 12-foot contour varied from about 600 feet opposite Morris Creek to 200-300 feet around Lighthouse Point to a point of no change and thence increased gradually to about 600 feet opposite the north limit of the park. The 18-foot depth contour moved 250 to 600 feet landward opposite the shore between Morris Creek and Profile 24, and also moved northward into the harbor about 1300 feet beyond its 1838 position. Profiles 22-25 surveyed during 1952 indicate that since 1872 there has been shoaling and seaward movement of the 6-foot depth contour opposite the easterly half of Lighthouse Point Beach, that there has been little change in the position of the 6-foot contour south and west of the outer tip of Lighthouse Point, that the 12-foot contour south of Lighthouse Point moved seaward, that little change occurred in the position of the 6-foot contour opposite the north end of the park, but some seaward movement of the 12-foot contour did occur in this latter area. The latter changes are believed to have resulted largely from the fill placed at Lighthouse Point Beach during 1949. Surveys of Profiles 22 and 23 at the south shore of the park indicate that offshore depth changes out to the 12-foot depth were negligible between 1952 and 1955. During the same period at Profile 24 shoaling of up to about 2 feet occurred in the offshore area out to the approximate 15-foot depth.

30. Fort Hale Park to Lighthouse Point Park (Morris Cove). This area extends from the tip of the point at Fort Hale Park, southward along Morris Cove to the northern boundary of Lighthouse Point Park located approximately 400 feet northeast of Profile 25. Shore line changes from 1838 to 1933 consisted generally of landward movement of the high water line along approximately 5000 feet of shore from Fort Hale Park to a point about 200 feet south of Profile 27, thence accretion or seaward movement of the high water line along the remainder of the shore. The recession in the erosion area consisted of a maximum movement of 150 feet at the outer tip of Fort Hale Park decreasing to about 100 feet at a point 500 feet to the southeast and thence varying between 100 feet and 25 feet, averaging about 50 feet. The seaward movement of the high water line in the accretion area was largest along the 2000 feet of shore

immediately adjacent and south of the erosion area in the southeast portion of Morris Cove extending southward to and just beyond Profile 26. It consisted of a shore line movement of 50 to 75 feet. Beyond Profile 26 to Lighthouse Point Park, the changes were irregular in shape consisting generally of accretion varying between 0 and 75 feet. The 1952 shore line was in approximately the same position as during 1933. Changes which did occur are too small to measure on available plans. There appears to have been a small amount of accretion, probably less than 25 feet, in the vicinity of Profile 27 and for about 1000 feet south thereof and probably a small amount of erosion and recession of the irregular shore line southwest of Profile 26.

31 Offshore depth changes between 1838 and 1872 consisted of deepening and landward movement of the 6 and 12-foot depth contours. The largest movements occurred opposite the most indented portion of the shore of Morris Cove. These movements amounted to about 1000 feet for the 6-foot depth contour and 1500 feet for the 12-foot depth contour. The amount of movement decreased southward toward Lighthouse Point Park and northward toward Fort Hale Park. Profiles 26 and 27 run during 1952 show little change in the location of the 6-foot depth contour since 1872.

APPENDIX F

LITTORAL DRIFT

1. Listed below are indices of littoral drift obtained from field inspection supplemented by study of aerial photographs. Direction of littoral drift was interpreted as being in the direction of growth of sand spits, towards the sides of groins or other projecting structures at which accretion was found or towards the ends of beaches where material was finer as shown by variation of beach composition where there was a change in gradation from coarser to finer material.

Indices of Drift

Shore Area	Indicated Direction of Drift	Evidence	Date	Authority
East from Guilford Point	East	Eastward trailing sand spit	11/21/52 6/6/48	Inspection Aerial Photo
West from Guilford Point	West	Westward trailing sand spit	11/21/52 6/6/48	Inspection Aerial Photo
East side of Mulberry Point	North	Accumulation of shells at south side of shore projection	11/21/52	Inspection
West side of Indian Cove	North	Shell beach held on south side of shore projection	11/21/52 6/6/48	Inspection Aerial Photo
Head of easterly cove at south face of Sachem Head	East	Width of sand beach increases to the east	11/20/52 2/8/49	Inspection Aerial Photo
Pine Orchard north of Brown Point	North	Accumulation of sand at groin and projecting sea wall	11/19/52 6/6/48	Inspection Aerial Photo
Pine Orchard west of Brown Point	Probably East	Beach slightly higher on west side groins and beach finer to east	11/19/52	Inspection

Indices of Drift (cont'd)

Shore Area	Indicated Direction of Drift	Evidence	Date	Authority
East of Haycock Point	East	Material held on west side of groins and projecting rock	11/19/52	Inspection
West side of Haycock Point	East	Wide sand beach held on west side of point	11/19/52 6/6/48	Inspection Aerial Photo
Limewood Beach	East	Material accumulated at west side of groins	11/19/52 6/6/48	Inspection Aerial Photo
First pocket west of Limewood Beach	East	Material accumulated at west side of groins	11/19/52 6/6/48	Inspection Aerial Photo
Between Jeffrey and Indian Neck Points	North	Sand beach finer and wider to the north	11/19/52 2/8/49	Inspection Aerial Photo
Momauguin Beach at Bradford Cove	East	Sand held at west side of rock outcrop	11/18/52	Inspection
		Sand spit trailing eastward	2/8/49 2/16/55	Aerial Photo Inspection
Momauguin Beach	East	Sand piled higher at west side of groins, rock pile and rock outcrop	11/18/52	Inspection
Silver Sands Beach	East	Sand accumulated at west side of groins and bedrock outcrop	11/18/52	Inspection
West side of South End	West	Sand accumulated at east side of groins	11/18/52	Inspection
West Silver Sands Beach	East	Sand higher at west side one timber groin	11/18/52	Inspection
Lighthouse Point Beach	East	Accumulation of sand at west side Morris Creek jetty	11/18/52	Inspection

Indices of Drift (cont'd)

Shore Area	Indicated Direction of Drift	Evidence	Date	Authority
North of Lighthouse Point	North	Sand higher at south side projecting rock outcrops	11/18/52	Inspection
South Shore Morris Cove	North-east	Material higher on southwest side of pier and rocks	11/17/52	Inspection
Morris Cove	North	Material piled higher at north end of sea wall	11/17/52	Inspection
North of Forbes Bluff	North	Gradation of shore finer to the north	11/17/52	Inspection

APPENDIX G

EXISTING PROTECTIVE STRUCTURES

1. General. - Large portions of the shore are unprotected or are protected by only comparatively light structures. Such shore areas are generally composed of exposed bedrock and are therefore not particularly subject to erosion. Structures in these areas have been built principally to protect lawns or shore roads which are low in elevation. Construction has generally been done by individuals or private groups and detailed information concerning the works built is not readily available. The effect of the structures has been mostly to protect the immediate shores which they front with little or no effect on adjacent shore lines. The research necessary to obtain detailed descriptive data concerning these structures would hardly be justified since little information of value in designing new structures would be gained. Readily available information concerning a breakwater at Pine Orchard and breakwaters at New Haven Harbor is included in the following paragraphs. In addition a list giving a general description of types of structures observed at specific shore locations during field inspections is included.

2. Pine Orchard Breakwater. - There is a riprap breakwater about 800 feet long extending 500 feet southeast from Brown Point to a rock outcrop and thence 300 feet in an easterly direction. The structure was built during 1926 by the Pine Orchard Association with top elevation 2.6 feet above mean low water, top width of 4 feet and side slopes of 1 on 1. Its purpose was to provide shelter for a dredged pleasure boat harbor. The breakwater incidentally provides protection against wave attack for the shore area lying in its lee immediately to the north.

3. New Haven Harbor Breakwaters. - There are three riprap breakwaters at the entrance to New Haven Harbor. They were constructed as

Federal projects authorized by the River and Harbor Acts of 3 March 1879 and 19 September 1890. Construction of the East Breakwater was started in 1880 and was completed to a length of 3,450 feet in 1890. The Middle or Luddington Rock Breakwater was started in 1891 and completed to a length of 4500 feet in 1896. The West Breakwater was begun in 1896 and completed to a length of 4200 feet in 1915. The breakwaters were built with a top width of 12 feet, top elevation 6 feet above mean high water, side slopes of 1 on 1.5 on the seaward side and 1 on 1 on the harbor side. They provide a harbor of refuge at the mouth of the harbor and afford protection to the harbor from all but southwest storms. They incidentally provide some protection against wave attack to the Morris Cove and Lighthouse Point region of the study area.

4. Structures at Various Locations. - The data tabulated below indicate the type and general locations of shore structures. Information was largely obtained from field inspections.

Location	Shore Structures
Guilford Point, Guilford	A loose stone wall along the south face. Dumped riprap revetment along the west side. Loose stone and rubble masonry walls along the east face. All fairly light construction.
Mulberry Point, Guilford	Light concrete and rubble masonry walls front lawns along the east side and outer end. A rubble masonry wall fronts a shore road along the west side.
Indian Cove, Guilford	Dumped boulders along the edge of the road at the head of the cove. Rubble masonry and loose stone walls front lawns at a few cottages along the west shore.
Vineyard Point, Guilford	Rubble masonry and curved face concrete sea walls and dumped stone revetment along east side. Low rubble masonry and concrete walls fronting lawns at south face and west side. There is a rubble masonry wall along the causeway at the head of the cove on the west side of the point. This wall is fronted by dumped stone along its west half.

Location	Shore Structures
Sachem Head area west of Vineyard Point including east shore of Joshua Cove, Guilford	Lawns and low portions of shore roads are protected by riprap revetment or rubble masonry walls. A low rubble masonry wall encloses a fill area at the southwest tip of Sachem Head. The shore to the northwest along the southerly third of the east side of Joshua Cove is lined with quarry waste.
Joshua Cove - west shore, Guilford	Some cottages are fronted by rubble masonry walls, apparently for protection of lawns.
Island Bay, Guilford	East shore - A low rubble masonry wall at the tip of the point. Riprap revetment fronting a low road and a loose stone wall south of the revetment. Head of Bay - Stone filled cribs, concrete and rubble masonry sea walls along east half with some riprap revetment in front of walls. Dumped stones along the west half. West shore - Large amounts of riprap apparently dumped as revetment along the shore.
Leetes Island, Branford	The outer end is revetted continuously with quarry waste.
Narrows Island, Branford	A low rubble masonry wall.
Shore east from Flying Point	Shore lined with low loose stone and rubble masonry walls. A number of rubble masonry piers.
Shore north from Flying Point to Stony Creek	A continuous system of rubble masonry and loose stone walls border the shore fronting lawns. There are a number of piers, boat slips and marine railways along the shore.
Pine Orchard north of Brown Point	Stone masonry and concrete walls line the entire shore. A riprap breakwater at Brown Point.
Pine Orchard west of Brown Point to Hotchkiss Grove, Branford	A continuous system of fairly heavy stone masonry and concrete sea walls or placed stone revetment. Along the easterly portion, the walls have a curved face. There are three timber groins along the central portion of the shore.
Hotchkiss Grove Beach, Branford	The east end (not bordered by the shore road) is protected by heavy rubble masonry walls and a concrete wall with secondary walls on the embankment slope above. There are loose and rubble masonry walls and riprap revetment along the shore road.

Location	Shore Structures
Haycock Point and the projecting shore to the east to Hotchkiss Grove, Branford	There are rubble masonry walls around Haycock Point and rubble masonry and concrete walls fronting lawns to the east. The shore projection adjacent to Hotchkiss Grove is protected by riprap revetment.
Limewood Beach, Branford	Structures consist of riprap revetment along the seaward edge of the road along the central part of the beach, rubble masonry and concrete walls along the west end and riprap, timber and concrete groins along the west half.
Pocket beach at Indian Neck west of and adjacent to Limewood Beach, Branford	A riprap groin to a rock outcrop at the east end and a few timber and riprap groins along the beach. Concrete and rubble masonry walls and a steel sheet pile bulkhead fronting lawns and a steep slope bordering a shore road.
Linden Point - Maltby Cove - Jeffrey Point area of Indian Neck, Branford	A stone groin and rubble masonry wall east of Linden Point. A system of generally low concrete and rubble masonry walls around Linden Point, Maltby Cove and Jeffrey Point fronting lawns, walks and cottages.
Shore of Branford Harbor north of Jeffrey Point to Indian Neck Point, Branford	Low concrete and rubble masonry walls close to the waters edge front residences adjacent to Jeffrey Point. Portions of the steep bluff along the middle and northern part of the beach are fronted by low concrete and rubble masonry walls and light timber bulkheads.
Parker Memorial Park in Branford Harbor, Branford	Shore of the park lined with a rubble masonry wall which is low behind the sand bathing beach and higher to the west.
Pages Cove, Branford	Riprap revetment borders shore road in east pocket. Rubble masonry walls front some residences in central portion along rocky shore. Loose stone walls and riprap revetment along toe of bank in west pocket.
Short Beach area including the shore from Stanley to Horton Points, Branford	Low loose stone and rubble masonry walls along the east side of Stanley Point. Low concrete and rubble masonry walls front lawns and residences in the pocket beach west of Stanley Point and also along the edge of road behind the next westerly sand pocket beach.

Location	Shore Structures
Momauguin Beach, East Haven	A riprap mound along the Bradford Cove shore and in front of adjacent residences. An occasional groin or bulkhead along the shore to the west. Rubble masonry walls around residences and a commercial building at the west end of the beach.
Silver Sands Beach, East Haven	One concrete groin and low concrete and rubble masonry walls front some cottages along the easterly half. A number of timber groins and an irregular line of fairly heavy concrete and masonry walls and timber and steel sheet pile bulkheads front cottages near the waters edge along the west half.
West Silver Sands Beach, East Haven	A timber bulkhead and jetty at South End acts as a groin. Buildings along portions of the shore are fronted by timber bulkheads and groins.
Morgan Point, East Haven	An irregular line of disconnected concrete and rubble masonry walls along the east side. A continuous line of fairly heavy concrete and rubble masonry walls and timber bulkheads along the west side.
Lighthouse Point Park, New Haven	A stone and timber jetty at Morris Creek. Riprap walls along the edge of a gravel road at the west shore of the park.
Morris Cove, south shore adjacent to Lighthouse Point Park, New Haven	Stone, concrete and rubble masonry walls and timber bulkheads, generally low, front buildings near the waters edge.
The head of Morris Cove, south of Morris Cove Park, New Haven	There are heavy cut stone masonry and concrete walls and timber bulkheads along the north end adjacent to the park. The size of structures decreases southward. No structures along the southerly third of the area where there is a fairly wide sand beach fronting buildings.
Morris Cove Park, New Haven	A high curved face cut stone masonry sea wall with a cutoff wall of steel sheet piling at the waters edge.
United States Naval Reserve Station south of Fort Hale Park	A heavy dumped riprap mound at the inshore end of the pier and along the approximate high water level of the shore.

APPENDIX H

ESTIMATES OF COSTS OF IMPROVEMENTS

1. General. - A useful life of 50 years has been used in determining amortization charges. A rate of interest of 2.5 percent per annum has been used. Maintenance requirements of sand fills are based on maximum rates of loss determined from past shore recession or a minimum rate of shore recession of one foot per year. No allowance has been taken for the effect of groins in reducing rates of loss. An assumption that the groins proposed for deferred construction would reduce the fill maintenance requirements by one-half indicates that the savings in fill maintenance would be less than the annual charges on the groins. On this basis, deferred construction of these groins is considered reasonable. Annual maintenance costs of groins have been estimated as replacement of one percent of the original structure.

2. Guilford Point Public Beach. - The plan of improvement and protection consists of widening the beach by direct placement of sand fill and construction of an impermeable groin.

a. First Cost of Construction

Sand Fill, 17,000 cu. yds. @ $1.25	$21,250
Riprap groin, 1,050 tons @ $ 10.00	10,500
Engineering and contingencies	8,250
Total Cost	$40,000

b. Annual Charges

Interest	$ 1,000
Amortization	410
Maintenance	
Groin, 11 tons riprap @ $10.00	110
Sand fill, 200 cu.yds.@ $ 1.25	250
Total Annual Charges	$ 1,770

3. Momauguin Beach. - The plan of protection consists of widening the beach by direct placement of sand fill, extension of an impermeable groin at Bradford Cove, and if necessary, construction of three other impermeable groins.

a. First Cost of Construction

Sand Fill, 155,000 cu.yds. @ $0.65	$100,750
Riprap groin, required construction 700 tons @ $10.00	7,000
Three riprap groins, deferred construction, 2,550 tons @ $10.00	25,500
Engineering and contingencies	32,750
Total Cost	$166,000

b. Annual Charges

Interest	$ 4,150
Amortization	1,700
Maintenance	
Sand Fill, 2,100 cu.yds. @ $1.25	2,625
Groins, 33 tons riprap @ $10.00	330
Total Annual Charges	$ 8,805

4. Silver Sands Beach. - The plan of protection consists of widening the beach by direct placement of sand fill, construction of an impermeable groin at Caroline Creek and if necessary, construction of four other impermeable groins.

a. First Cost of Construction

Sand Fill, 171,000 cu. yds. @ $0.65	$111,150
Riprap groin, required construction, 1000 tons @ $10.00	10,000
Four riprap groins, deferred construction, 3200 tons @ $10.00	32,000
Engineering and contingencies	36,850
Total Cost	$190,000

b. Annual Charges

Interest	$ 4,750
Amortization	1,950
Maintenance	
Sand Fill, 3000 cu.yds. @ $1.25	3,750
Groins, 42 tons riprap @ $10.00	420
Total Annual Charges	$ 10,870

5. West Silver Sands Beach. - The plan of protection consists of widening the beach by direct placement of sand fill, construction of an impermeable groin at Caroline Creek, and if necessary, construction of four other impermeable groins.

a. First Cost of Construction

Sand Fill 212,000 cu.yds. @ $0.65	$137,000
Riprap groin, required construction, 750 tons @ $10.00	7,500
Four riprap groins, deferred construction, 3,250 tons @ $10.00	32,500
Engineering and contingencies	43,000
Total Cost	$220,000

b. Annual Charges

Interest	$ 5,500
Amortization	2,260
Maintenance	
Sand Fill, 2,900 cu.yds. @ $1.25	3,625
Groins, 40 tons riprap @ $10.00	400
Total Annual Charges	$ 11,785

6. Shell Beach. - The plan of protection consists of widening the beach by direct placement of sand fill and construction of one impermeable groin.

a. First Cost of Construction

Sand Fill, 62,000 cu.yds. @ $0.85	$52,700
Riprap groin, 1,150 tons @ $10.00	11,500
Engineering and contingencies	15,800
Total Cost	$80,000

b. Annual Charges

Interest	$ 2,000
Amortization	820
Maintenance	
Sand Fill, 660 cu. yds. @ $1.25	825
Groin, 12 tons riprap @ $10.00	120
Total Annual Charges	$ 3,765

7. Lighthouse Point Park. - The plan of protection consists of construction of an impermeable groin at Lighthouse Point.

a. First Cost of Construction

Riprap groin, 950 tons @ $10.00	$ 9,500
Engineering and contingencies	2,500
Total Cost	$12,000

b. Annual Charges

Interest	$ 300
Amortization	120
Maintenance	
Groin,10 tons riprap @ $10.00	100
Total Annual Charges	$ 520

APPENDIX I

ESTIMATES OF BENEFITS FROM IMPROVEMENTS

1. General. - The benefits computed herein are based on the promotion and encouragement of the healthful recreation of the people by protection and improvement of beaches, on protection of shore property and increased earning power or value of shore lands. Benefits accruing from increased value of areas behind and adjacent to shore property and increased business returns have not been evaluated. The United States does not own land in any of the areas considered for protection or improvement. Therefore, no Federal benefit will result from the plans considered.

2. Guilford Point Public Beach. - This is the only public bathing beach in the town of Guilford. The beach area is small and can accommodate only a small percentage of prospective beach patrons. The annual patronage of public beaches in Connecticut shore towns, based on available attendance records, has been found to be at least 10 times the population. Guilford, with a summer population of about 8,000 people, could, on this basis, produce a potential annual beach attendance of 80,000 persons. Lack of public beach space precludes the possibility of development of such a beach attendance without overcrowding. At a desirable optimum beach space standard of 75 square feet per person, the existing beach can accommodate about 375 persons. The proposed beach widening will provide space for an additional 675 persons. Analysis of attendance records at Eastern Point Beach Park in Groton shows that the average daily attendance for a 93-day season was one-third of the peak attendance. Assuming a similar pattern for the proposed additional area at the Guilford Point public beach, the estimated attendance for the new beach area would be as follows:

Peak attendance	675	persons
Average daily attendance	225	"
Seasonal attendance	93 x 225 = 21,000	" (approx.)

The above computed seasonal attendance is well within the potential attendance which could be developed if space were available. The recreational value per

person for beach use is evaluated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. This is estimated as $0.20 per person. The annual recreational benefit, which is non-Federal public, therefore becomes

$$21,000 \times \$0.20 = \$4,200.$$

3. Momauguin Beach

a. Direct Damages Prevented

(1) Private Benefit. - The proposed plan of protection will result in a saving in the maintenance cost of existing protective structures, prevent losses of shore land and reduce recurring storm damages to the existing shore development.

Saving in Maintenance Cost of Existing Protective Structures	
Estimated value of existing structures	$21,000
Estimated annual maintenance cost of structures	1,050
Therefore, benefit or saving in maintenance cost	1,050
Prevention of Loss of Shore Land	
Value of land per square foot	$ 0.50
Annual loss averaging one foot along 2200 feet	2200 sq. ft.
Therefore, value of land lost or benefit	$ 1,100

Reduction of Storm Damages to Existing Shore Development. - The proposed fill will provide a protective beach fronting the existing shore development which is now subject to recurring damages during storms. Based on the same data used in subparagraph a(1) of this appendix pertaining to Silver Sands Beach and the assumption that since Momauguin Beach represents about 21 percent of the East Haven Shore, the benefit will apply to only 21 percent of the total town storm damages, the average annual storm damages prevented or

the annual benefit will be

$4,000 x 0.5 x 0.5 x 0.21 = $4,410.

b. Increased Earning Power or Value of Shore Land

(1) Non-Federal Public Benefit. - The proposed plan of protection will increase the area of shore land, enlarge the tax base and be reflected in a lower tax rate for the town. The benefit therefrom is evaluated as a probable 30 percent increase in value and taxes on shore front lots.

Increase in Tax Income

Length of shore	2,600 feet
Assessed value per linear foot, 1,200 feet at $50 and 1,400 feet at $60	
Total assessed value	$144,000
Tax rate	35 mills
Estimated increase in taxes or benefit = 144 x 35 x 0.3 =	$1,510

(2) Private Benefit. - The sand fill will increase the area and result in an estimated 30 percent increase in value of shore land. The benefit therefrom is computed as 5 percent of this increase.

Estimated value of shore land	$144,000
Estimated increase in value	43,200
Estimated annual gain or benefit @ 5%	2,160

c. Summary of Benefits, Momauguin Beach

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	0	$6,560	$6,560
Increased earning power	$1,510	2,160	3,670
Total	$1,510	$8,720	$10,230

4. Silver Sands Beach

a. Direct Damages Prevented

(1) Private Benefit. - The proposed plan of protection will result in a saving in the maintenance cost of existing protective structures.

prevent losses of shore land and reduce recurring storm damages to the existing shore development.

Saving in Maintenance Cost of Existing Protective Structures

Estimated value of existing sea walls and bulkheads	$35,000
Estimated annual maintenance cost of walls and bulkheads	1,750
Estimated value of existing groins	6,000
Estimated annual maintenance cost of groins	600
Therefore, benefit or saving in maintenance cost	2,350

Prevention of Loss of Shore Land

Value of land per square foot	$0.50
Annual loss of land averaging one foot per year along 2600 feet	2,600 sq. ft.
Therefore, value of land lost or benefit	1,300

Reduction of Storm Damages to Existing Shore Development. - The proposed fill will provide a protective beach fronting the existing shore development which is now subject to recurring damages during storms. Reported storm damages along the entire shore of East Haven have occurred as follows:

November 25, 1950	$ 50,000
November 6 - 7, 1953	150,000
August 31, 1954	105,000
September 11, 1954	30,000
Total	$335,000
Average per storm	$ 84,000 (approximate)

The above storm damages have probably occurred at more frequent intervals than can ordinarily be expected. Some of the damages are probably due to wind and water and are of a nature that will not be prevented by the proposed beach fill. In order to arrive at a conservative estimate of the benefits to be derived from the protective beach it is assumed that severe storms will occur once every two years (instead of four in five years listed above) and that only 50 percent of the total damages will be prevented.

Since Silver Sands Beach represents about 23 percent of the entire East Haven shore, it is further assumed that the benefit will apply to only 23 percent of the total town storm damages. Therefore, the average annual storm damages prevented or the annual benefit will be

$84,000 \times 0.5 \times 0.5 \times 0.23 = \$4830$

b. Increased Earning Power or Value of Shore Land

(1) Non-Federal Public Benefit. - The proposed plan of protection will increase the area of shore land, enlarge the tax base and be reflected in a lower tax rate for the town. The benefit therefrom is evaluated as a probable 30 percent increase in value and taxes on shorefront lots.

Increase in Tax Income

Length of shore	2,600 feet
Assessed value per linear foot	$60
Total assessed value	$156,000
Tax rate	35 mills
Estimated increase in taxes or benefit = 156 x 35 x 0.3 =	$1,640 (approx)

(2) Private Benefit. - The sand fill will increase the area and result in an estimated 30 percent increase in value of shore land. The benefit therefrom is computed as 5 percent of this increase.

Estimated value of shore land	$156,000
Estimated increase in value	46,800
Estimated annual gain or benefit @ 5%	2,340

c. Summary of Benefits, Silver Sands Beach

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	0	$8,480	$8,480
Increased earning power	$1,640	2,340	3,980
Total	$1,640	$10,820	$12,460

5. West Silver Sands Beach

a. Direct Damages Prevented

(1) Private. - The proposed plan will result in a saving in the maintenance cost of existing protective structures, prevent losses of shore land and reduce recurring storm damages to the existing shore development.

Saving in Maintenance Cost of Existing Protective Structures

Estimated value of existing sea walls and bulkheads	$12,000
Estimated maintenance cost of walls and bulkheads	600
Estimated value of existing groins	8,000
Estimated maintenance cost of groins	800
Therefore, benefit or saving in maintenance cost	1,400

Prevention of Loss of Shore Land

Value of shore land per square foot	$0.50
Annual loss of land of 3 feet per year along 800 feet	2,400 sq. ft.
Therefore, value of land lost or benefit	$1,200

Reduction of Storm Damages to Existing Shore Development. - The proposed fill will provide a protective beach fronting the existing shore development which is now subject to recurring damages during storms. Based on the same data and methods used in subparagraph a(1) of this appendix pertaining to Silver Sands Beach and the assumption that since West Silver Sands Beach represents about 25 percent of the East Haven shore, the benefit will apply to only 25 percent of the total town storm damages, the average annual storm damages prevented or the annual benefit will be

$$\$4,000 \times 0.5 \times 0.5 \times 0.25 = \$5,250$$

b. Increased Earning Power or Value of Shore Land

(1) Non-Federal Public Benefit. - The proposed plan of protection will increase the area of shore land, enlarge the tax base and be

reflected in a lower tax rate for the town. The benefit therefrom is evaluated as a probable 40 percent increase in value and taxes on shore front lots.

Increase in Tax Income

Length of shore	2,950 feet
Assessed value per linear foot, 600 ft @ $40 and 2,350 ft. @ $50	
Total assessed value	$141,500
Tax rate	35 mills
Estimated increase in taxes or benefit = 141.5 x 35 x 0.4 =	$1,980 (approx)

(2) Private Benefit. - The sand fill will increase the area and result in an estimated 40 percent increase in value of shore land. The benefit therefrom is computed as 5 percent of this increase.

Estimated value of shore land	$141,500
Estimated increase in value	56,600
Estimated annual gain or benefit @ 5%	$2,830

c. Summary of Benefits, West Silver Sands Beach

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	0	$7,850	$7,850
Increased earning power	$1,980	2,830	4,810
Total	$1,980	$10,680	$12,660

6. Shell Beach

a. Direct Damages Prevented

(1) Private Benefit. - The proposed plan of protection will result in a saving in the maintenance cost of existing protective structures along the adjacent Morgan Point area and prevent losses of shore land along Shell Beach.

Saving in Maintenance Cost of Existing Protective Structures

Estimated value of existing structures	$4,500
Estimated benefit or saving in maintenance cost	250

Prevention of Loss of Shore Land

Value of land per square foot	$0.35
Annual loss of land of one foot per year along 900 feet	900 sq. ft.
Therefore, benefit or value of land lost	$300 (approx)

b. Increased Earning Power or Value of Shore Land

(1) Non-Federal Public Benefit. - The proposed plan of protection will increase the area of shore land, enlarge the tax base and be reflected in a lower tax rate for the town. The benefit therefrom is evaluated as a probable 50% increase in value and taxes on shore front lots.

Increase in Tax Income

Length of shore	1,350 feet
Assessed value per linear foot	$35
Total assessed value	$47,250
Tax rate	35 mills
Estimated increase in taxes or benefit = 47.25 x 35 x 0.5 =	$820 (approx)

(2) Private Benefit. - The sand fill will increase the area and result in an estimated 50 percent increase in value of shore land. The benefit therefrom is computed as 5 percent of this increase.

Estimated value of shore land	$47,250
Estimated increase in value	$23,625
Estimated annual gain or benefit @ 5%	$ 1,180 (approx)

c. Summary of Benefits, Shell Beach

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	0	$ 550	$ 550
Increased earning power	$820	1,180	2,000
Total	$820	$1,730	$2,550

7. Lighthouse Point Park. - Benefits consist of direct damages prevented. They are estimated as reduction of losses of sand from the bathing beach at Lighthouse Point Park. Comparative surveys made during August 1952 and June 1955 indicate that average annual losses of beach sand east of and adjacent to Lighthouse Point are about 2,300 cubic yards. Based on an assumption that the proposed groin will result in a 50 percent reduction of losses of beach material in this area, the benefit will consist of a saving of 1/2 x 2300 or 1150 cubic yards of sand per year. The monetary value of this saving, evaluated at $1.25 per cubic yard is estimated as 1150 x $1.25 or approximately $1400 per year.

Appendix J

Sanitary Study of the Connecticut Shore

1. General. - The Department of Health of the State of Connecticut has periodically conducted bacterial and sanitary surveys of shore bathing waters to obtain specific information concerning their condition. The surveys have served to point out to municipal authorities and other interested persons the "danger spots" along the shore which are seriously affected by sewage pollution.

2. Bacterial Survey. - The bacterial survey consists of sampling of the water at approximate 1000-foot intervals along the shore in water depths of from 2 to 6 feet, such depths covering most of the areas used for bathing. The samples are taken as nearly as possible at four stages of the tide; namely, high, low, one-half ebb and one-half flood. Wind direction at the time of sampling is recorded but no attempt is made to take samples under different wind conditions as it is believed that the run of the tide is the principal factor influencing the travel of pollution along the shore. Three 10 milliliter, three 1 milliliter and three 0.1 milliliter portions of each sample are examined and the concentration of coliform organisms per 100 milliliter is reported. The most probable number of coliform organisms for each station is obtained by averaging the figures for the four tidal stages. The analytical figure for a shore section is obtained by averaging the results for different stations included. Classification is made as follows:

Bacterial Classification	Most Probable Number of Coliform Organisms for 100 Ml.
A	0 - 50
B	51 - 500
C	501 - 1000
D	over 1000

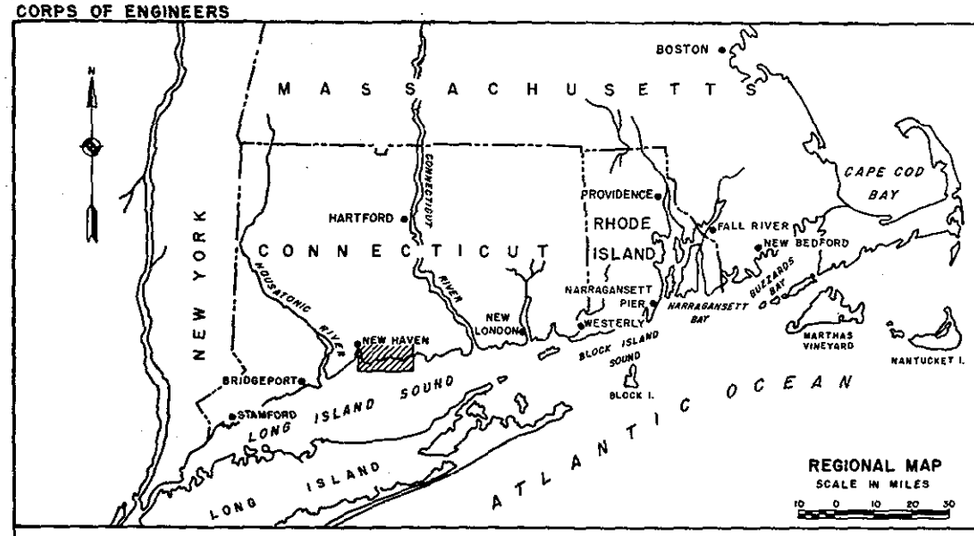
Class D waters are considered to be in a questionable category from the standpoint of bathing water safety.

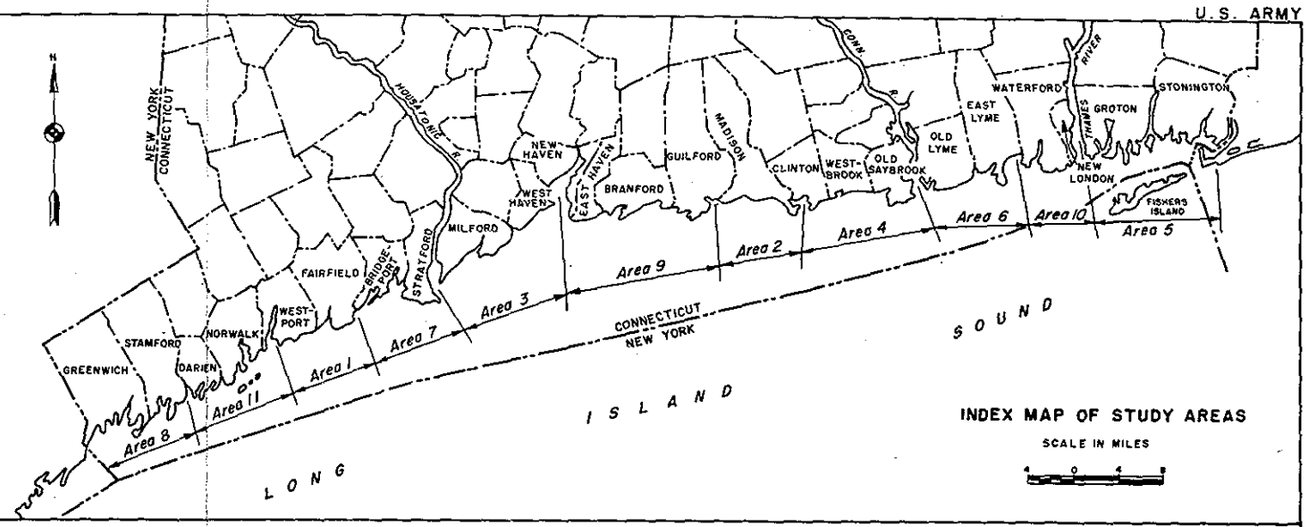
3. Sanitary Survey. - In addition to the bacterial survey, a sanitary survey has been conducted. This includes the location of sewer outlets with data as to flows and character of untreated and treated sewage. The nearness of polluting influences and possibilities of shifting direction of travel of pollution under different wind conditions were taken into account in this part of the study. In connection with studies of shellfish areas in many harbors, floats had been set out to measure the rapidity of water travel and these data were available in considering bathing waters in these localities. The sanitary survey was used to classify waters and afforded comparison with results obtained by the bacterial survey.

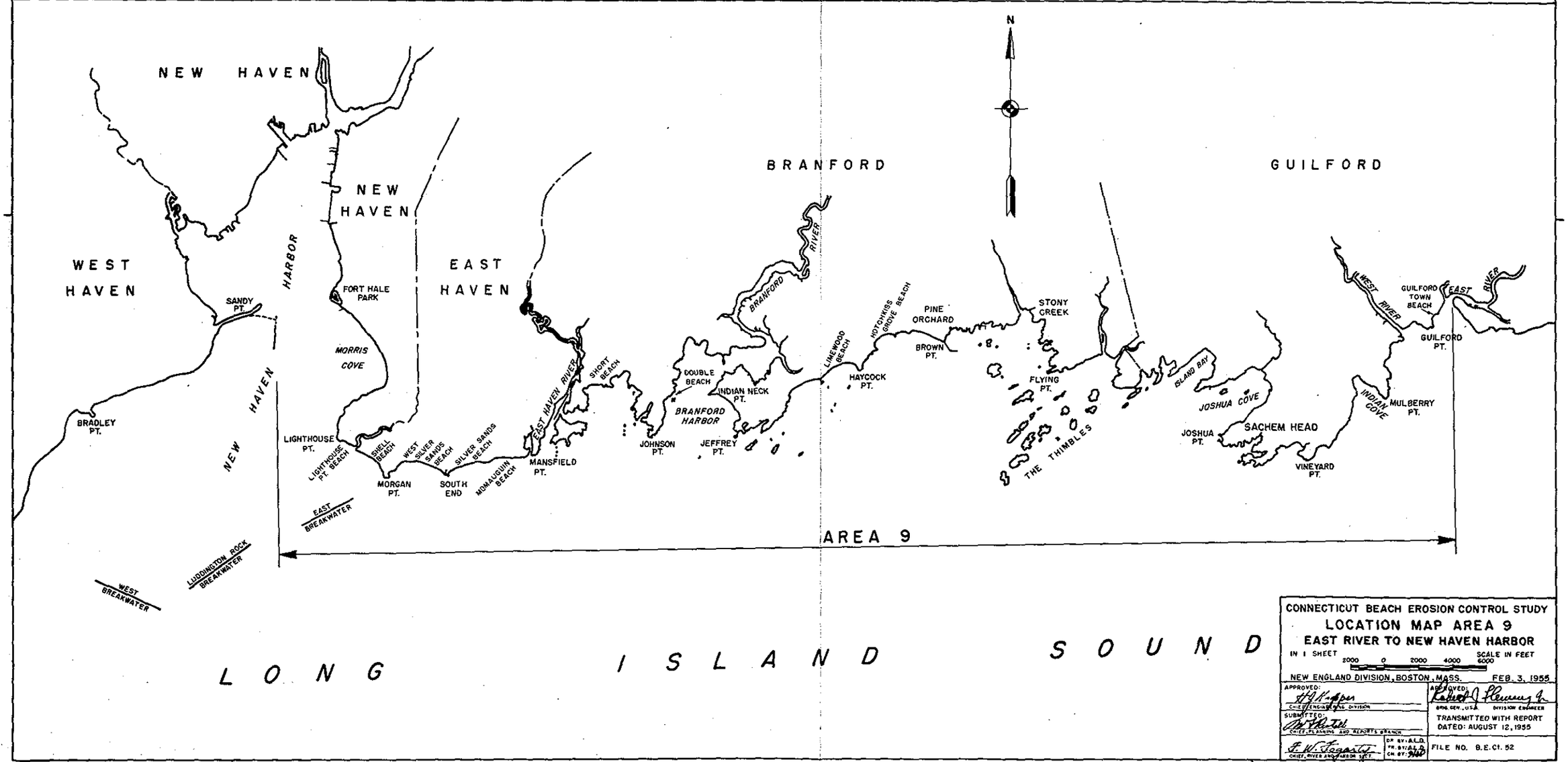
4. Classification of the Shore. The shore was classified by bacterial analysis of samples collected during 1951 and 1952. According to this classification all shore areas for which plans of protection or improvement have been considered were rated as A, B, or C. None of these shore areas were found to be in a questionable category from the standpoint of bathing water safety.

CORPS OF ENGINEERS

U.S. ARMY







CONNECTICUT BEACH EROSION CONTROL STUDY

LOCATION MAP AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 1 SHEET

SCALE IN FEET 2000 0 2000 4000 6000

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 3, 1955

APPROVED: H.H. Hopson, CHIEF ENGINEERS, NED DIVISION

APPROVED: Robert J. Fleming Jr., BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

F.W. Fogarty, CHIEF, RIVER AND HARBOR SECT.

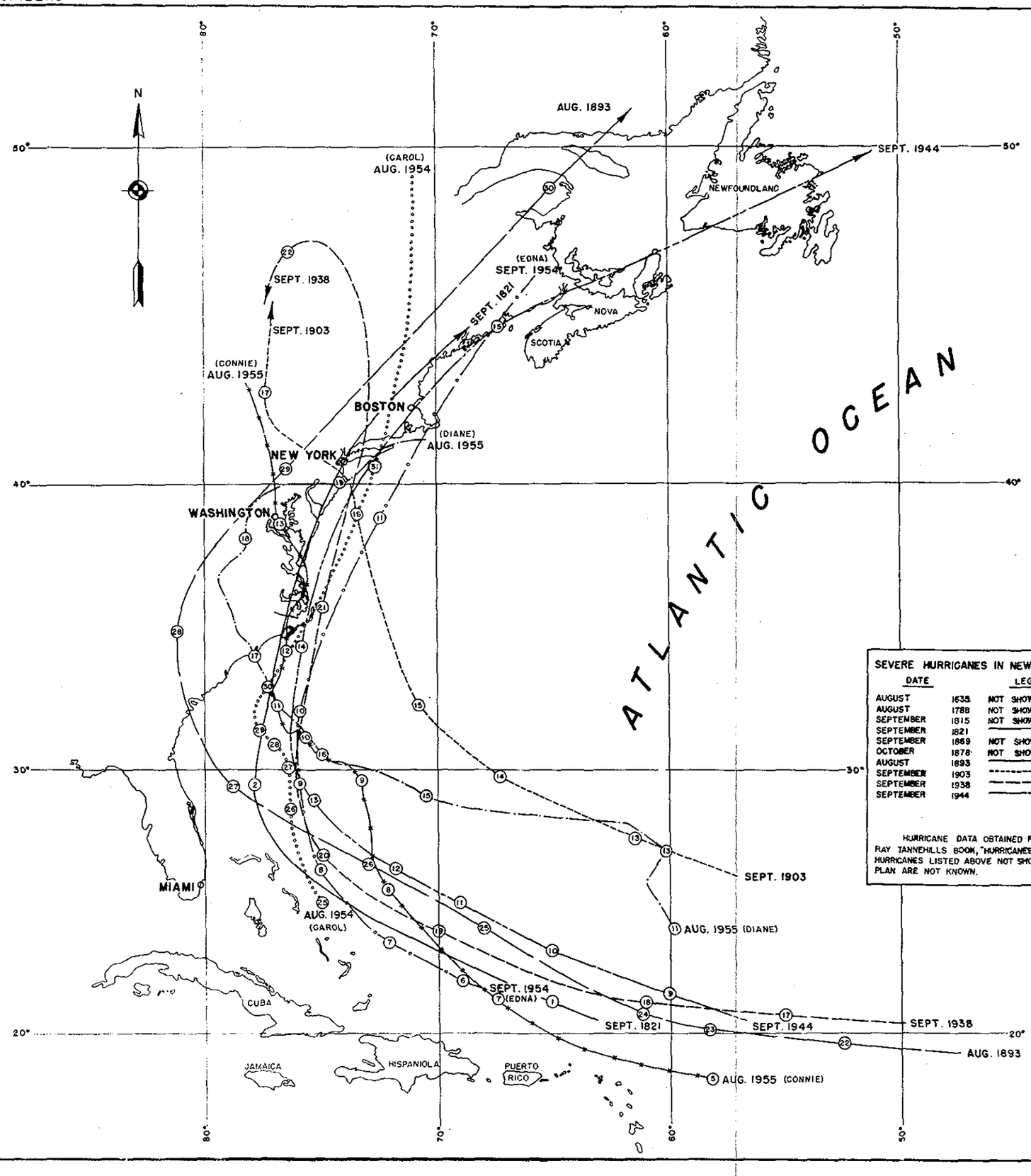
DR BY: A.L.D. TR BY: A.L.D. CH BY:

FILE NO. B.E.C.I. 52

PLATE 1

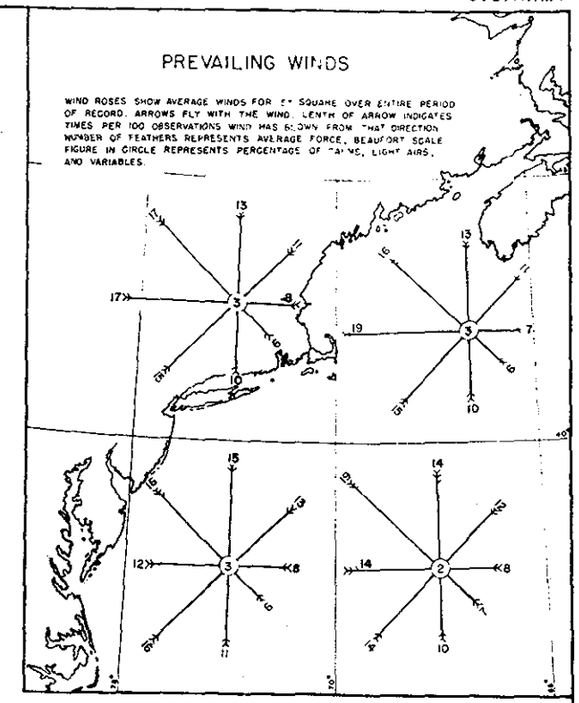
CORPS OF ENGINEERS

U.S. ARMY



PREVAILING WINDS

WIND ROSES SHOW AVERAGE WINDS FOR 5° SQUARE OVER ENTIRE PERIOD OF RECORD. ARROWS FLY WITH THE WIND. LENTH OF ARROW INDICATES TIMES PER 100 OBSERVATIONS WIND HAS BLOWN FROM THAT DIRECTION. NUMBER OF FEATHERS REPRESENTS AVERAGE FORCE, BEAUFORT SCALE. FIGURE IN CIRCLE REPRESENTS PERCENTAGE OF CALMS, LIGHT AIRS, AND VARIABLES.



RECENT HURRICANES

DATE		LEGEND	CODE NAME
AUG.	25-31, 1954		CAROL
SEPT.	6-11, 1954		EDNA
AUG.	5-13, 1955		CONNIE
AUG.	11-19, 1955		DIANE

SEVERE HURRICANES IN NEW ENGLAND

DATE		LEGEND
AUGUST	1635	NOT SHOWN
AUGUST	1788	NOT SHOWN
SEPTEMBER	1815	NOT SHOWN
SEPTEMBER	1821	
SEPTEMBER	1869	NOT SHOWN
OCTOBER	1878	NOT SHOWN
AUGUST	1893	
SEPTEMBER	1903	
SEPTEMBER	1938	
SEPTEMBER	1944	

HURRICANE DATA OBTAINED FROM IVAN RAY TANNEHILL'S BOOK, "HURRICANES." PATHS OF HURRICANES LISTED ABOVE NOT SHOWN ON PLAN ARE NOT KNOWN.

NOTE

Figures in circles shown thus (13) represent location of the center of hurricane on the day of month of its occurrance.

REVISION	DATE	DESCRIPTION	BY
1	10/6/55	Hurricane paths during 1954 and 1955 added.	C.T.M

CONNECTICUT BEACH EROSION CONTROL STUDY

HURRICANES AND PREVAILING WINDS

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED
Henry A. Whitworth
CHIEF, R & O OPERATIONS DIVISION

APPROVED
LT COL, C.E., ASST DIVISION ENGINEER

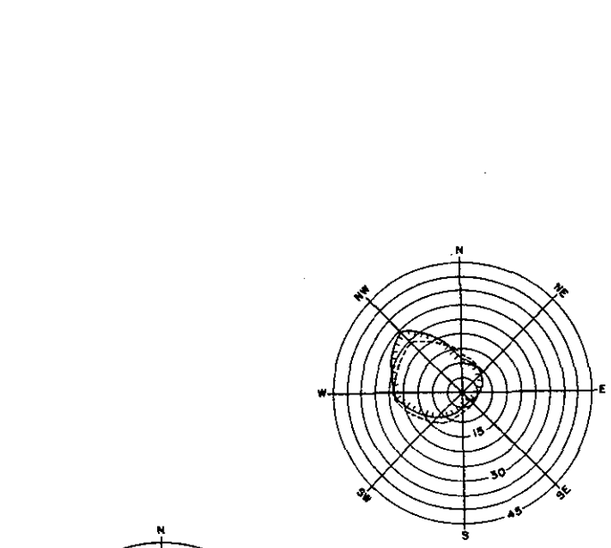
SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949

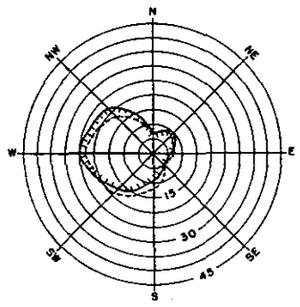
DR BY M.S.F.
TR BY W.R.
CH BY [illegible]

FILE NO. B.E.C1.2

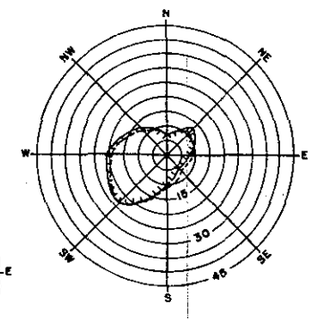
PLATE 2



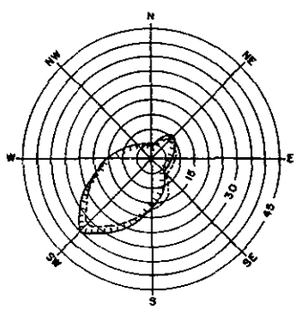
FEBRUARY



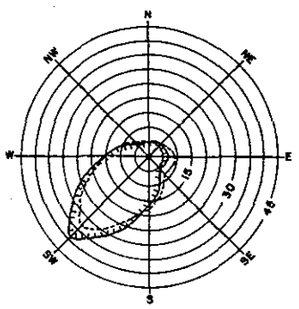
MARCH



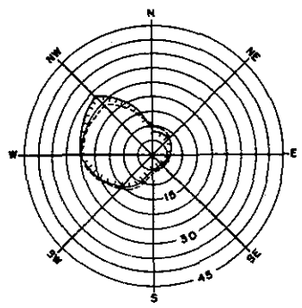
APRIL



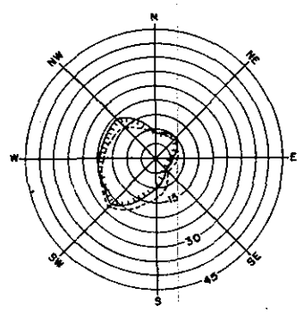
MAY



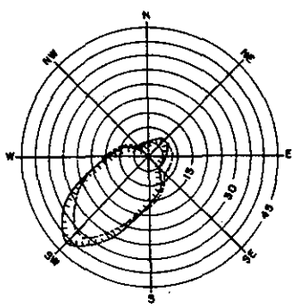
JUNE



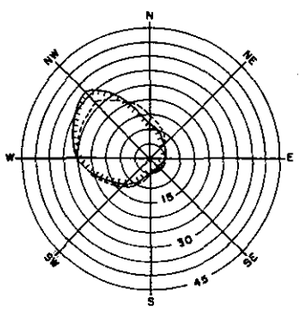
JANUARY



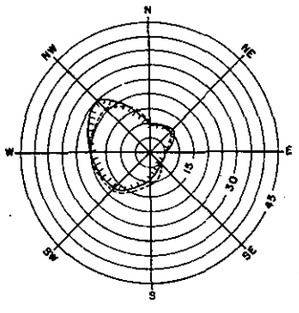
ANNUAL



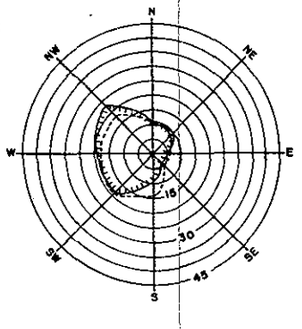
JULY



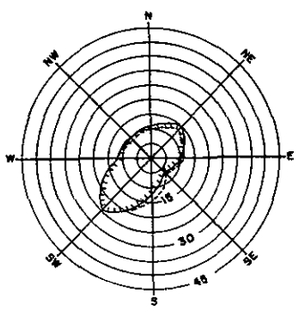
DECEMBER



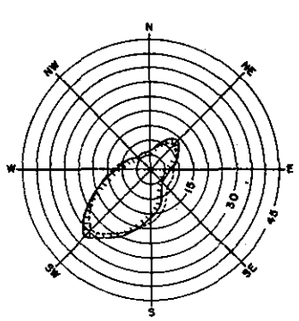
NOVEMBER



OCTOBER



SEPTEMBER



AUGUST

LEGEND

PERCENTAGE OF TOTAL WIND MOVEMENT

PERCENTAGE OF TOTAL WIND DURATION

NOTES

EACH CONCENTRIC CIRCLE STARTING AT THE CENTER REPRESENTS FIVE PERCENT OF THE TOTAL WIND MOVEMENT OR TOTAL WIND DURATION.

THE WIND DIAGRAMS REPRESENT PERCENTAGE OF TOTAL WIND MOVEMENT OR WIND DURATION AVERAGED FOR A PERIOD FROM 1921 TO 1939.

THE ANNUAL DIAGRAM REPRESENTS AVERAGES COMPUTED FOR THE ENTIRE PERIOD. THE MONTHLY DIAGRAMS REPRESENT AVERAGES COMPUTED FOR EACH MONTH OF THE YEAR FOR THE ENTIRE PERIOD.

BASIC DATA COMPILED FROM OBSERVATIONS OF THE U.S. WEATHER BUREAU AT BLOCK ISLAND, RHODE ISLAND.

CONNECTICUT BEACH EROSION CONTROL STUDY

WIND DATA

BLOCK ISLAND, RHODE ISLAND

1921 - 1939

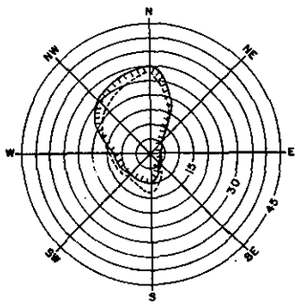
IN 1 SHEET

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

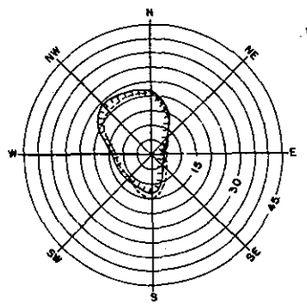
APPROVAL RECOMMENDED CHIEF, R & H OPERATIONS DIVISION	APPROVED LT. COL., C.E., ASST. DIVISION ENGINEER
SUBMITTED R & H PROJECTS AND REPORTS BRANCH	
DR. BY H.S.P. TR. BY R.S. CH. BY [illegible]	FILE NO. B.E.C.I.3

PLATE 3

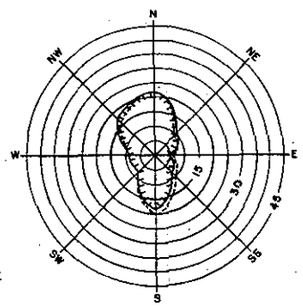
JANUARY



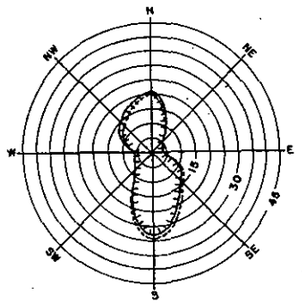
FEBRUARY



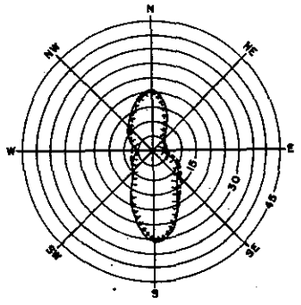
MARCH



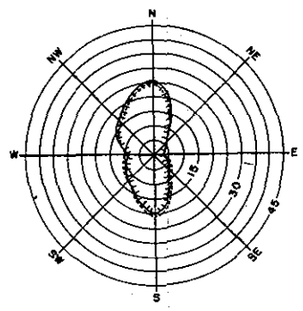
APRIL



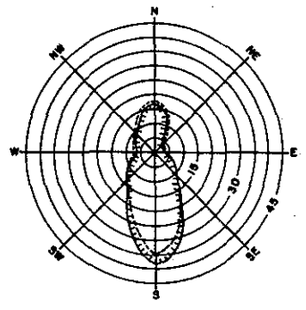
MAY



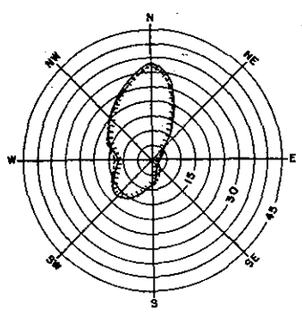
JUNE



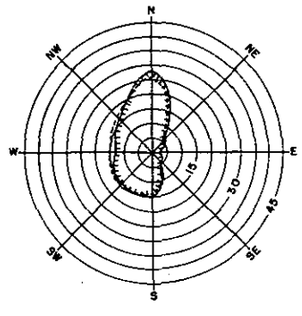
ANNUAL



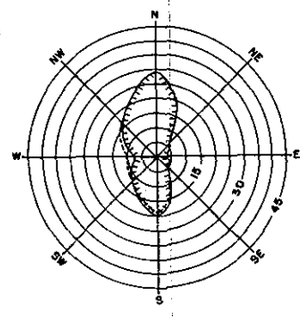
JULY



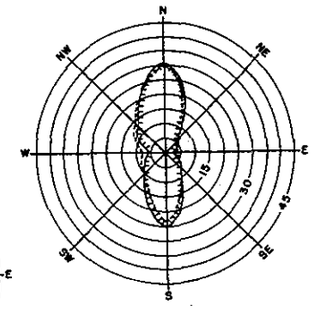
DECEMBER



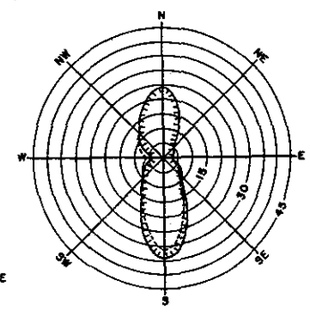
NOVEMBER



OCTOBER



SEPTEMBER



AUGUST

NOTES

EACH CONCENTRIC CIRCLE STARTING AT THE CENTER REPRESENTS FIVE PERCENT OF THE TOTAL WIND MOVEMENT OR TOTAL WIND DURATION.

THE WIND DIAGRAMS REPRESENT PERCENTAGE OF TOTAL WIND MOVEMENT OR WIND DURATION AVERAGED FOR A PERIOD FROM 1932 TO 1942

THE ANNUAL DIAGRAM REPRESENTS AVERAGES COMPUTED FOR THE ENTIRE PERIOD. THE MONTHLY DIAGRAMS REPRESENT AVERAGES COMPUTED FOR EACH MONTH OF THE YEAR FOR THE ENTIRE PERIOD.

BASIC DATA COMPILED FROM OBSERVATIONS OF THE U.S. WEATHER BUREAU AT NEW HAVEN, CONNECTICUT.

LEGEND

PERCENTAGE OF TOTAL WIND MOVEMENT

PERCENTAGE OF TOTAL WIND DURATION

CONNECTICUT BEACH EROSION CONTROL STUDY

WIND DATA

NEW HAVEN, CONNECTICUT

1932 - 1942

IN 1 SHEET

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED
CHIEF, R & H OPERATIONS DIVISION

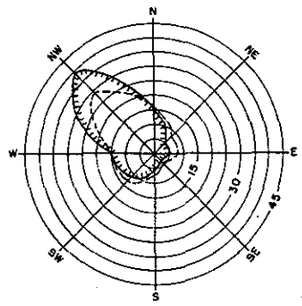
APPROVED
LT COL, C.E., ASST DIVISION ENGINEER

SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

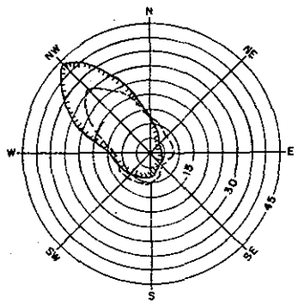
DR. BY H.S.P.
TR. BY J.S.
CH. BY J.S.P.

FILE NO. 8.E.C1.4

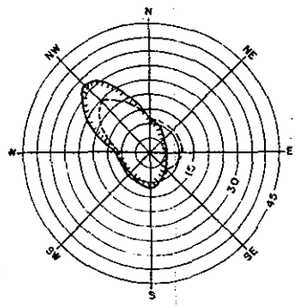
PLATE 4



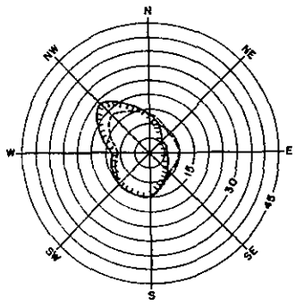
FEBRUARY



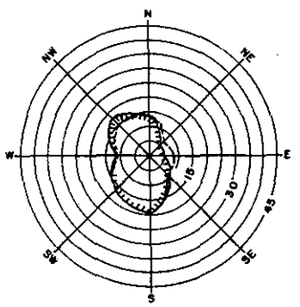
MARCH



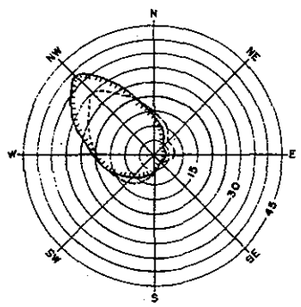
APRIL



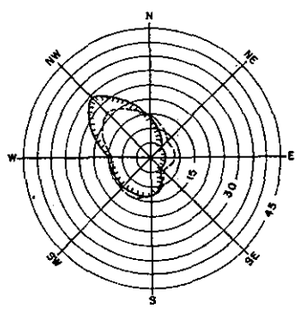
MAY



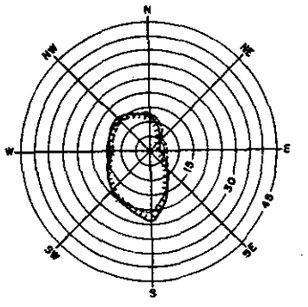
JUNE



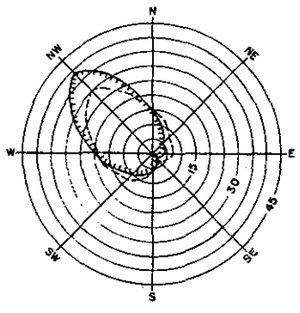
JANUARY



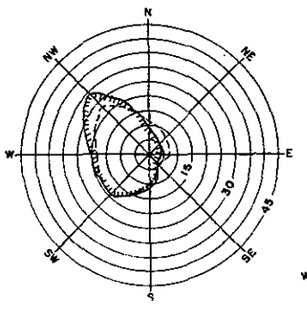
ANNUAL



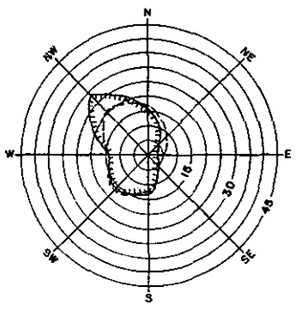
JULY



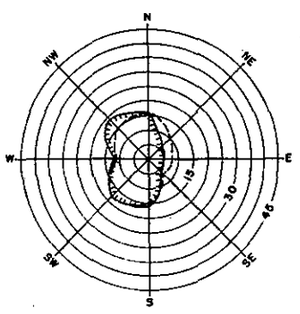
DECEMBER



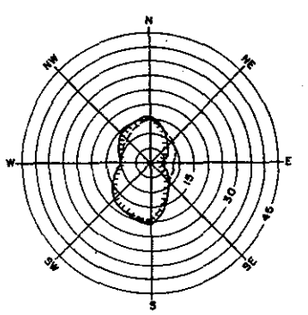
NOVEMBER



OCTOBER



SEPTEMBER



AUGUST

NOTES

EACH CONCENTRIC CIRCLE STARTING AT THE CENTER REPRESENTS FIVE PERCENT OF THE TOTAL WIND MOVEMENT OR TOTAL WIND DURATION.

THE WIND DIAGRAMS REPRESENT PERCENTAGE OF TOTAL WIND MOVEMENT OR WIND DURATION AVERAGED FOR A PERIOD FROM 1921 TO 1942

THE ANNUAL DIAGRAM REPRESENTS AVERAGES COMPUTED FOR THE ENTIRE PERIOD. THE MONTHLY DIAGRAMS REPRESENT AVERAGES COMPUTED FOR EACH MONTH OF THE YEAR FOR THE ENTIRE PERIOD.

BASIC DATA COMPILED FROM OBSERVATIONS OF THE U.S. WEATHER BUREAU AT NEW YORK CITY, NEW YORK.

LEGEND

PERCENTAGE OF TOTAL WIND MOVEMENT

PERCENTAGE OF TOTAL WIND DURATION

CONNECTICUT BEACH EROSION CONTROL STUDY

WIND DATA

NEW YORK CITY, NEW YORK

1921 - 1942

IN 1 SHEET

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED
Henry A. Whitworth
CHIEF, A&H OPERATIONS DIVISION

APPROVED
LT COL, C.E., ASST DIVISION ENGINEER

SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

DR. BY W.S.P.
TR. BY
CH. BY

FILE NO. B.E.Ct.5

PLATE 5

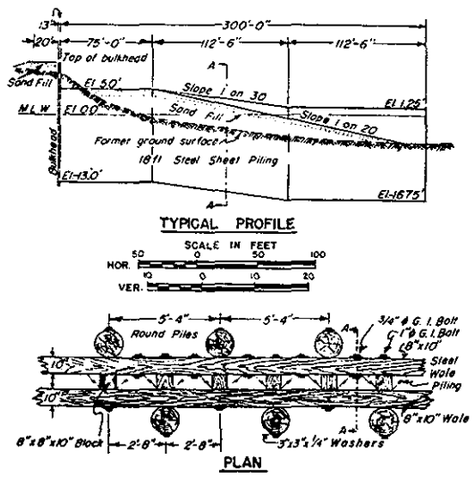


FIGURE 1

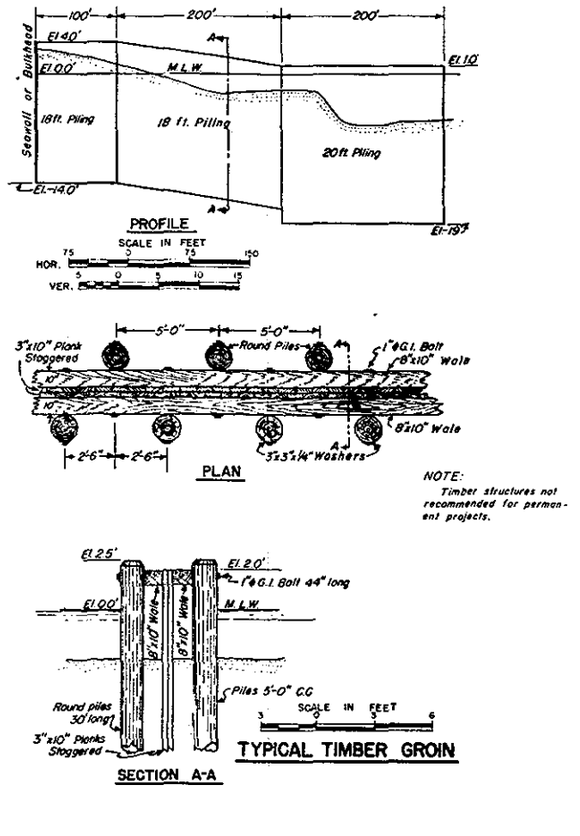


FIGURE 2

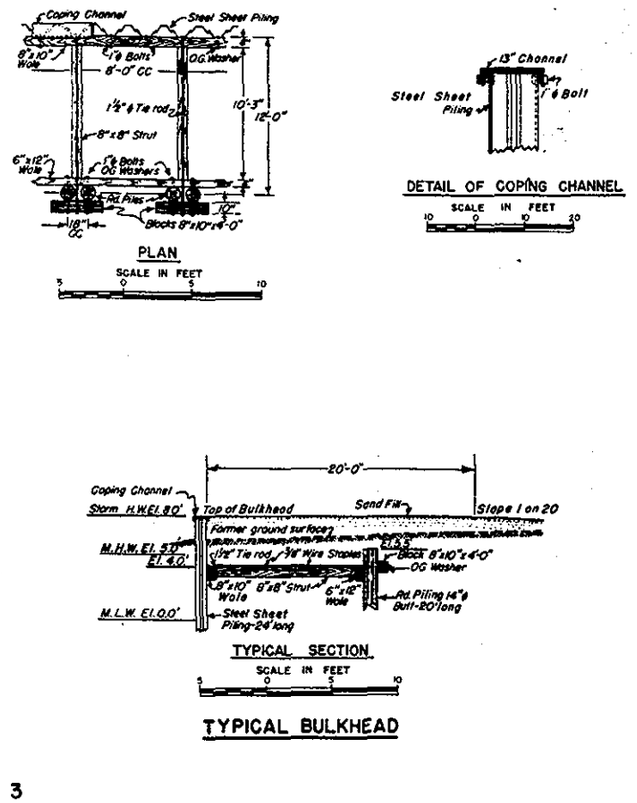


FIGURE 3

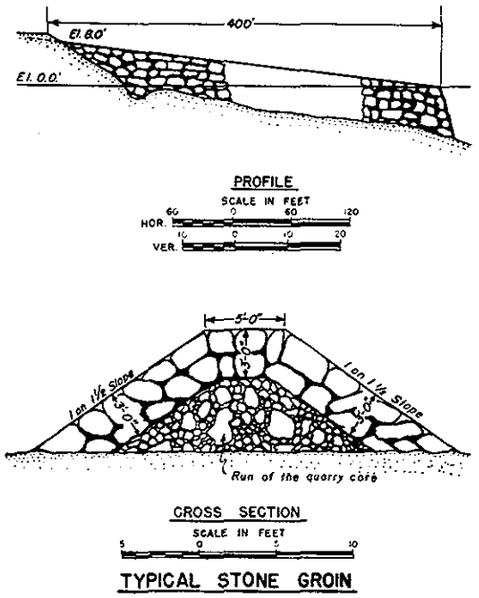


FIGURE 4

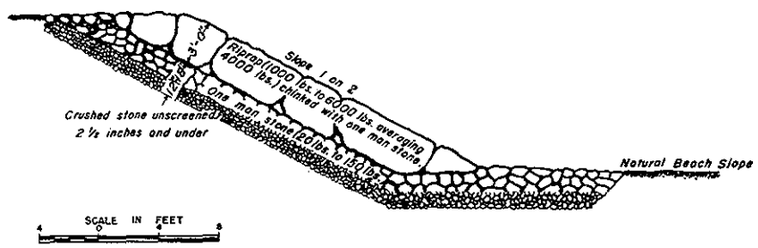


FIGURE 5

NOTE

Typical construction details reproduced from "Engineering Manual for Civil Works, Beach Erosion Studies," Part CXXXIII dated April 1947.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORE STRUCTURES

TYPICAL CONSTRUCTION DETAILS

IN 1 SHEET SCALE AS SHOWN

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED — APPROVED

CHIEF, R.&M. OPERATIONS DIVISION — LT COL., C.E., ASST. DIVISION ENGINEER

SUBMITTED

R & M PROJECTS AND REPORTS BRANCH

DR. BY H.S.P.
TR. BY R.M.
CH. BY

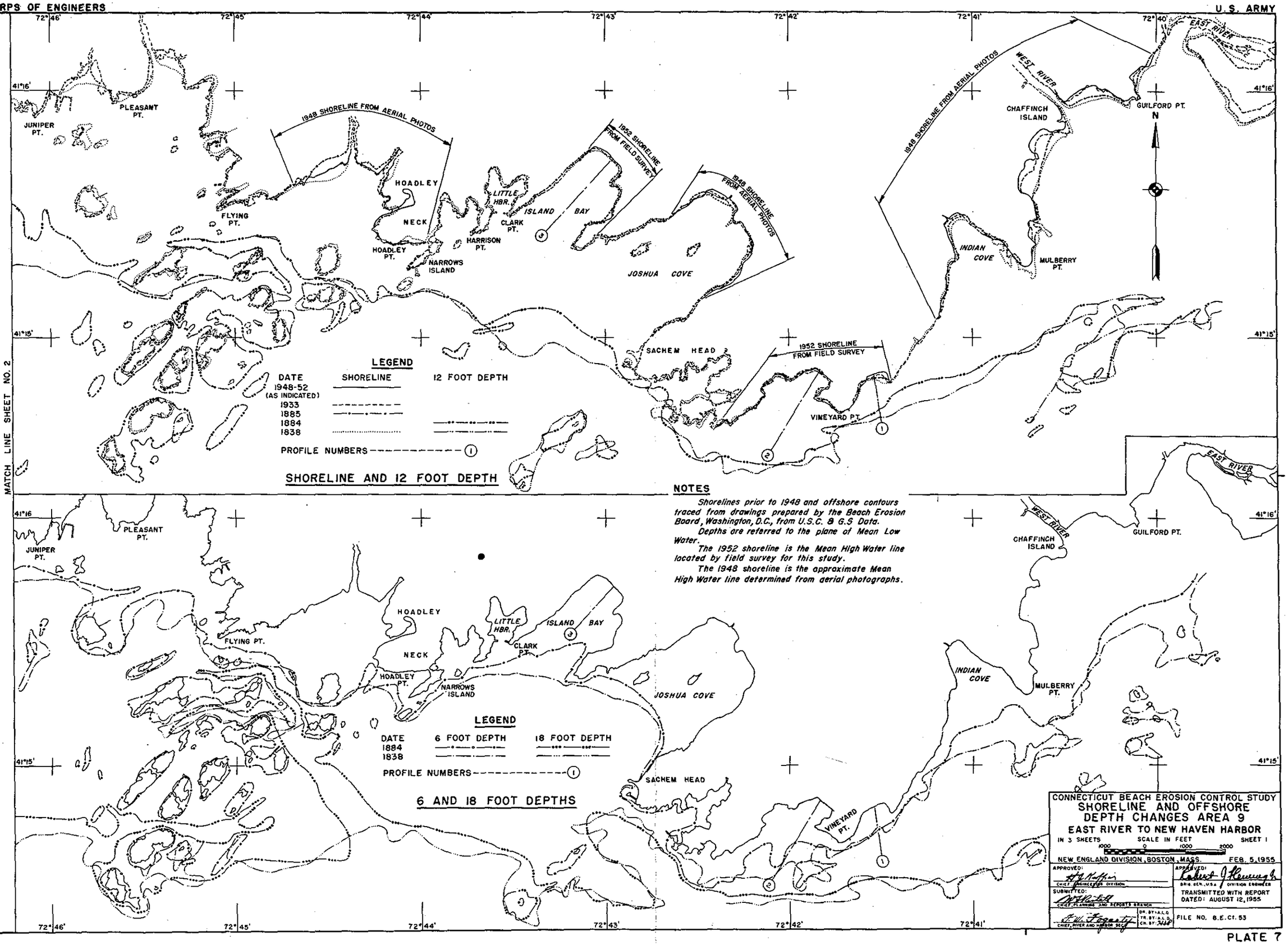
FILE NO. B.E.Ct. 6

PLATE 6

CORPS OF ENGINEERS

U.S. ARMY

MATCH LINE SHEET NO. 2



NOTES

Shorelines prior to 1948 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S Data.

Depths are referred to the plane of Mean Low Water.

The 1952 shoreline is the Mean High Water line located by field survey for this study.

The 1948 shoreline is the approximate Mean High Water line determined from aerial photographs.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREA 9 EAST RIVER TO NEW HAVEN HARBOR

IN 3 SHEETS — SCALE IN FEET 1000 0 1000 2000 — SHEET 1

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 5, 1955

APPROVED: CHIEF ENGINEERS DIVISION

APPROVED: Robert J. Fleming Jr. BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

DR. BY: A.L.D. TR. BY: A.L.D. CH. BY: J.W.F.

CHIEF, RIVER AND HARBOR SECT.

FILE NO. B.E.Ct. 53

PLATE 7

CORPS OF ENGINEERS

U. S. ARMY

72°52' 72°51' 72°50' 72°49' 72°48' 72°47' 72°46'

41°16' 41°15'

N

LINDSEY COVE
LAMPHIER COVE
BRANFORD PT.
SHORT BEACH
INDIAN NECK PT.
EAST HAVEN RIVER
HORTON PT.
KELSEY ID.
JOHNSON PT.
JEFFREY PT.
MALTBY COVE
LINDEN PT.
LIMEWOOD BEACH
HAYCOCK PT.
HOTCHKISS GROVE BEACH
PINE ORCHARD
BROWN PT.

1872-86 | 1884

MATCH LINE SHEET NO. 3

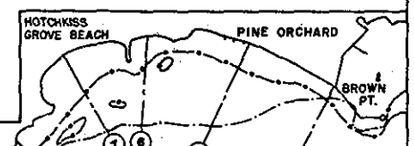
MATCH LINE SHEET NO. 1

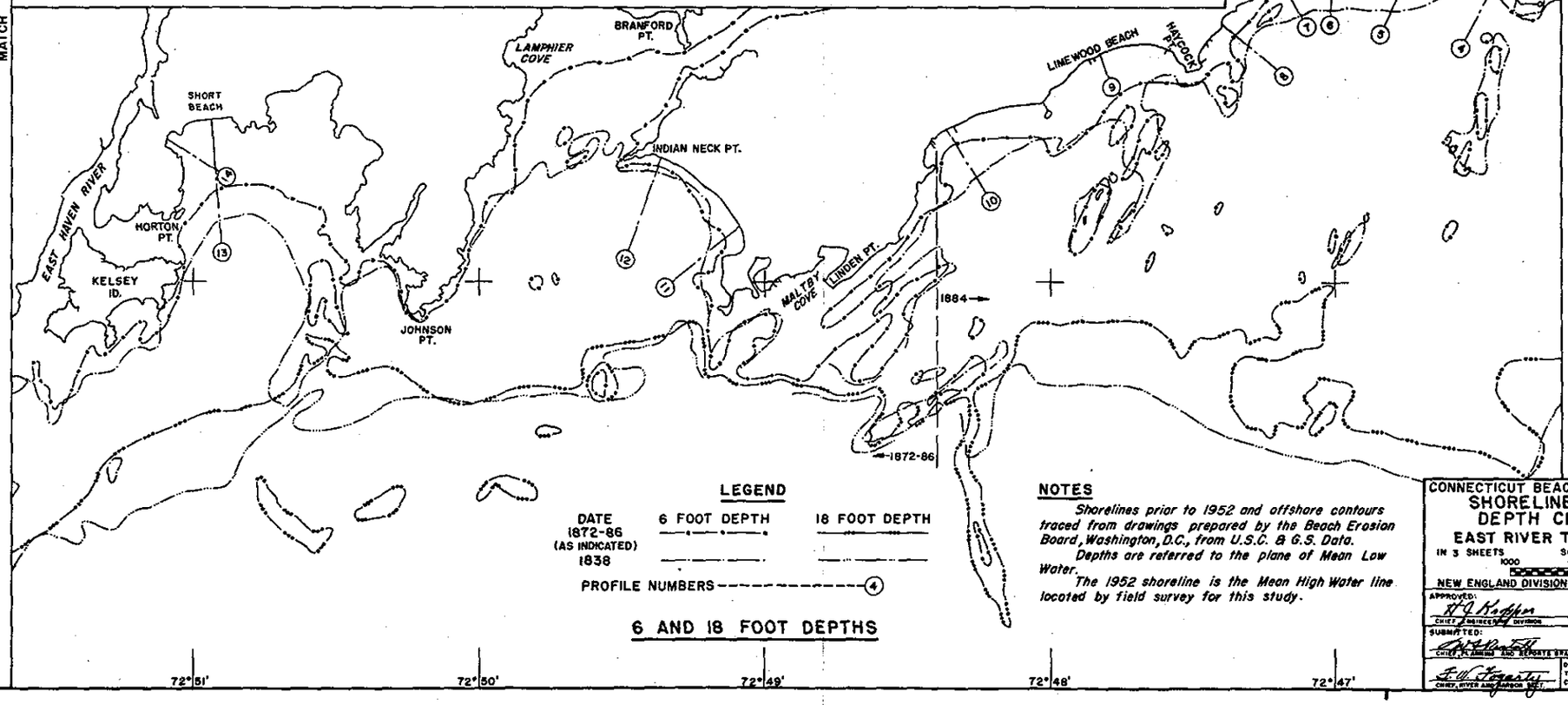
LEGEND

DATE	SHORELINE	12 FOOT DEPTH
1952	———	
1933	- - - - -	——·——·——
1872-86 (AS INDICATED)		
1885	——·——·——	
1838	·····	——··——··——

PROFILE NUMBERS ----------④

SHORELINE AND 12 FOOT DEPTH





LEGEND

DATE	6 FOOT DEPTH	18 FOOT DEPTH
1872-86 (AS INDICATED)	——·——·——	
1838	- - - - -	- - - - -

PROFILE NUMBERS ----------④

6 AND 18 FOOT DEPTHS

NOTES

Shorelines prior to 1952 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. Data.

Depths are referred to the plane of Mean Low Water.

The 1952 shoreline is the Mean High Water line located by field survey for this study.

72°52' 72°51' 72°50' 72°49' 72°48' 72°47' 72°46'

41°16' 41°15'

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 3 SHEETS SCALE IN FEET 1000 0 1000 2000 SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 5, 1955

APPROVED: H. J. Rodgers, CHIEF ENGINEERS DIVISION

APPROVED: Edward J. Flemming, BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

F. W. Fogarty, CHIEF, RIVER AND HARBOR SECT.

DR. BY I.A.L.D. TR. BY I.A.L.D. CH. BY [illegible]

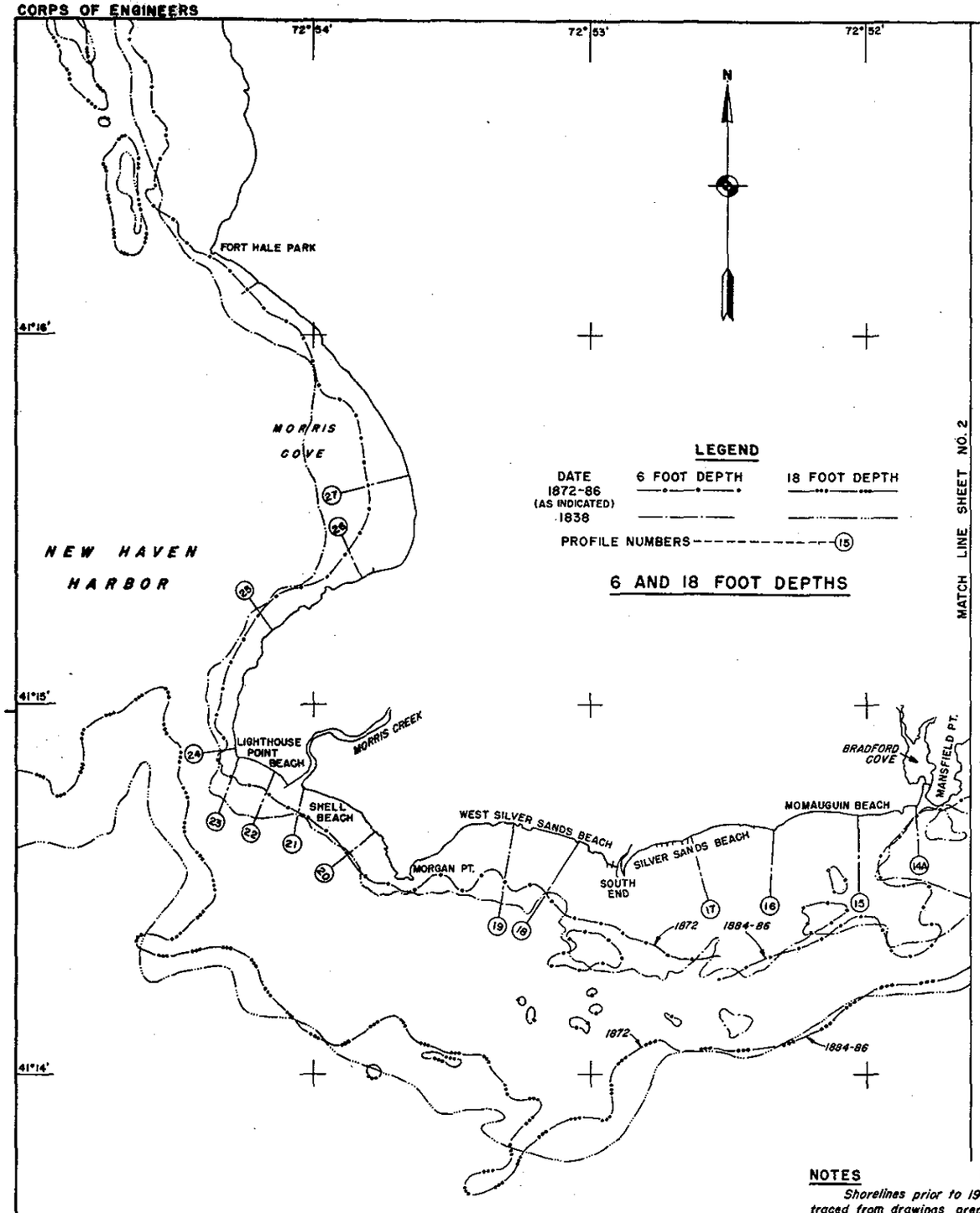
TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

FILE NO. B.E.Ct.55

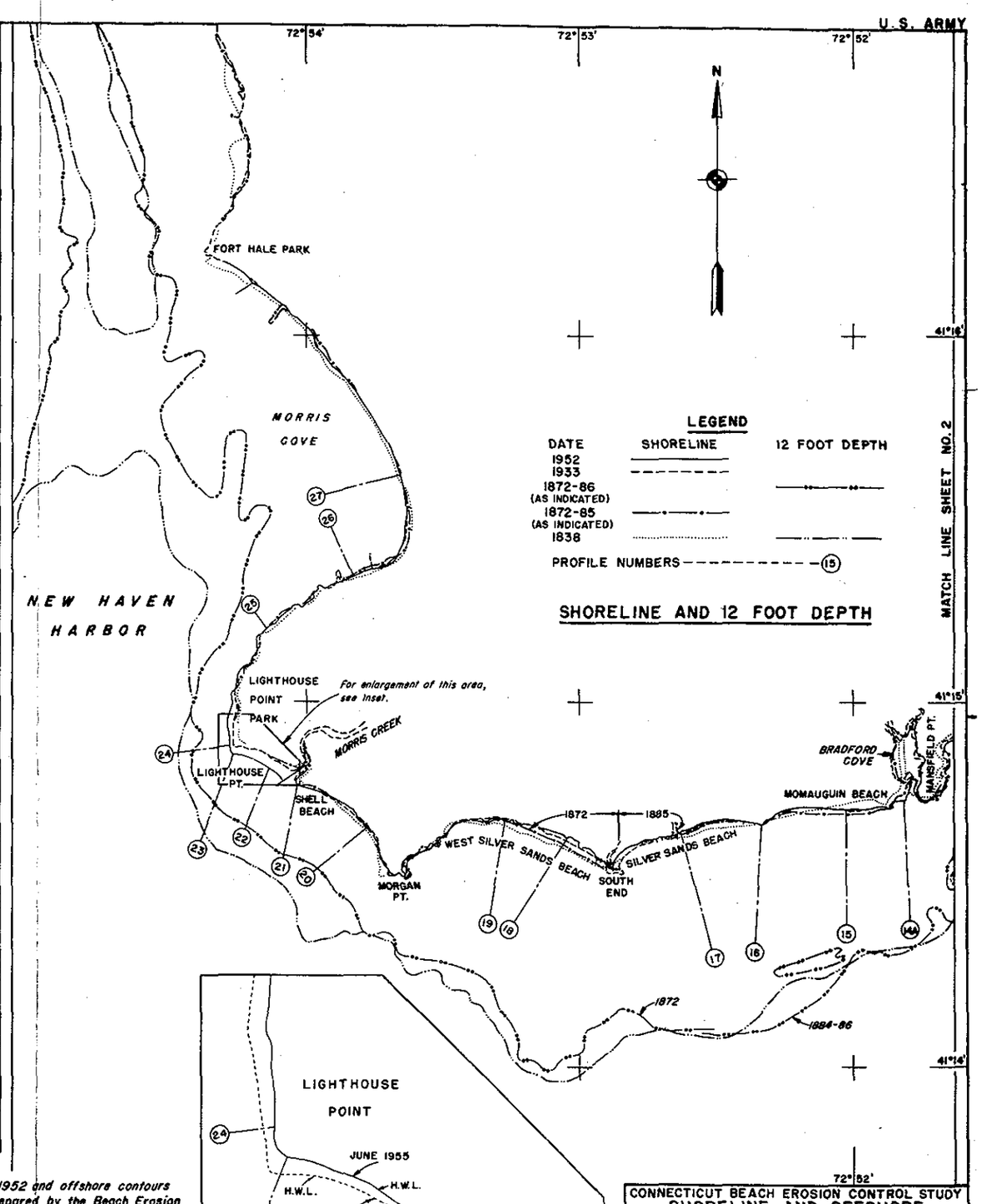
PLATE 8

CORPS OF ENGINEERS

U.S. ARMY



MATCH LINE SHEET NO. 2



MATCH LINE SHEET NO. 2

NOTES

Shorelines prior to 1952 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. Data.

Depths are referred to the plane of Mean Low Water.

The 1952 shoreline is the Mean High Water line located by field survey for this study.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREA 9 EAST RIVER TO NEW HAVEN HARBOR

IN 3 SHEETS. SCALE IN FEET 1000 0 1000 2000 SHEET 3

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 5, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: Robert J. Hummel, BRIG. GEN., U.S.A., DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

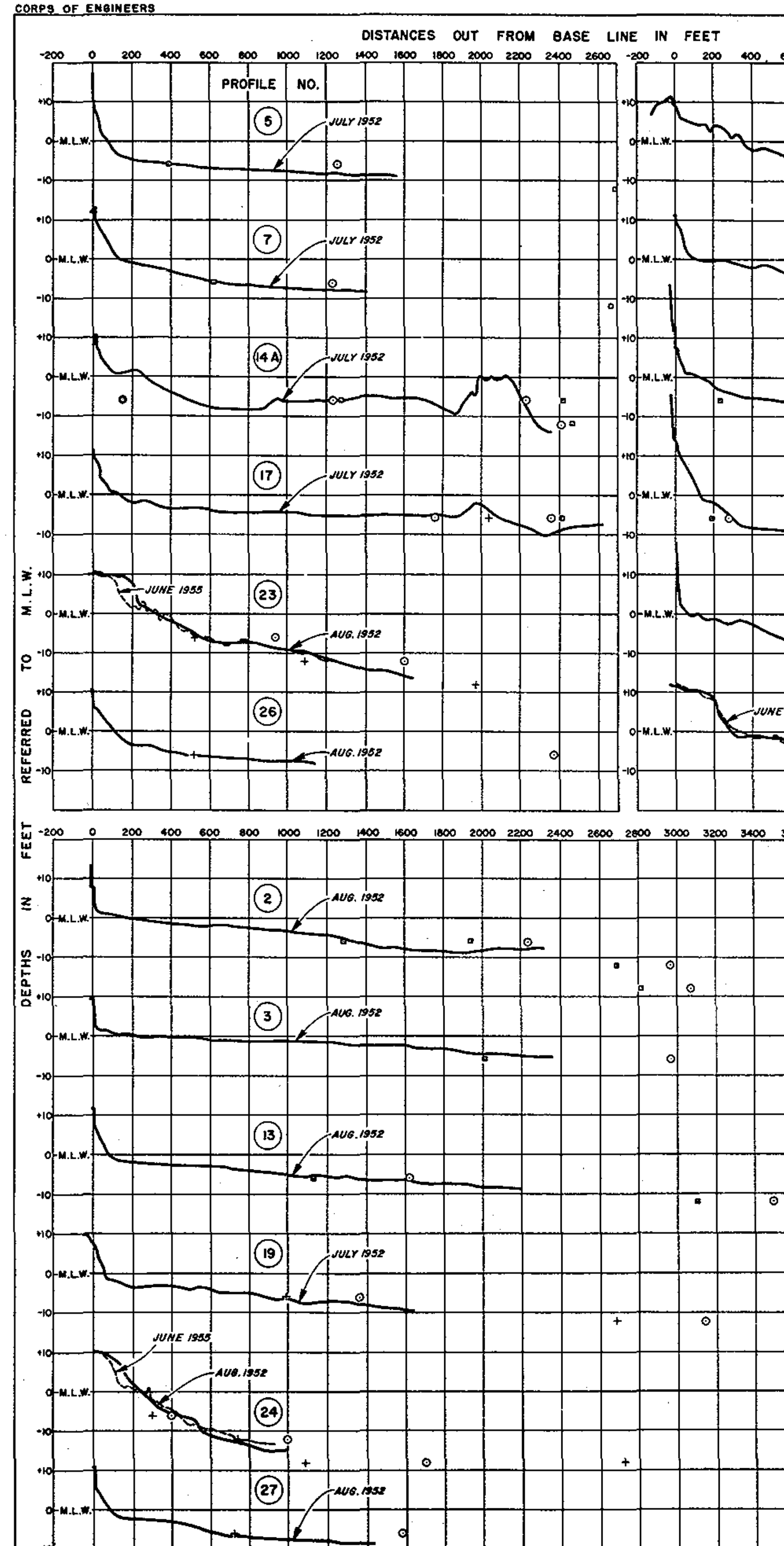
CHIEF, RIVER AND HARBOR SECT.

DR. BY I.A.L.D. TR. BY A.L.S. CH. BY

FILE NO. B.E.C.I. 53

PLATE 9

CORPS OF ENGINEERS U.S. ARMY



LEGEND

LOCATION OF 6, 12, AND 18 FOOT DEPTHS PRIOR TO 1952 SHOWN THUS:

DATE	SYMBOL
1838	⊙
1872	+
1884	⊡

SURVEY OF 1952 BY CORPS OF ENGINEERS, U.S. ARMY. PRIOR SURVEYS BY U.S.C.&G.S. SURVEY OF 1955 BY CORPS OF ENGINEERS, U.S. ARMY.

NOTE

FOR LOCATION OF PROFILES, SEE PLATES 11-15.

CONNECTICUT BEACH EROSION CONTROL STUDY
COMPARATIVE PROFILES AREA 9
EAST RIVER TO NEW HAVEN HARBOR

IN 1 SHEET SCALES AS SHOWN

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 4, 1956

APPROVED: [signature]
SUBMITTED: [signature]
APPROVED: [signature]
TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

FILE NO. B.E. C1. 54

CORPS OF ENGINEERS

U.S. ARMY

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P1	8.9	14.9	6.0' Sand and mud to refusal.
P2	4.0	15.7	11.7' Sand and mud.
P20	0.5	11.7	3.1' Silt, 8.1' Sand.
P21	2.8	10.0	7.2' Sand.
P22	0.4	10.0	9.6' Sand.
P23	0.8	10.2	6.8' Sand, 2.6' Sand & Gravel.
P24	0.6	10.0	9.4' Sand.
P25	2.4	10.2	7.8' Sand.
P26	3.9	11.2	7.3' Sand.
P27	6.3	11.7	5.4' Sand
P28	6.7	12.9	2.2' Mud, 4.0' Sand.

Probings are in feet and tenths and are referred to the plane of Mean Low Water. Probings were made by hand.

P1 and P2 are from 1952 survey and P20-P28 from 1939 survey.

MATCH LINE SHEET NO. 2

G U I L F O R D

EAST RIVER

WEST RIVER

GUILFORD PUBLIC BATHING BEACH

CHAFFINCH ISLAND

GUILFORD POINT

GUILFORD HARBOR

INDIAN COVE

MULBERRY POINT

FOSKETT ISLAND

HORSE ISLAND

NEW COTTAGE DEVELOPMENT

JOSHUA COVE

S A C H E M H E A D

JOSHUA POINT

SACHEM HEAD HARBOR

VINEYARD POINT

L O N G I S L A N D S O U N D

P1 P2 P20 P21 P22 P23 P24 P25 P26 P27 P28

E610 000 E612 000 E614 000 E616 000 E618 000 E620 000 E622 000

72°-43' 72°-42' 72°-41' 72°-40'

N158 000 41°-16' N156 000 N154 000 N152 000 41°-15' N150 000

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 5.4 feet at the East River.

Hydrography, shoreline and shore structures from survey of July-Aug. 1952, subsequent field inspections and aerial photos of 1948 & 1949. Topography and contours from U.S.C. & G.S. Chart No. 217

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

LEGEND

PROBINGS ---------- ●P1

PROFILE NUMBERS ---------- (2)

PUBLICLY OWNED PROPERTY --------

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 6 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 1

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 8, 1955

APPROVED: Chief Engineers Division

APPROVED: Robert J. Fleming Jr. Brig. Gen., U.S.A. Division Engineer

SUBMITTED: Chief, Planning and Reports Branch

DR. BY: H.C.B. TR. BY: H.L.S. CH. BY:

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

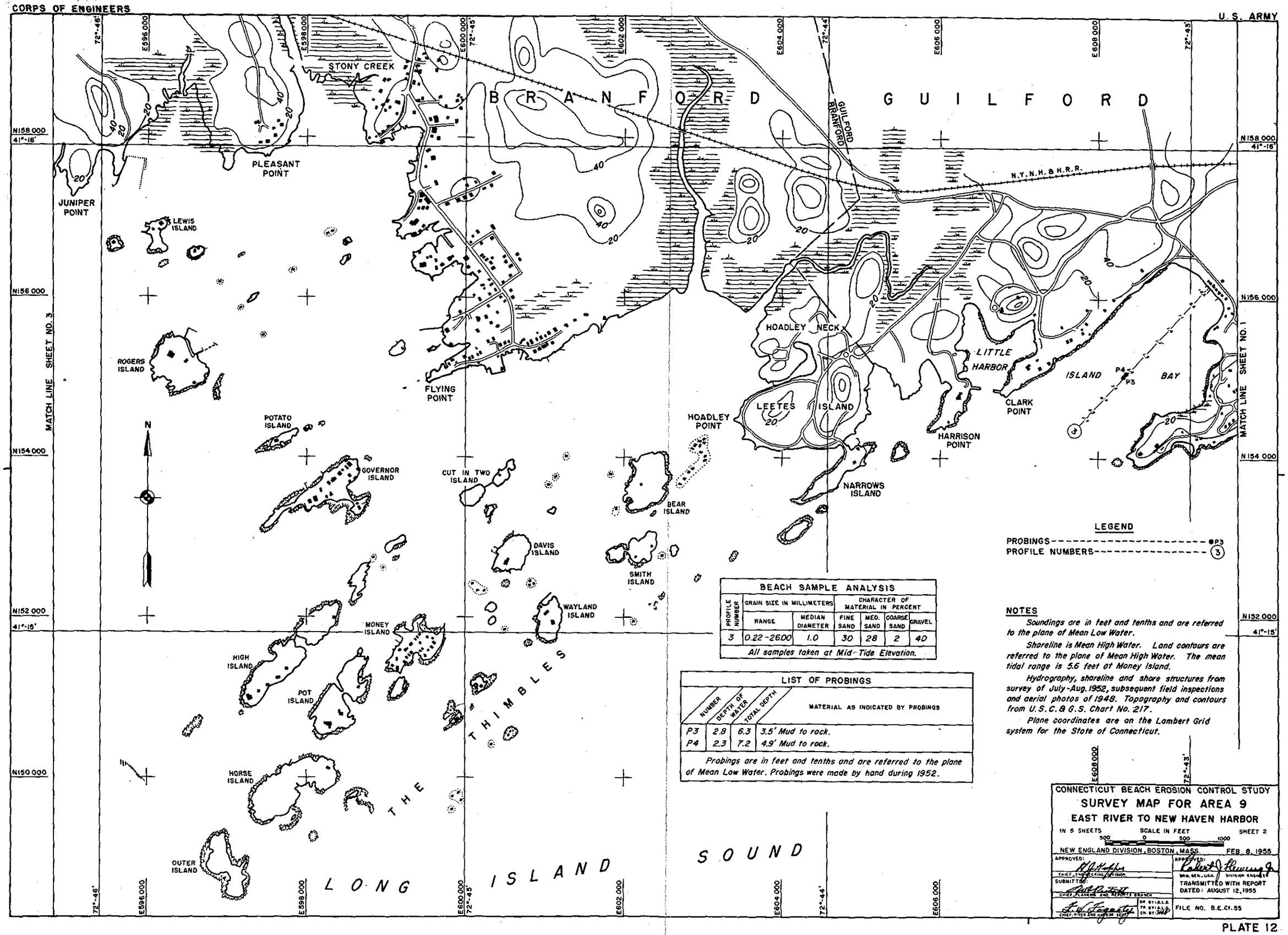
Chief, River and Harbor Sec.

FILE NO. B.E.Ct. 55

PLATE II

CORPS OF ENGINEERS

U. S. ARMY



BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT			
	RANGE	MEDIAN DIAMETER	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
3	0.22-26.00	1.0	30	28	2	40

All samples taken at Mid-Tide Elevation.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P3	2.8	6.3	3.5' Mud to rock.
P4	2.3	7.2	4.9' Mud to rock.

Probings are in feet and tenths and are referred to the plane of Mean Low Water. Probings were made by hand during 1952.

LEGEND

PROBINGS ---------- ●P3

PROFILE NUMBERS ---------- (3)

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 5.6 feet at Money Island.

Hydrography, shoreline and shore structures from survey of July-Aug. 1952, subsequent field inspections and aerial photos of 1948. Topography and contours from U.S.C.&G.S. Chart No. 217.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 5 SHEETS — SCALE IN FEET 500 0 500 1000 — SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 8, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: Robert J. Fleming Jr. BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

CHIEF, RIVER AND HARBOR SECT.

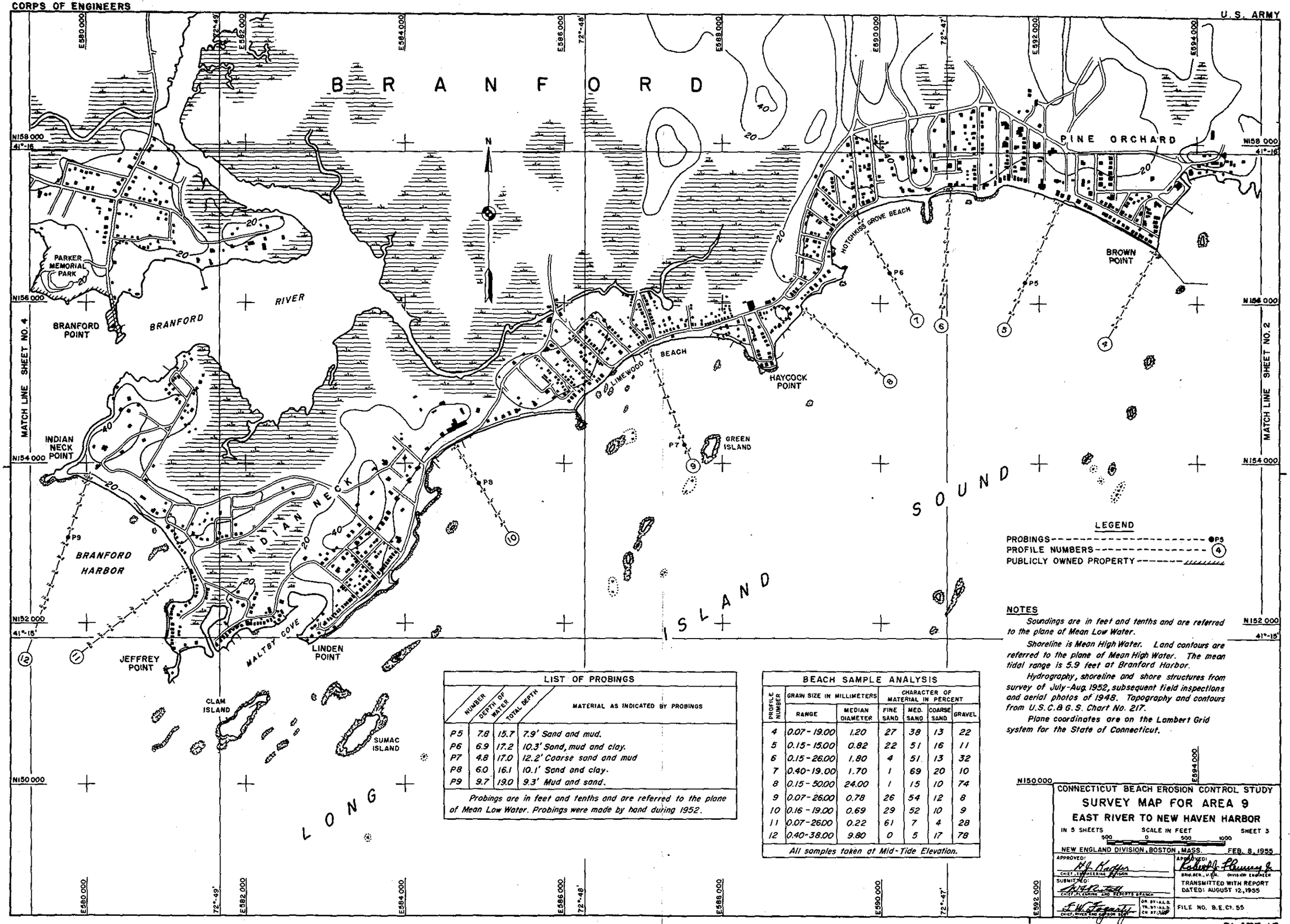
DR BY I.A.L.D. TR BY I.A.L.D. CH BY

FILE NO. B.E.C.I.-55

PLATE 12

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

PROBINGS ---------- ●P5

PROFILE NUMBERS ---------- (4)

PUBLICLY OWNED PROPERTY ---------- ////////

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 5.9 feet at Branford Harbor.

Hydrography, shoreline and shore structures from survey of July-Aug. 1952, subsequent field inspections and aerial photos of 1948. Topography and contours from U.S.C.& G.S. Chart No. 217.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P5	7.8	15.7	7.9' Sand and mud.
P6	6.9	17.2	10.3' Sand, mud and clay.
P7	4.8	17.0	12.2' Coarse sand and mud
P8	6.0	16.1	10.1' Sand and clay.
P9	9.7	19.0	9.3' Mud and sand.

Probings are in feet and tenths and are referred to the plane of Mean Low Water. Probings were made by hand during 1952.

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT			
	RANGE	MEDIAN DIAMETER	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
4	0.07 - 19.00	1.20	27	38	13	22
5	0.15 - 15.00	0.82	22	51	16	11
6	0.15 - 26.00	1.80	4	51	13	32
7	0.40 - 19.00	1.70	1	69	20	10
8	0.15 - 50.00	24.00	1	15	10	74
9	0.07 - 26.00	0.78	26	54	12	8
10	0.16 - 19.00	0.69	29	52	10	9
11	0.07 - 26.00	0.22	61	7	4	28
12	0.40 - 38.00	9.80	0	5	17	78

All samples taken at Mid-Tide Elevation.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 5 SHEETS — SCALE IN FEET (500 0 500 1000) — SHEET 3

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 8, 1955

APPROVED: H.J. Kapp, CHIEF, ENGINEERING DIVISION

APPROVED: Robert J. Fleming Jr., BRIG. GEN., U.S.A., DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

DR BY: A.A.S. TR. BY: A.A.S. CH BY: J.W.F.

CHIEF, RIVER AND HARBOR SECTION

FILE NO. B.E.C. 55

PLATE 13

CORPS OF ENGINEERS

U. S. ARMY

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT			
	RANGE	MEDIAN DIAMETER	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
13	0.07 - 38.00	1.90	8	43	9	40
14	0.15 - 10.00	0.45	32	63	4	1
14 A	0.40 - 38.00	0.80	0	86	5	9
15	0.20 - 19.00	1.80	1	56	33	10
16	0.20 - 19.00	0.93	7	78	6	9
17	0.30 - 38.00	2.70	0	39	27	34

All samples taken at Mid-Tide Elevation.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P10	7.0	17.8	10.8' Mud
P11	8.2	18.5	10.3' Sand and mud
P12	1.3	6.3	5.0' Sand and stones to refusal
P13	5.2	16.5	11.3 Loose rocks, sand and mud

Probings are in feet and tenths and are referred to the plane of Mean Low Water. Probings were made by hand during 1952.

EAST HAVEN

BRANFORD

N

MATCH LINE SHEET NO. 5

MATCH LINE SHEET NO. 3

E566 000 | 72°-52' | E568 000 | E570 000 | E572 000 | 72°-51' | E574 000 | E576 000 | 72°-50' | E578 000

N156 000 | N154 000 | N152 000 | 41°-15' | N150 000 | N148 000

SHORT BEACH

PAGES COVE

STANLEY POINT

LINDSEY COVE

LAMPHIER COVE

DOUBLE BEACH

LOVERS ISLAND

BRANFORD HARBOR

HORTON POINT

EAST HAVEN BRANFORD

KELSEY ISLAND

EAST HAVEN RIVER

UMBRELLA ISLAND

JOHNSON POINT

DARROW ROCKS

MANSFIELD POINT

BRADFORD COVE

MOMAUGUIN BEACH

SILVER SANDS BEACH

P10

P11

P12

P13

Connecticut Oyster Maps indicate beds extend to shore opposite this area.

(13) (14) (14A) (15) (16) (17)

L O N G I S L A N D S O U N D

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 5.9 feet at Branford Harbor.

Hydrography, shoreline and shore structures from survey of July-Aug. 1952, subsequent field inspections and aerial photos of 1948. Topography and contours from U.S.C.& G.S. Charts No. 217 & 218.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

LEGEND

PROBINGS ---------- P10

PROFILE NUMBERS ---------- (14)

LANDWARD LIMIT OF OYSTER BEDS ———

LEASED OYSTER BEDS ----------

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 5 SHEETS | SCALE IN FEET 500 0 500 1000 | SHEET 4

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 8, 1955

APPROVED: CHIEF ENGINEERING BR.

APPROVED: Robert J. Fleming Jr. BRIG GEN, U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT. DATED: AUGUST 12, 1955

DR BY A.L.D. TR BY A.L.D. CH BY

CHIEF, ENGINEERING BRANCH

FILE NO. B.E. Ct. 55

PLATE 14

CORPS OF ENGINEERS

U.S. ARMY

MATCH LINE

SHEET NO. 4

N158 000 | 41°-16' | N156 000 | N154 000 | N152 000 | 41°-15' | N150 000 | N148 000 | N146 000 | 41°-14'

E564 000 | 72°-53' | E562 000 | E560 000 | 72°-54' | E558 000 | E556 000

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P14	7.4	14.6	7.2' Sand and gravel to refusal.
P15	10.7	18.1	7.4' Medium to coarse sand to refusal.
P16	11.0	17.3	6.3' Sand.
P17	9.5	16.4	6.9' Sand and mud.
P18	10.4	16.3	5.9' Sand and mud.
P19	6.6	16.1	9.5' Sand and mud.

Probings are in feet and tenths and are referred to the plane of Mean Low Water. Probings were made by hand during 1952.

EAST HAVEN

NEW HAVEN

EAST HAVEN
NEW HAVEN

SILVER SANDS BEACH

SOUTH END

CAROLINE CREEK

WEST SILVER SANDS BEACH

MORRIS CREEK

MORGAN POINT

SHELL BEACH

LIGHTHOUSE POINT PARK

LIGHTHOUSE POINT

LIGHTHOUSE POINT BEACH

EAST BREAKWATER

FORBES BLUFF

MORRIS COVE PARK

FORT HALE PARK

MORRIS COVE

NEW HAVEN HARBOR

ISLAND SOUND

LONG

P14 P15 P16 P17 P18 P19

Connecticut Oyster Maps indicate beds extend to shore opposite this area.

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT			
	RANGE	MEDIAN DIAMETER	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
18	0.20-26.00	0.66	22	66	4	8
19	0.30-19.00	1.00	0	88	9	3
20	0.07-38.00	0.46	30	58	1	11
21	0.20-26.00	3.00	4	32	26	38
22	0.07-26.00	1.30	15	53	11	21
23	0.07-38.00	0.89	30	35	9	26
24	0.07-38.00	0.98	25	40	9	26
25	0.15-38.00	10.0	4	40	4	52
26	0.07-38.00	3.50	5	38	9	48
27	0.07-26.00	0.37	52	17	5	26

All samples taken at Mid-Tide Elevation.

LEGEND

PROBINGS ---------- P14

PROFILE NUMBERS ---------- (18)

LANDWARD LIMIT OF OYSTER BEDS ----------

LEASED OYSTER BEDS ----------

PUBLICLY OWNED PROPERTY ----------

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 6.2 feet at New Haven Harbor.

Hydrography, shoreline and shore structures from survey of July-Aug. 1952, subsequent field inspections and aerial photos of 1948. Topography and contours from U.S.C.&G.S. Chart No. 218.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREA 9

EAST RIVER TO NEW HAVEN HARBOR

IN 5 SHEETS | SCALE IN FEET 500 0 500 1000 | SHEET 5

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 8, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: Robert J. Fleming Jr. BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

CHIEF, RIVER AND HARBOR SECT.

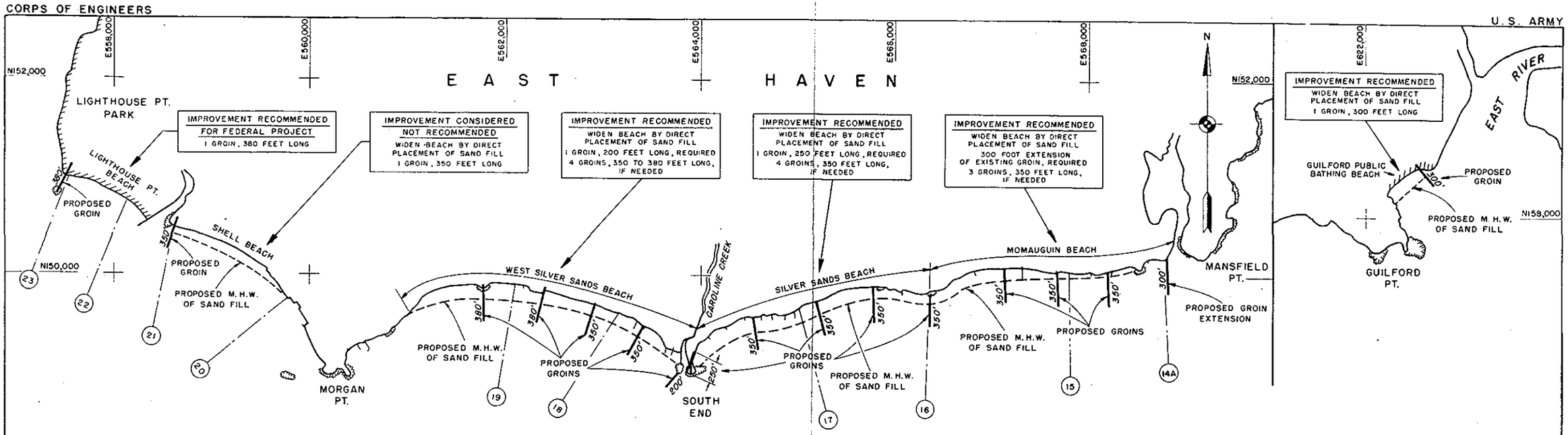
DR BY: A.L.O. TR. BY: A.L.O. CH. BY: J.W.S.

FILE NO. B.E. Cr. 55

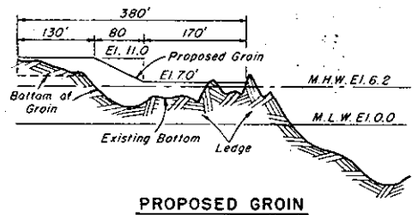
PLATE 15

CORPS OF ENGINEERS

U.S. ARMY



NOTE:
Groin & Slope details shown below



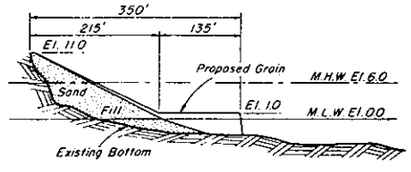
PROPOSED GROIN

GROIN DETAILS

Top width 5'
Side slopes, 1 on 1.5
Top and slope stones; minimum size, 1 ton
Sand tight core of quarry run stone up to 150 lbs. in weight

PROFILE AT LIGHTHOUSE POINT PARK

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20



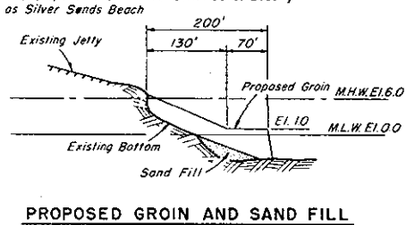
PROPOSED GROIN AND SAND FILL

GROIN DETAILS	FILL SLOPES (Approx.)
Top width 5'	1 on 20 above M.L.W.
Side slopes; Outer 150' - 1 on 3	1 on 30 below M.L.W.
Remainder - 1 on 1.5	
Top and slope stones, minimum size;	
Outer 150' - 2 tons	
Remainder - 1 ton	
Sand tight core of quarry run stone up to 150 lbs. in weight	

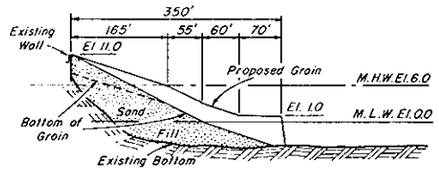
PROFILE AT SHELL BEACH

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20

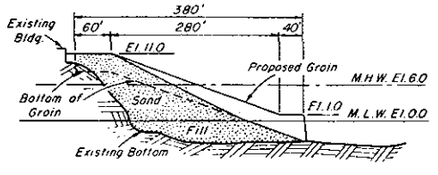
NOTE:
Groin & Slope details for West Silver Sands Beach, same as Silver Sands Beach



PROPOSED GROIN AND SAND FILL (CAROLINE CREEK)



PROPOSED GROIN AND SAND FILL (TYPICAL PROFILE)

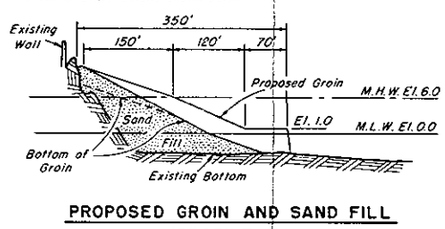


PROPOSED GROIN AND SAND FILL (TYPICAL PROFILE)

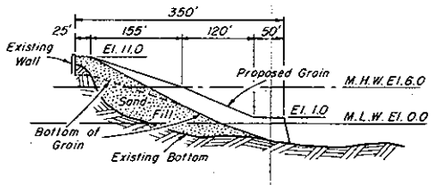
PROFILES AT WEST SILVER SANDS BEACH

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20

NOTE:
Groin & Slope details shown below



PROPOSED GROIN AND SAND FILL (PROFILE 16)



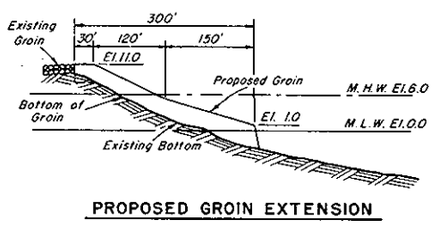
PROPOSED GROIN AND SAND FILL (TYPICAL PROFILE)

GROIN DETAILS	FILL SLOPES (Approx.)
Top width 5'	1 on 20 above M.L.W.
Side slopes; Outer 150' - 1 on 3	1 on 30 below M.L.W.
Remainder - 1 on 1.5	
Top and slope stones, minimum size;	
Outer 150' - 2 tons	
Remainder - 1 ton	
Sand tight core of quarry run stone up to 150 lbs. in weight	

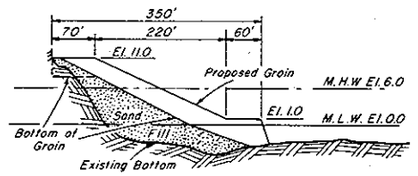
PROFILES AT SILVER SANDS BEACH

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20

NOTE:
Groin & Slope details shown below



PROPOSED GROIN EXTENSION (PROFILE 14A)



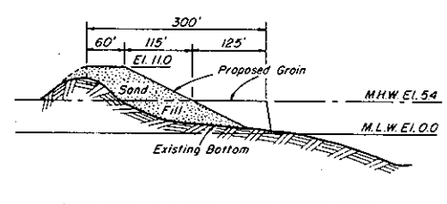
PROPOSED GROIN AND SAND FILL (TYPICAL PROFILE)

GROIN DETAILS	FILL SLOPES (Approx.)
Top width 5'	1 on 20 above M.L.W.
Side slopes; Outer 150' - 1 on 3	1 on 30 below M.L.W.
Remainder - 1 on 1.5	
Top and slope stones, minimum size;	
Outer 150' - 2 tons	
Remainder - 1 ton	
Sand tight core of quarry run stone up to 150 lbs. in weight	

PROFILES AT MOMAUGUIN BEACH

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20

NOTE:
Groin & Slope details shown below



PROPOSED GROIN AND SAND FILL

GROIN DETAILS	FILL SLOPE (Approx.)
Top width 5'	1 on 20 above M.L.W.
Side slopes; Outer 100' - 1 on 2	
Remainder - 1 on 1.5	
Top and slope stones; minimum size, 1 ton	
Sand tight core of quarry run stone up to 150 lbs. in weight	

PROFILE AT GUILFORD POINT

SCALE IN FEET
HOR. 100 0 100 200
VER. 10 0 10 20

NOTES

Shoreline and shore structures from 1952 survey and aerial photographs of 1948-49.

Coordinates are on the Lambert Grid System for the State of Connecticut.

For additional construction details for shore structures, see Plate 6.

Publicly owned portions of shore shown thus: ▨

CONNECTICUT BEACH EROSION CONTROL STUDY

PLANS OF IMPROVEMENT AREA 9
EAST RIVER TO NEW HAVEN HARBOR

IN 1 SHEET

SCALE IN FEET
500 0 500 1000

NEW ENGLAND DIVISION, BOSTON, MASS. JULY 28, 1955

APPROVED:
CHIEF ENGINEERS, N.E. DIVISION

APPROVED:
BRIG. GEN., U.S.A. DIVISION ENGINEER

SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: AUGUST 12, 1955

CHIEF, RIVER AND HARBOR SECT.

DR BY: A.L.B.
TR BY: A.L.D.
CH BY: JWD

FILE NO. B.E. Ct. 56

PLATE 16

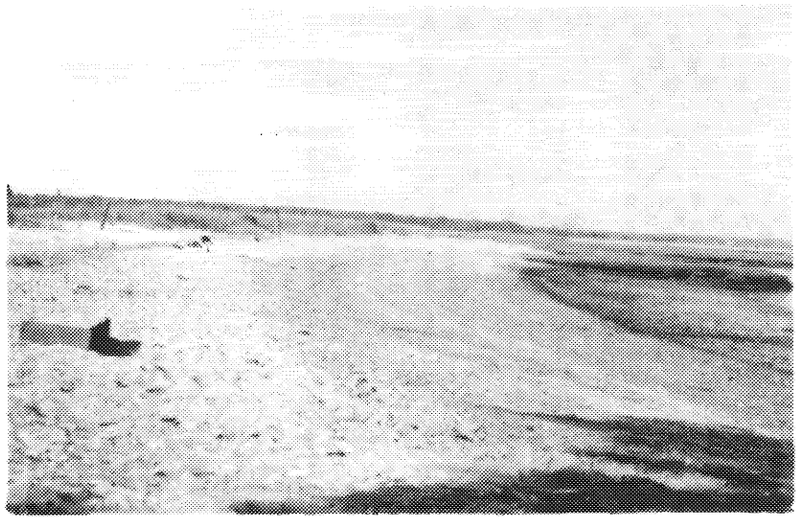


FIG. 1. TOWN BEACH, GUILFORD POINT, GUILFORD. July 20, 1948. A sandy barrier bar retreating over marsh.

FIG. 2. GUILFORD POINT, GUILFORD. July 20, 1948. Looking east from Chaffinch Island across West River.

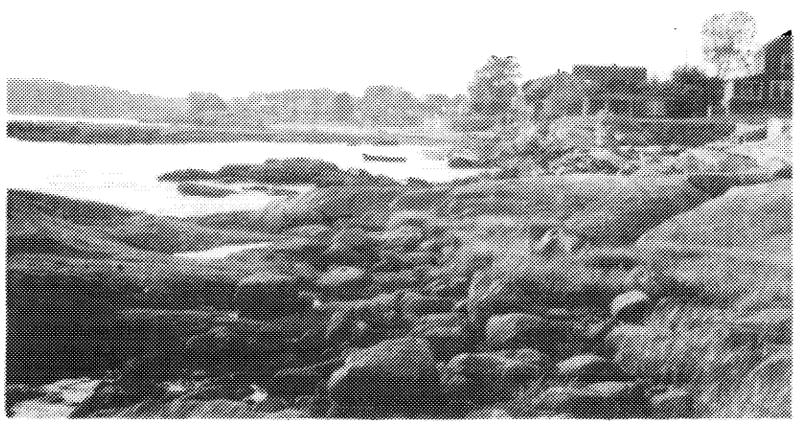


FIG. 3. MULBERRY POINT, GUILFORD. July 20, 1948. Rocky shore. Walls protect lawns fronting residences.

FIG. 1. FIRST POINT NORTH OF VINEYARD POINT, GUILFORD. July 21, 1948. Boulders and bedrock protect the shore.

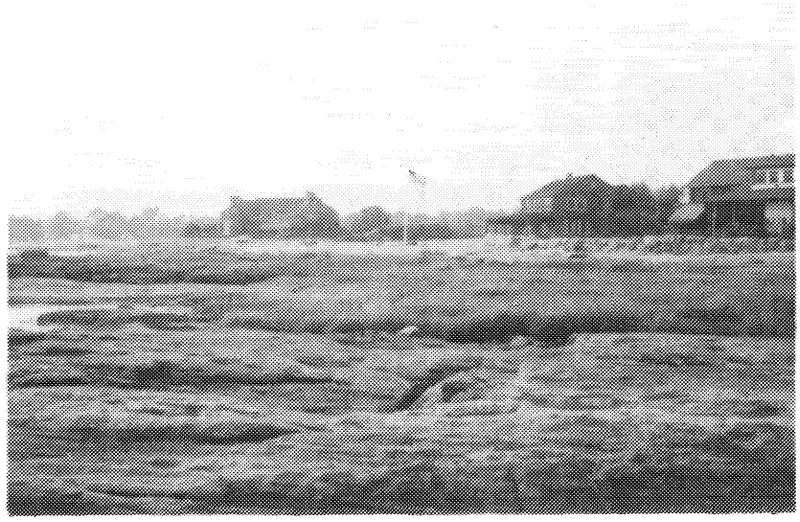


FIG. 2. VINEYARD POINT, GUILFORD. July 21, 1948. Rocky south shore of Point. Low sea walls front residences.

FIG. 3. VINEYARD POINT, GUILFORD. July 21, 1948. Road on barrier bar at head of cove on west side Vineyard Point.

FIG. 1. JOSHUA POINT, GUILFORD. July 21, 1948. Rocky shore along Sachem Head Harbor. Walls protect lawns.

FIG. 2. JOSHUA COVE, GUILFORD. July 21, 1948. Boulder strewn east shore near head of cove.

FIG. 3. JOSHUA COVE, GUILFORD. February 17, 1955. New cottage development on barrier bar at head of cove.

FIG. 1. ISLAND BAY, GUILFORD. November 20, 1952. Cottages on low barrier bar.

FIG. 2. ISLAND BAY, GUILFORD. July 22, 1948. Bedrock shore north from Clark Point.

FIG. 3. FLYING POINT, BRANFORD. July 22, 1948. Low sea walls protect south shore of Flying Point.

FIG. 1. STONY CREEK, BRANFORD. July 22, 1948. Stone walls line low irregular shore line.

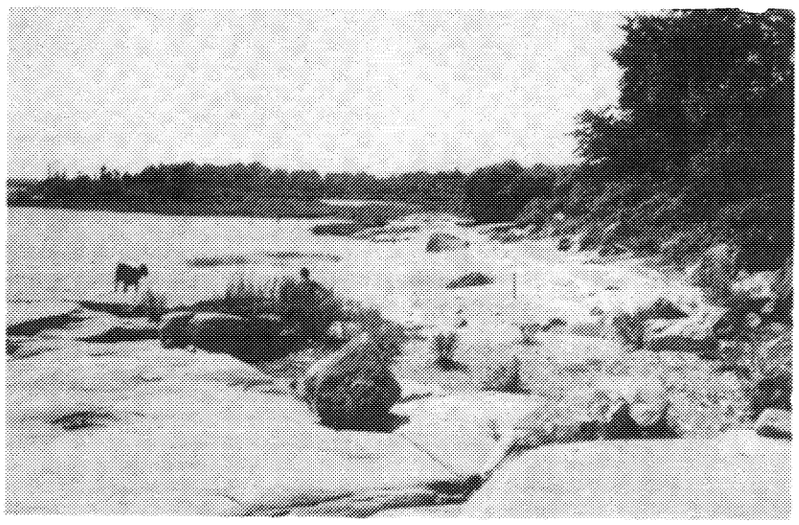


FIG. 2. PLEASANT POINT, BRANFORD. July 22, 1948. Rocky and marshy shore looking west from south face of point.

FIG. 3. PINE ORCHARD, BRANFORD. July 22, 1948. Narrow sandy beach and seawalls west from Brown Point.

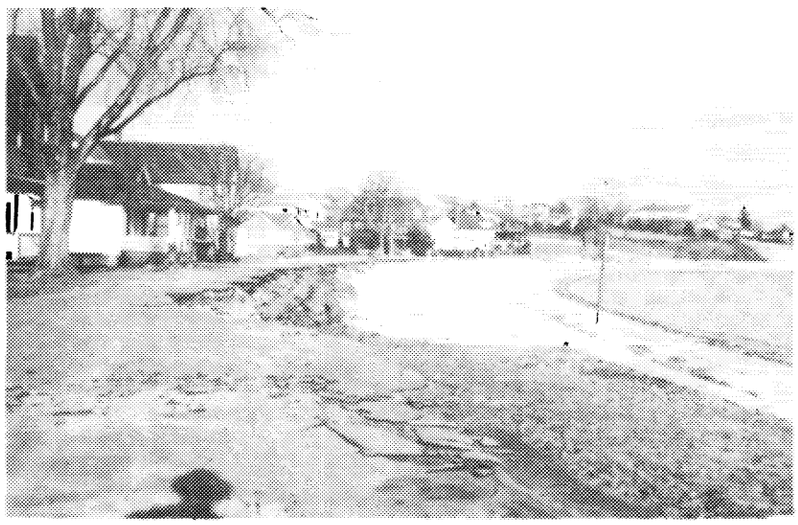


FIG. 1. HOTCHKISS GROVE BEACH, BRANFORD. December 1, 1950. Road washed out by storm of November 25, 1950.

FIG. 2. HAYCOCK POINT, BRANFORD. July 28, 1948. Walls protect lawns along rocky shore.

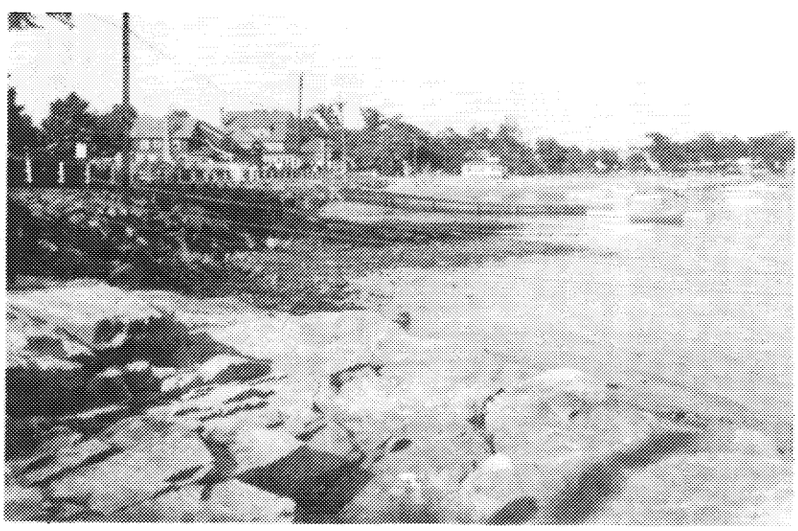


FIG. 3. LIMEWOOD BEACH, BRANFORD. July 22, 1948. Bedrock and rip-rap revetment in foreground. Sand beach in background.

FIG. 1. FIRST POCKET BEACH WEST OF LIMEWOOD BEACH, BRANFORD. February 16, 1955. Narrow private bathing beach.

FIG. 2. BETWEEN JEFFREY AND INDIAN NECK POINTS, BRANFORD. Aug. 16, 1948. Narrow beach and low walls front residences.

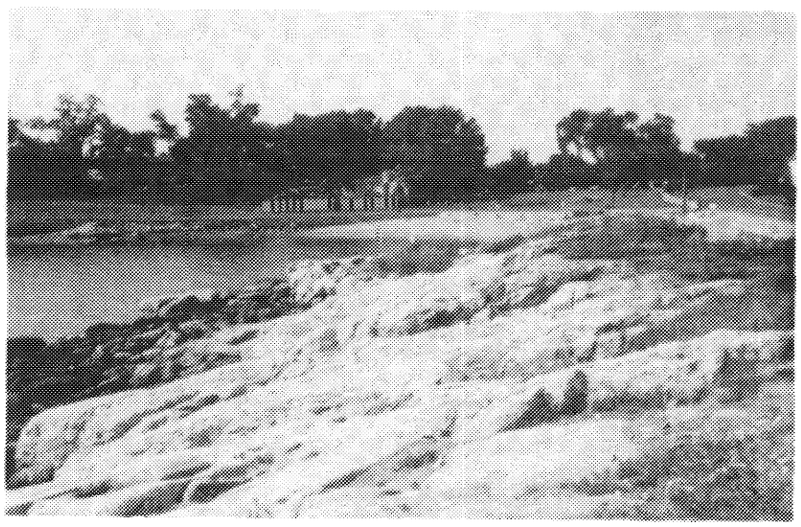


FIG. 3. PARKER MEMORIAL PARK, BRANFORD. August 16, 1948. Town beach in pocket adjacent to Branford Point.

FIG. 1. MOMAUGUIN BEACH, EAST HAVEN. February 1, 1952. Erosion of beach has endangered residences at Bradford Cove.

FIG. 2. MOMAUGUIN BEACH, EAST HAVEN. February 16, 1955. Compare with Fig. 1, above. Beach reformed in front of residences.

FIG. 3. MOMAUGUIN BEACH, EAST HAVEN. February 16, 1955. Cottages closely border the shore.

FIG. 1. SILVER SANDS BEACH, EAST HAVEN. November 18, 1952. Cottages located close to the shore.

FIG. 2. SILVER SANDS BEACH, EAST HAVEN. February 16, 1955. Cottages near South End located close to the shore.

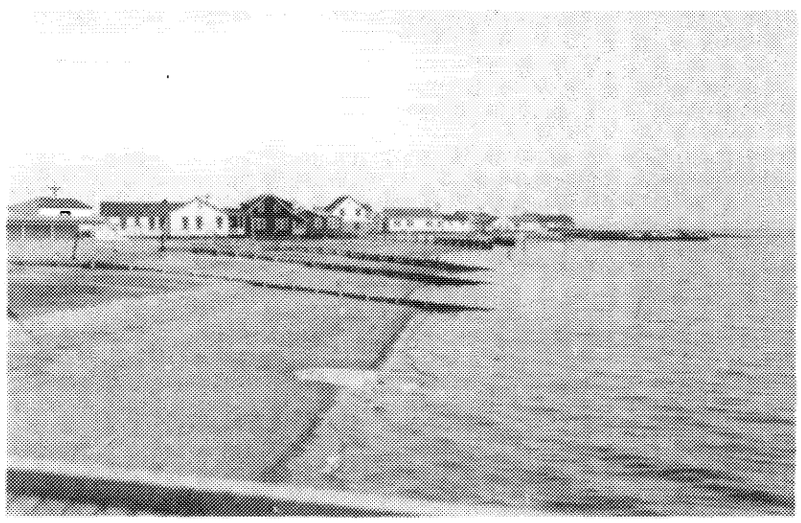


FIG. 3. WEST SILVER SANDS BEACH, EAST HAVEN. February 16, 1955. Groins and cottages on sandy barrier beach.

FIG. 1. WEST SILVER SANDS BEACH, EAST HAVEN. November 18, 1952. Cottages on low sandy barrier beach.

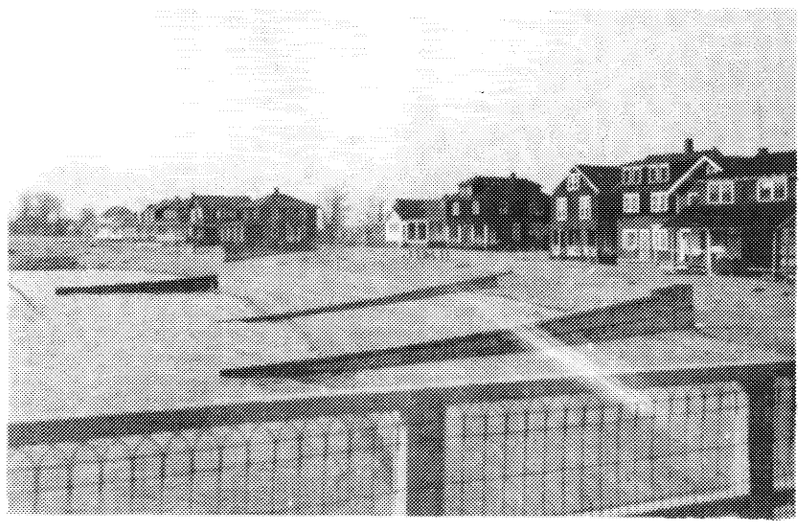


FIG. 2. WEST SILVER SANDS BEACH, EAST HAVEN. February 16, 1955. Compare with Fig. 1 above. Note lowering of beach at groins.

FIG. 3. MORGAN POINT, EAST HAVEN. February 16, 1955. East from Shell Beach at low tide.

FIG. 1. SHELL BEACH, EAST HAVEN. February 16, 1955. Cottages on low sandy barrier beach.

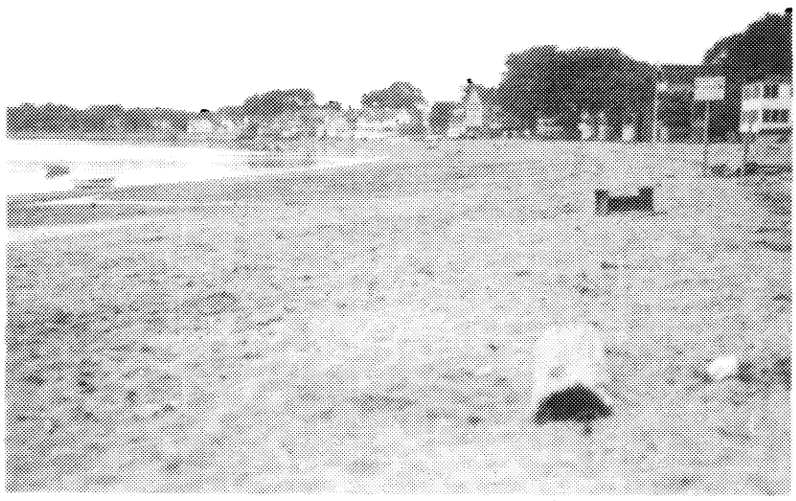


FIG. 2. MORRIS COVE, NEW HAVEN. August 17, 1948. Wide sandy beach at the head of Morris Cove.

FIG. 3. MORRIS COVE, NEW HAVEN. August 17, 1948. Residences at water's edge south of Morris Cove Park.

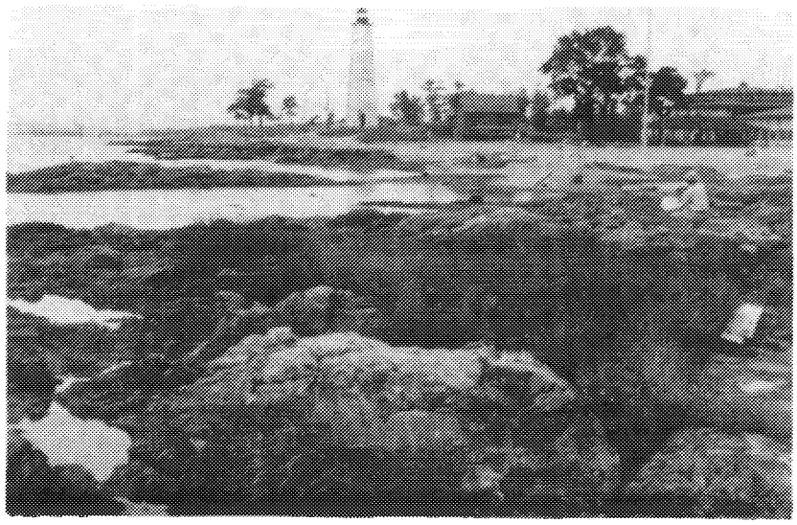


FIG. 1. LIGHTHOUSE POINT, NEW HAVEN. August 17, 1948. Rocky shore.

FIG. 2. LIGHTHOUSE POINT, NEW HAVEN. September 2, 1949. Six months after placement of sand fill.

FIG. 3. LIGHTHOUSE POINT, NEW HAVEN. February 16, 1955. Compare with Fig. 2 above. Erosion of the fill has moved the shore back to bedrock at the light.