DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

THE BULLETIN OF THE BEACH EROSION BOARD

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TABLE OF CONTENTS

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
BEACH EROSION BOARD

VOL. 8 1 JULY 1954 NO. 3

LOCALITY MAP

SHORE PROTECTION IN HARRISON COUNTY, MISSISSIPPI

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Mobile, Alabama

Affording over 700 acres of recreational beach area, the recently completed hydraulic fill protecting the sea wall and adjacent Federal highway in Harrison County, Miss., is reported to be the longest man-made beach in the world.

The joint sea wall repair and beach restoration venture undertaken by Harrison County with Federal aid covers about 25 miles of Mississippi Sound shore line between Biloxi and Henderson Point, near Pass Christian, Miss. Mississippi Sound, extending east and west for about 75 miles along the Mississippi and Alabama coasts, is separated from open water of the Gulf of Mexico by a chain of barrier islands lying some 10 to 12 miles offshore. Depths in the sound are shallow, increasing progressively from the mainland to a maximum of 15 to 20 feet near the barrier islands. The contour of 6-foot depth in places is as much as a mile offshore. Much of the land bordering the coast is low, flat, and subject to inundation by hurricane tides.

The Mississippi Gulf coast, long a favorite resort area for tourists and vacationers from all parts of the country, has been developed to the extent that practically the entire coastal strip in Harrison County is urban in character. The three principal coastal cities, Biloxi, Gulfport, and Pass Christian, are linked by a multi-million dollar highway, part of transcontinental U. S. 90, consisting of a multi-lane divided roadway. The traffic load thereon varies from 18,000 vehicles daily during the week to 22,000 daily on week ends. The highway closely borders Mississippi Sound and is protected by the sea wall throughout most of its length in Harrison County.

Hurricanes and beach erosion have always taken heavy tolls in lives and property damage along the Mississippi coast. The formation of exceptionally high storm tides in Mississippi Sound is facilitated by the progressively diminishing depths of water encountered by the wind-driven currents as they move onshore and further by the converging shore lines of the mainland and the Mississippi River delta, which act to confine and pile up the wind-driven water. In 1915, a hurricane of great magnitude destroyed over half the coastal highway between Biloxi and Pass Christian and altogether caused about $13,000,000 in damages to beach front property in Mississippi and Louisiana. The enormous damage resulting from this storm later prompted the State of Mississippi to pass a law appointing an investigative commission and authorizing the coastal communities concerned to issue bonds to finance construction of a sea wall. The bonds were to be retired with proceeds derived from local and state gasoline taxes.

The 25-mile-long sea wall in Harrison County, and probably the longest continuous sea wall in the world of any one modern design, was constructed during the period 1925-28 at a cost of $3,400,000. The design selected by engineers employed by the local government consisted of a reinforced concrete stepped-type slab supported at the toe by a continuous concrete sheet pile curtain wall and at the rear by square concrete bearing piles. The sheet-pile curtain wall is of particular interest since much of the trouble experienced in maintaining the Harrison County sea wall was apparently due to construction difficulties with respect to that feature. The sheet piles are 37 inches wide, 7 inches thick, and 10 feet long, and extend 8 feet below mean sea level. The bottom third of each pile's length was of tongue-and-groove design to facilitate guiding during the jetting operation. The top two-thirds of each pile's section was designed in such a manner that grooves in adjacent piles would abut each other. These grooves were later filled with grout to make a solid impervious core and seal the joint. Although theoretically suitable for the purpose, the workmen were unable to drive and grout the piling in such a manner as to obtain a sand-tight curtain wall. As a result, much sand backfill leaked through the curtain wall. Tread elevation of the bottom step is 3 feet above mean sea level and the top elevation of the sea wall is either 8 or 11 feet above mean sea level, the height being governed by the elevation of the backshore area. A concrete sidewalk 5 feet wide originally adjoined the top of the wall throughout its length. Storm drains led from catch basins under the side walk and discharged at the seaward face of the wall.

The bottom step was built at about the original ground level and a low, narrow beach existed in front of the wall at the time of its original construction. The beach material soon eroded, exposing the curtain wall to direct wave action at normal stages of the tide. The loss of sand backfill through openings in the curtain wall, and also through defective joints in the storm sewers, permitted the adjoining sidewalk to settle and disintegrate, and endangered the foundation of the parallel Federal highway. However, the unsightly condition of the sidewalk and lack of backfill which exposed the underside of the sea wall, and other minor defects, gave observers the impression that the wall was in much worse condition structurally than was actually the case. Other than cracks and crevices, spalling of concrete, stripping of the transverse rib at a number of the expansion joints, and exposure of reinforcing bars to the corrosive action of sea water, the wall was in relatively good condition, considering its age and lack of maintenance. The exceptionally destructive tropical

FIGURE 1. TYPICAL CONDITION OF SEAWALL PRIOR TO REPAIRS
(Fissure along back of bottom step extended throughout practically the entire length of the seawall.—Note A).

FIGURE 2. TYPICAL FILLING OPERATION

hurricane which passed over the Mississippi coast in September 1947 inflicted remarkably little damage on the sea wall considering the height of the wind tide and the severity of wave action. The wind tide reached a height of about 14 feet during this hurricane. (See Bulletin of the Beach Erosion Board, Vol. 2-No. 1, Jan. 1948).

Beach erosion control studies by the Corps of Engineers were undertaken in 1944 and again in 1947 in cooperation with the Harrison County Board of Supervisors. These studies indicated that, after all factors were taken into consideration, a hydraulic fill placed adjacent to the sea wall, if properly maintained, would be the most suitable means of stopping leakage of sand through the curtain wall and prolonging the life of the concrete stepped-slab, and would in addition provide a recreational facility for the general public. The plan of improvement and protection formulated by these studies was adopted as a Federal project in the 1948 River and Harbor Act. Elements of improvement and protection incorporated in this project included structural repair of the stepped concrete slab by the pressure concrete or "gunite" method, replacing backfill, constructing a sand beach about 24 miles long, 300 feet wide with a berm width of 50 feet at top elevation of 5 feet above mean sea level adjacent to the sea wall, and reconstructing the drainage system. Design slope from the edge of the berm of the proposed fill outward to the natural bottom of the sound was 1 on 50. The total estimated volume of sand required for the beach was 5,700,000 cubic yards. The drainage plan included a collecting sewer back of the sea wall, discharging at intervals through relatively few laterals across the beach. All drainage lines were designed to minimize differential settlement and to assure tight joints in the interest of preventing infiltration of sand. Sewer pipes laid across the beach were anchored at their seaward ends by means of creosoted timber piling structures. At the larger outfalls, the plans specified that drainage be carried across the beach between two parallel rows of interlocking concrete sheet piles. The original (1947) estimate for the project, exclusive of the cost of "gunite" and other wall repairs, was $2,038,000. Dredging unit cost was estimated at that time at 15 cents per cubic yard, including items for engineering and contingencies. The Beach Erosion Board recommended the maximum Federal participation in the cost of the project under the policy stated in the so-called "sea-wall proviso" of Public Law 727, 79th Congress, amounting to one-third of the original cost of the wall. The recommended Federal share was therefore one-third of $3,400,000, or $1,133,000.

Assurances that all conditions of local cooperation imposed by the project would be met were approved by the Chief of Engineers on 10

FIGURE 3. LAYING COLLECTING DRAIN BEHIND SEAWALL

FIGURE 4. DRAIN OUTFALL THROUGH SEAWALL
(Old outfall at left.)

January 1951 and a contract between the Corps of Engineers and Harrison County was drawn and executed on 23 January 1951. Policy of the Corps of Engineers' District Office at Mobile with respect to prosecution of the work was declared to be as follows:

a. That all plans and specifications for the work would be reviewed and approved in their engineering and construction aspects as required by the Act of Congress authorizing the project.

b. That all bids received by the county would be examined by the District Office and, if such bids appeared excessive, this fact would be discussed with the sponsoring agency, with appropriate suggestions and recommendations. If the county deemed it inadvisable to follow such suggestions or recommendations, the Mobile District would not require the rejection of any bid or the readvertisement of any work provided the low bidder was qualified and all engineering and construction requirements were satisfactory.

c. That since the Mobile District would be held accountable for any progress payments made, such payments would be conditional on the assurance in the form of a guarantee from the county that the entire project would be completed.

Structural repairs to the concrete stepped-slab were commenced on 16 January 1950 and completed by the end of the year. The work consisted of chipping out cracks to provide space for a minimum of 6 inches of gunite grout, cleaning, sandblasting, and pressure grouting. A membrane curing compound was applied over the finished grout. All old reinforcing bars were cleaned of rust by sandblasting and mesh reinforcing, properly spliced and tied, was placed where needed before commencement of grouting. The sidewalk was removed and the broken concrete used in the construction of groins at Henderson Point and at several other localities along the shore.

Placing of the beach fill was commenced on 3 January 1951 and completed during November of the same year, a total construction period of about 11 months. Creation of the beach was accomplished by the direct placement method. Two dredges were employed, one with 20-inch discharge beginning at Henderson Point and working eastward and the other with 16-inch discharge commencing at Biloxi Lighthouse and working westward. Material was obtained from a parallel borrow channel, dredged to a depth of 14 feet, about 1,500 feet offshore. Specifications for the project called for beach material to be composed of sand having 20 percent or less of foreign matter. In order to determine the composition of source material in the borrow area, exploratory borings were taken to a depth of about 20 feet below mean sea level at intervals of 1,000 feet. Except for occasional isolated lenses of clay, all material in the borrow area west of Beauvoir, about midway between Gulfport and Biloxi, was determined by sampling to be practically pure sand. Opposite Beauvoir, clay was found at a depth of 18 feet and from there eastward there was a continued gradual rise of the clay strata, which reached the surface opposite Biloxi. Although the dredges avoided clay areas as much as possible, its predominance opposite Biloxi is manifested in the appearance of the finished beach in that area. Median diameter of sand in the foreshore slope of the finished beach was about 0.27 millimeter. Gradation of representative samples of material in place is indicated in the following tabulation. Sample No. 1 was taken when material was first pumped on the beach and Sample No. 2 was taken from the foreshore slope about two months later.

Sieve No.	Size Opening (mm)	Sample No. 1 Percent Retained	Sample No. 2 Percent Retained
-	-	-	-
10	2.00	0.0	0.0
20	0.840	0.6	0.4
40	0.420	9.9	6.3
60	0.250	51.0	56.4
100	0.149	89.5	95.4
200	0.074	98.0	100.0

In placing the material, an outer retaining dike with its crest at an elevation of about 2 feet above mean sea level was first deposited for a distance of about 1,000 feet parallel to and slightly less than 300 feet from the sea wall. The intervening space between the retaining dike and the wall was then filled with sufficient material to bring the beach to design grade and cross section, plus an excess to be used to fill slack areas and to supply backfill for the rear of the sea wall. This process was then repeated for the next 1,000 feet and so on throughout the job. It was subsequently found, however, that use of the retaining dike in beach construction was unnecessary. Actually, the dike had prevented the run-off of undesirable fine material. Restoration of the beach along the Biloxi waterfront, recently completed, was successfully and efficiently accomplished without the use of a retaining dike, and the use of such dikes in future construction of artificial beaches is considered inadvisable.

In order to provide continuous drainage for surface run-off, depressions were left across the beach at the locations of outfalls and a stockpile of material left adjacent thereto for backfill. The placing and backfilling of the drainage outfall pipe followed the hydraulic fill as closely as practicable. Draglines were employed to transfer the surplus material from the stockpile, across the sea wall, for backfill purposes and after all other work was finished the surface of the beach was dressed to design cross section by bulldozer.

Volume of sand required for the hydraulic beach fill was slightly less than 6,000,000 cubic yards. Contract unit prices for dredging were 22.43¢ for the section west of Gulfport and 24.98¢ between Gulfport and Biloxi. About 170,000 cubic yards were required to replace backfill which had seeped from the rear of the sea wall. Reconstruction of the drainage system involved laying of 104,370 linear feet of concrete sewer pipe of diameters from 8 to 42 inches, construction of 406 junction boxes and manholes, driving 29,600 linear feet of concrete sheet piling for the larger outfalls, and miscellaneous appurtenant works. The final costs of the various features of the project are summarized as follows:

Structural repairs by gunite process - - - - - - - -	$201,046
Hydraulic fill (5,985,000 cu. yds.) - - - - - - - - -	1,411,671
Reconstruction of drainage system - - - - - - - - - -	1,109,909
Backfill (169,000 cu. yds.) - - - - - - - - - - - - -	142,007
Subtotal, construction - - - - - - - - - - - - -	2,864,633
Preparation of Plans and Specifications - - - - - -	83,147
Engineering and Inspection on Construction - - - -	44,630
Government costs:	
Supervision and inspection - - - - - - - - - - -	6,545
General overhead - - - - - - - - - - - - - - - - -	2,825
Subtotal - Engineering, supervision, overhead, etc	137,147
GRAND TOTAL COST OF PROJECT - - - - - - - - - - - - - - -	$3,001,780

Detail plans and specifications for the project were drawn up by the Harrison County Engineering Department and submitted to the Corps of Engineers for review and approval prior to initiation of the work, in accordance with the terms of the Federal River & Harbor Act authorizing the project. Construction was carried out under the supervision of the County with frequent inspection by an engineer of the Mobile District office to see that the work was being prosecuted according to the performance schedule and in compliance with the approved plans and specifications. Monthly payments were made to the county commensurate with the physical stage of completion of the work. The Government's pro-rata share of the cost of work actually in place was computed at 37.74 percent, equivalent to the ratio of the fixed Federal participation to the total estimated cost for the job.

Shortly after completion of the hydraulic fill, natural adjustments began to take place in the beach slopes. Wave and tidal action formed a ridge of sand, with a foreshore slope of about 1 on 10, parallel to and a short distance landward of the shore line. Elevation of this ridge, or berm crest, is at about 3.2 feet above mean sea level, which is about the maximum elevation normally reached by the uprushing waves at high tide in Mississippi Sound. The formation of the sand ridge created several undesirable conditions to the beach. Water, which collected in the impounding area landward thereof in some localities, at times became stagnant and collection of fine silt in the wet areas resulted in intermittent growth of marsh grass. These conditions marred the appearance of the beach and detracted from recreational usefulness; however, remedial measures were promptly undertaken by the local government. The beach is now being filled and regraded with excess material to a slope of 1 on 100 outward to the berm crest, and allowed to assume its natural slope, about 1 on 10, thence to the water's edge. The sand ridge also seals up the outer ends of the drainage pipes, but during a heavy rainfall a head of water usually develops sufficient to clean them out; otherwise they are opened by maintenance crews when necessary. In general, the drainage system is functioning efficiently. Loose sand transported from the beach by southerly winds during dry periods banks up against the eleven-foot wall and is blown over the eight-foot wall and across the adjacent roadway. Although such loss of beach sand is relatively insignificant, additional expense is nevertheless incurred in removing it from the roadway and parkways.

Cross sections were taken shortly after completion of the hydraulic fill in 1951 and again in June 1953. The sections were located to represent beach areas not under the direct influence of the groin effect of the various outfall pipes or other projections extending into the sound. Subsequent to the 1951 survey, about 170,000 cubic yards of material were removed from the beach for backfilling the sea wall. A comparison of the 1951 and 1953 cross sections, and allowing for the quantity of material removed for backfill, indicates that the loss of sand by erosion amounted roughly to 65,000 cubic yards for the two-year period, or an average of 32,500 cubic yards annually.

FIGURE 5. CONDITION OF BEACH EAST OF HENDERSON POINT - OCT. 1950.

FIGURE 6. FINISHED BEACH EAST OF HENDERSON POINT - FEB. 1952.

The protection afforded by the offshore barrier islands renders Mississippi Sound a relatively quiet body of water except during storms or tropical hurricanes. The greatest fetch over which the wind blows lies to the southeast and the predominant onshore winds are from that sector. The natural forces therefore are such as to produce a westerly littoral drift along the Harrison County shore, but the quantity of material transported, insofar as can be determined by visual inspection, is relatively low. Pipe outfalls extending across the beach, usually for distances of about 260 feet from the sea wall, and other projections having similar groin effects, have accumulated small quantities of material on their eastern sides, accompanied by loss of some material and recession of the shore line on the opposite sides. At Henderson Point, sand is escaping past the end of the broken-concrete groin and is being deposited in the form of an underwater bar trailing off to the southwest. There is also evidence of seasonal reversals in direction of littoral drift, as illustrated by the accompanying aerial photograph of the finished beach (Fig.6.). At the outer end of a number of outfalls, maintenance forces have recently placed short rock groins at an angle bearing to the southwest in an attempt to arrest the erosion on the downdrift side of the drainage outlet pipes. Their effectiveness for this purpose so far has not been established.

The beach maintenance program is carried out by a crew of about 50 men. The work includes reshaping the beach, filling low areas, removing wind-blown sand from the adjacent roadway, cleaning the outfall pipes and building the rock groins at their seaward ends, and sifting debris from the beach area by employing a beach "sanitizer". The latter is a tractor-drawn machine which picks up sand to depths of 6 inches or less and removes debris from it by means of a series of mechanically agitated wire-mesh sieves. The sanitizer is effective only during dry periods when moisture content of the sand is low. The beach maintenance and upkeep costs so far average about $10,000 per month, according to engineers employed by the county. No beach replenishment by dredging has been necessary since completion of the fill and no major repairs to the drainage system or sea wall structure have been required. It may thus be noted that a considerable part of the maintenance cost so far applies to maintenance as a recreational project rather than as a protective measure.

The observed slope adjustments, the effect of the sand ridge on the outfall drains and other experiences with the finished beach in Harrison County were used as a guide in planning an extension to the project along the waterfront in the City of Biloxi. The artificial beach in Biloxi, completed in March 1954, was designed with a top elevation of 5 feet above mean sea level adjacent to the sea wall and a slope of 1 on 100 outward 220 feet to a berm crest at elevation 2.8 feet, thence 1 on 10 to the natural floor of the sound. Drainage outfalls extend 248 feet from the seawall, discharging approximately on the foreshore slope. Apparently little, if any, beach material has been lost by erosion and no appreciable slope adjustments have occurred. The advantage of the steeper foreshore slope (1 on 10 as compared to 1 on 50 in the original project) is evident..

The hydraulic fill along the Harrison County sea wall has proven effective as a means of sealing the curtain wall against escape of sand backfill. Insufficient time has elapsed since its completion, however, to determine its resistance to erosion, particularly during hurricanes or severe tropical disturbances. Cross sections should be taken periodically, at least once a year and after all severe storms, to determine the rate of erosion during all weather conditions. Steps should be taken to replenish eroded areas as soon as they appear in order that the beach may continue to function as a protective measure for the sea wall. Planting of a suitable species of beach shrub might be desirable to reduce loss of sand by wind action.

The protective beach was justified on the basis of its value as a large-scale recreational facility for general public use as well as a means of prolonging the effective useful life of the sea wall and adjacent transcontinental highway. Although no actual count has been taken of the number of daily visitors to the beach, its extensive use has been noted by county officials and representatives of the Corps of Engineers. The area is densely populated and is only a relatively short distance from large urban centers such as New Orleans, Mobile, and inland cities which have long been in need of the advantages afforded by the new facility. The Mississippi coast has been an outstanding seashore resort for many years and the creation of the artificial beach has attracted many new visitors and encouraged substantial additional investments in hotels, tourist cottages, and other recreational property.

Acknowledgments

The writers desire to express appreciation to Mr. Arthur MacArthur, County Engineer, and Mr. J. K. Muether, Assistant County Engineer, Harrison County, for furnishing much of the data analysed in this paper.

COMPARISON OF HINDCAST AND OBSERVED WAVES ALONG THE NORTHERN NEW JERSEY COAST FOR THE STORM OF NOVEMBER 6-7, 1953

by

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On November 6 and 7, 1953 a severe Atlantic Coast storm caused extensive damage to beaches and structures in the Long Island-Northern New Jersey coastal area. The most intense part of the storm (Figure 1) coincided with the occurrence of high tides and produced record or near record high water marks in the area. In wind intensity the storm compared with many of the most violent that preceded it; the wind waves accompanying it were, therefore, among the highest observed along this coastal segment.

During the period March 22 through April 9, 1954, the Beach Erosion Board conducted the third in a series of classes dealing with wave, beach erosion, and shore protection phenomena. One topic to which almost a week of class instruction and practice time was devoted was wind wave forecasting and hindcasting. After instruction in and demonstration of forecasting methods, the class, divided into several teams, performed a supervised series of wave hindcasts climaxing in a hindcast for the Northern New Jersey shore of waves from the storm of November 1953. As a control the class instructors (the authors) also performed a wave hindcast for this storm. All forecasting teams operated independently using the Sverdrup-Munk methods of forecasting and decay analysis as revised by Bretschneider (1,2)*. As a further item of interest, the authors performed an additional hindcast analysis of the storm utilizing the method recently devised by W. J. Pierson and G. Neumann of New York University (3,4). A comparison has also been made with reported visual observations.

Hindcast summaries of wave data by three class teams and the instructors, all derived by the Sverdrup-Munk-Bretschneider approach and by the authors using the Pierson-Neumann method are shown graphically on Figure 2.

Table 1 includes summaries of both the forecasting parameters derived by the instructors from the six-hourly U. S. Weather Bureau North American Surface charts, and the hindcast wave parameters, obtained first by use of the Bretschneider forecasting and decay curves, then by the Pierson-Neumann technique. The forecasting parameters (i.e. wind velocity, fetch, and initial duration) utilized are the same for both methods.

* Numbers in parentheses refer to the Bibliography at the end of the report.

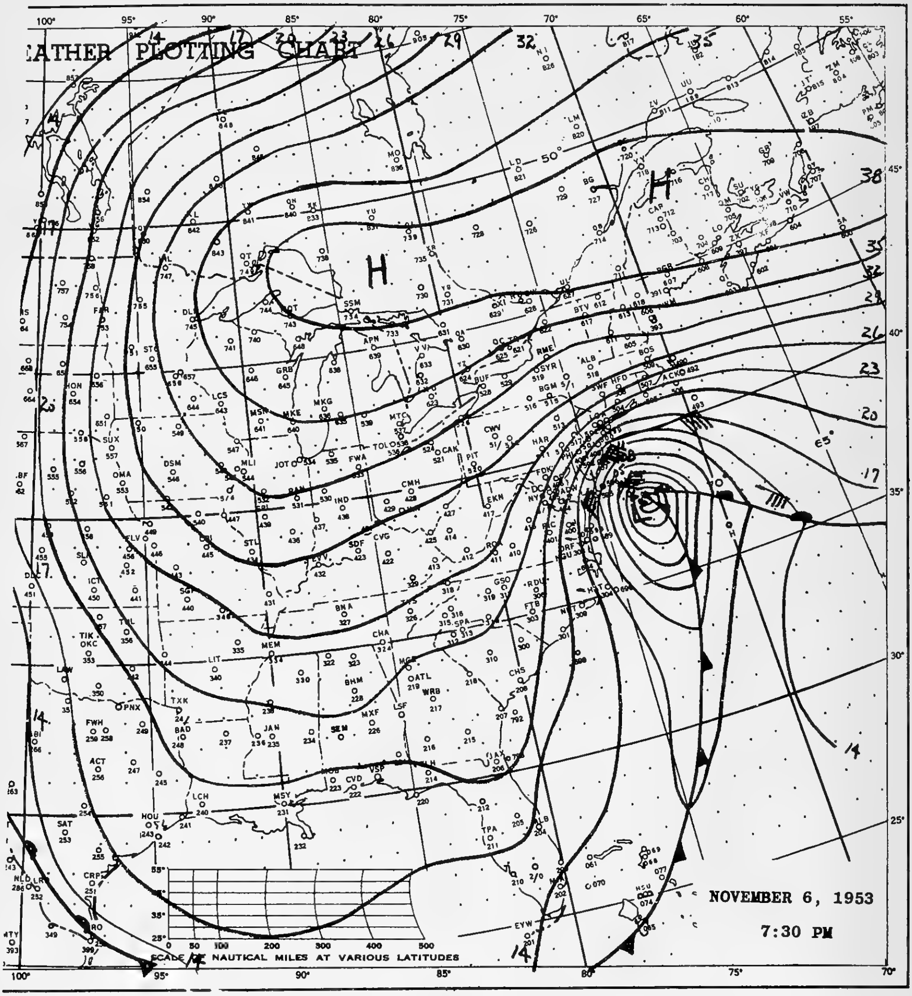

FIGURE 1-SYNOPTIC SITUATION, 1930 EST NOVEMBER 6, 1953

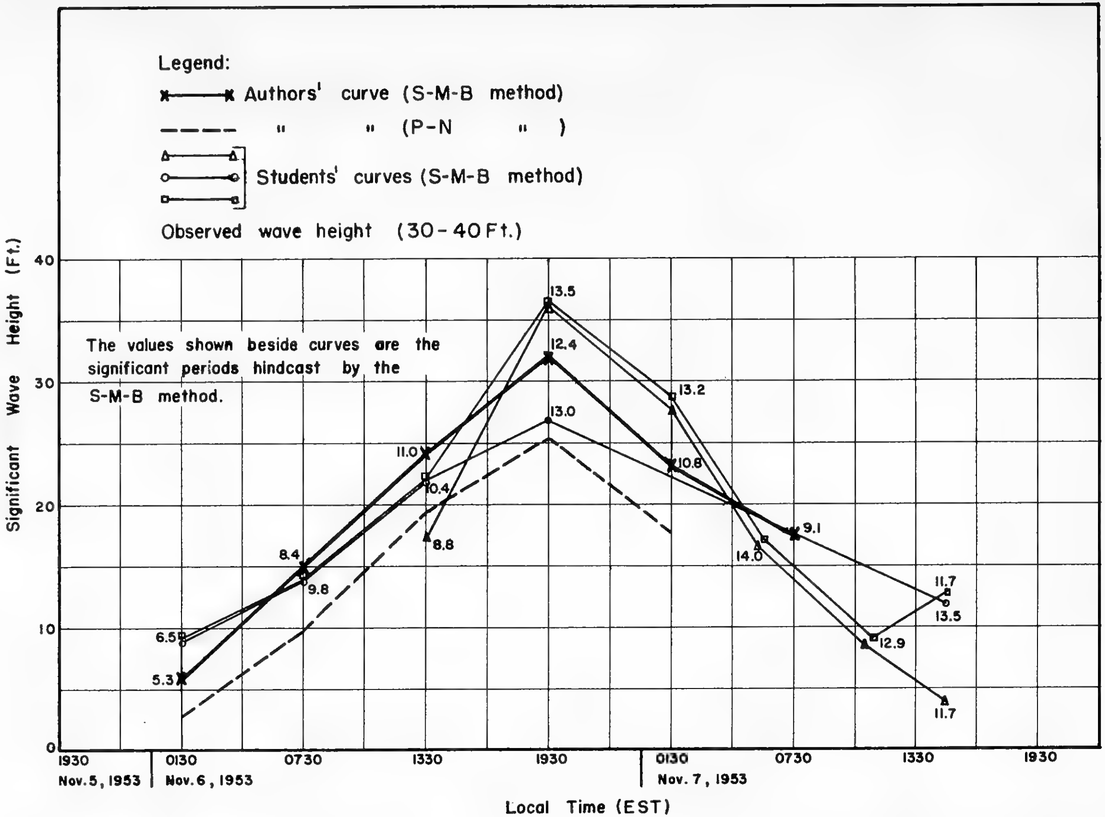

FIGURE 2 - HINDCAST WAVE DATA FOR NORTHERN NEW JERSEY COAST FOR NOVEMBER 1953 STORM.

Table 1

PARAMETERS FOR HINDCASTS

Date	6 Nov				7 Nov
Time (EST)	0130	0730	1330	1930	0130
Velocity (kn)	26	39	45	55	42
Fetch (n.mi.)	not lim.	200	180	120	120
Duration (hr.)	3				
By Sverdrup - Munk - Bretschneider Methods					
Min. Dur. (hr.)	3	5.7	9.4	9	10.1
Min. Fetch (n.mi.)	18	55	110	120	120
Sig. Height (ft.)	5.8	15	24	32	23
Sig. Period (sec.)	5.3	8.4	11.0	12.4	10.8
By Pierson-Neumann Method					
Min. Dur. (hr.)	3	5	9	11	—
Min. Fetch (n.mi.)	—	—	—	120	120
E	0.9	12	45	80	40
Sig. Ht. (ft.)	2.7	9.8	19.3	25.4	17.9
Max. Period (sec.)	4.2	6.3	9.5	10.2	9.3

It is of interest to note that two of the class teams hindcast a wave maximum of 36 feet while the third hindcast a maximum of 27 feet. The authors' maximum using the Bretschneider curves was 32 feet; using the Pierson-Neumann technique (with the same forecasting parameters) it was 25 feet. That class team reporting the 27-foot wave height maximum, in analyzing the weather charts determined a maximum wind velocity significantly lower than that determined by the other class groups. This is not unexpected, interpretation of weather charts being still often a subjective matter.

Hindcast wave periods also differ. The three class teams reported periods for the maximum portion of the storm of between 13.0 and 13.5 seconds. The authors' hindcast periods were 12.4 seconds for the significant period by the Bretschneider technique and 10.2 seconds as the maximum period by the Pierson-Neumann technique; this value corresponds to an average period of about 8 seconds.

Visual wave observations although not considered entirely accurate, do give a fairly good measure of wave conditions off the coast. The observed wave heights reported in the Northern New Jersey area (5) are as follows:

Location	Observed Wave Height (feet)
Manasquan Inlet, Coast Guard Station	40
Shark River Coast Guard Station	40
Monmouth Beach Coast Guard Station	35
Sandy Hook Coast Guard Station	30

The comparison of these observations with the hindcast heights of 25 to 36 feet appears to be quite reasonable, particularly when it is realized that visual observations of high waves are often on the high side. It should be noted that the hindcast values of wave height are so-called significant heights. There was no way of ascertaining whether the observed heights were also significant heights, or some other value, the mean or maximum, for example.

The class members whose hindcasts are discussed herein are: Mr. Bert W. Allen of the London, Ontario, district office, Mr. Manuel A. Fine of the Toronto, Ontario district office, Mr. Malcomb W. Paul of the Saint John, New Brunswick district office, all of the Department of Public Works of Canada; Mr. Harry S. Perdikis of the New England Division, Corps of Engineers; and Messrs. Robert A. Jachowski and George W. Simmons of the Beach Erosion Board staff. Their permission to use the results of their hindcasts in this report is gratefully acknowledged.

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(4) Neumann, Gerhard - On Ocean Wave Spectra and a New Method of Forecasting Wind Generated Sea, Beach Erosion Board Technical Memorandum No. 43, December 1953.

(5) U. S. Corps of Engineers, * Report on Storm of 6-7 November 1953, in two volumes, New York District, February 1954.

NOTICE

FIFTH CONFERENCE ON COASTAL ENGINEERING

on 8-11 September 1954

Sponsored by the University of Grenoble
at
Ecole National D'Electrotechnique Et D'Hydraulique
46 Avenue Felix - Viallet
Grenoble, France

This series of conferences is one of the activities of the Council on Wave Research of the Engineering Foundation. Four conferences have been held to date - the first at Long Beach, California, in 1950, the second at Houston, Texas, in 1951, the third in Cambridge, Massachusetts, in 1952, and the fourth in Chicago, Illinois in 1953. The proceedings of these conferences have been published. The primary purpose of these conferences has been to aid the engineer by summarizing the present state of the art and science related to the design and planning of coastal works. Although much remains to be done in the way of developing reliable design methods, the series of papers presented at the conferences represent a thorough summary of coastal engineering as now practiced. Although many papers to be given at the fifth conference will pertain to the European Coast it is the aim and purpose to present papers that present basic information for general application. Inquiriesregarding this conference, and requests for application forms, should be directed to the above address or to the following:

Monsieur René Frappat - Secrétaire Général
Association Amis de L'Universite de Grenoble
Cinquieme Congrès de Coastal Engineering
Palais de L'Universite
Grenoble , France

COUNCIL ON WAVE RESEARCH - THE ENGINEERING FOUNDATION
245 Hesse Hall, University of California
Berkeley, California

PROGRESS REPORTS ON RESEARCH SPONSORED BY THE BEACH EROSION BOARD

Abstracts from progress reports on several research contracts in force between universities or other institutions and the Beach Erosion Board, together with brief statements as to the status of research projects being prosecuted in the laboratory of the Beach Erosion Board are presented as follows:

I. University of California, Contract No. DA-49-055-eng-8, Status Report No. 14, 1 March 1954 through 1 May 1954

Mechanical analysis of the sand samples collected during the survey of the movement of sand around the rocky promontories of Point Arguello, Point Conception and Point Dume in Southern California is now completed. The results are being compiled on charts to aid in interpretation of the mechanics of sand movement around these points.

The series of sand samples collected during February on Point Reyes Beach to determine the variability of individual samples taken on a beach, irregular in composition and exposed to storm action, are in the process of mechanical analysis.

In the latter part of April a series of sand samples were collected in Santa Barbara harbor and along the adjacent beach to the east to supplement previous studies of sand movement in these areas. Special emphasis was given to depths shallower than 20 feet.

II. University of California, Contract No. DA-49-055-eng-31, Status Report No. 3 - 1 February to 30 April 1954

The runs with a smooth bed in the channel were completed. The measurements included the set-up at 5 locations and wave conditions at 4 locations along the channel for five different wind velocities with seven different still-water depths. An interim report is being prepared for the smooth bottom conditions.

Runs on set-up have been made with a bed roughened by means of expanded metal lath. Preliminary analysis indicates that this degree of roughness gives a set-up about 10 percent greater than with the smooth bottom. Exploratory experiments were made with strips of cheese cloth in the channel to simulate the roughness effects of vegetation in nature.

III. Scripps Institution of Oceanography, Contract No. DA-49-055-eng-3, Quarterly Progress Report No. 19, January to March 1954

Analysis of orbital velocity associated with wave motion in shallow water is nearing completion. Agreement with solitary wave theory is best near the breaker zone; the field velocity tends to be greater than theoretical velocity for long-period waves and less for short-period waves.

Continued measurements of sand-level changes show greatest changes are taking place in shallow water; at the deepest station (70 feet) there have been no changes exceeding 0.05 feet.

A single device for accurately measuring the profile of large ripples has been perfected. It consists of a series of parallel brass prongs welded at right angles to a metal bar. The prongs are coated with grease. When the device is forced into the sand bottom, the imprint of the ripple profile is clearly marked. A spirit level is attached.

The valley heads leading into Scripps Submarine Canyon have shown a shoaling that amounts to as much as 4 feet in portions where the slide took place during the previous quarter.

IV. The Agricultural and Mechanical College of Texas, Contract No. DA-49-055-eng-18, Final Report

This contract has now been completed except for the submission of a report "Change in Wave Height Due to Bottom Friction, Percolation, and Refraction" which is presently in preparation and essentially completed. This project has studied the effect of shallow water bottom conditions on the generation and propagation of waves in the shallow water of the Gulf coast both theoretically and by field studies. The results are largely contained in a series of three reports. The first is that mentioned above, which makes use of the dissipation functions presented by Putnam, and Putnam and Johnson, to obtain a direct general solution of wave height transformation incorporating the effect of refraction as well as friction and percolation; the second, entitled "Generation of Wind Waves Over a Shallow Bottom" presents a numerical method for determining shallow water wave generation by successive approximations wherein wave energy is added due to wind stress (as determined from the revised Sverdrup-Munk relations for deep water generation) and subtracted due to bottom friction and percolation; the third, "Field Investigation of Wave Energy Loss of Shallow Water Ocean Waves", summarizes the field data gathered in the two years of the contract and presents a tentative analysis of the effect of a non-rigid bottom. It is presently planned that the major portions of these reports will be reproduced as Technical Memorandums of the Board.

V. New York University, Contract No. DA-49-055-eng-32, Quarterly Progress Report Dated 2 April 1954

The spectrum analyser for wave records has been completed and shipped to the Board where it will be set up for use. A draft of the paper on the statistical analysis of hindcast data on the North Atlantic coast is being prepared.

VI. Massachusetts Institute of Technology, Contract No. DA-49-055-eng-16, 6th Progress Report dated 15 June 1954

Additional data was gathered on the mean (sand) particle velocity along the beach and its relation to the wave and depth characteristics; and on the location of the null point (point separating the areas of onshore and offshore movement) and its relation to wave characteristics.

VII. Waterways Experiment Station, Vicksburg, Mississippi -

Wave Run-up Study: Overtopping tests on the Lake Okeechobee levee section (1 on 3 smooth slope) with an expanded series of wave conditions were completed for crown elevations through 12 feet and a water depth of 29.5 feet.

Effect of Inlets on Adjacent Beaches: An additional test series has been initiated, everything being the same as for the previous test except that the lagoon depth in back of the inlet is relatively shallow (about the same as the inlet depth) instead of being very deep.

VIII. Beach Erosion Board, Research Division, Project Status Report for Quarter ending 18 June 1954

In addition to the research projects under contract to various institutions which are reported on above, the Research Division of the Beach Erosion Board is carrying out certain projects with its own facilities. The main unclassified projects have been described in previous numbers of the Bulletin, and a short description of some of the work accomplished through the last quarter is given below.

Study of Effect of Tsunamis: Additional tests have been performed to relate the wave height at the shoreline to the deep water height and to the run-up. Run-up on these idealized shore structures has also been measured and related to the deeper water wave characteristics.

Study of Reforming of Waves After Breaking: Tests of reforming waves, and the relation between the energy of the reformed wave and the initial unbroken wave have been made for a smooth slope, and for two bar shapes (for numerous depths and wave conditions) and the data is now being analysed. Preliminary analysis indicates that the increase in water level at the shore due to mass transport has an important effect.

Groin Study: A new project is being initiated to study the effect of groins on beaches, and the rate of littoral drift passing a groin field. The test is presently being set up in the Coast Model Test Basin where waves will be generated at a 30-degree angle to a sand beach containing a groin field; material will be fed into the littoral regime at the upbeach end (at varying ratios of the equilibrium rate) and measurements of the material passing the field will be made at the downbeach end.

Routine progress, testing and analysis has been made on the other projects being carried out by the Research Division. In addition, a three-week class on water wave phenomena and design was held for representatives of some of the coastal Districts, Division, and other offices of the Corps of Engineers; several representatives of the Department of Public Works of Canada also attended. A report on "Coast Erosion and the Development of Beach Profiles" by the Danish engineer Per Bruun discussing methods of analysis of shore problems used abroad, and the application of some of these to profiles in the Mission Bay, California area, was completed and is being published as Technical Memorandum 44.

Beach erosion control studies of specific localities are usually made by the Corps of Engineers in cooperation with appropriate agencies of the various States by authority of Section 2 of the River and Harbor Act approved 3 July 1930. By executive ruling the costs of these studies are divided equally between the United States and the cooperating agencies. Information concerning the initiation of a cooperative study may be obtained from any District or Division Engineer of the Corps of Engineers. After a report on a cooperative study has been transmitted to Congress, a summary thereof is included in the next issue of this Bulletin. Summaries of reports transmitted to Congress since the last issue of the Bulletin and lists of completed and authorized cooperative studies follow.

SUMMARIES OF REPORTS TRANSMITTED TO CONGRESS

PINELLAS COUNTY, FLORIDA

Pinellas County is located on the Gulf Coast of Florida, about midway of the peninsula. Its shore line consists of numerous keys or barrier islands, separated from the mainland by generally shallow tidal lagoons, and from each other by shallow natural passes. The study area, about 25 miles of shore line, comprises the four most developed of these keys, namely Clearwater Beach Island, Sand Key, Treasure Island, and Long Key. These four islands contain 13 separate incorporated communities. Six causeways and bridges connect these islands with the mainland. The principal activities in this area are tourish accommodation, citrus fruit growing and commercial fishing.

The four islands have a permanent population of about 11,000, but the summer and winter tourist trade increases the population to more than 26,000 the year round. The permanent population of the general tributary area, comprising Pinellas and Hillsborough Counties which include the cities of Clearwater, St. Petersburg and Tampa, is in excess of 400,000. During the winter season this figure is about doubled by the influx of winter residents and tourists. Of the Gulf frontage for which protection is required, about one-eighth is publicly owned, including one Federally owned parcel 500 feet long.

Geologically, the shore line under study is one of emergence, with the numerous barrier islands and beaches having been formed in geologically recent times by the action of waves and currents. The low narrow keys are composed of recent marine deposits consisting of quartz, sand and shell in varying mixtures. Beach samples taken at about mean tide level had median diameters of from 0.2 to 0.3 millimeter after removal of shell, and a variable shell content ranging up to about 30 percent.

Tides in the vicinity of the study area are the mixed type, with mean and spring ranges averaging about 1.5 feet and 2.0 feet respectively. The maximum storm tide stage may have reached about 13 feet above mean low water, but storm tide stages exceeding 5 feet above mean low water are rare.

Available wind and wave data are insufficient to define accurately the characteristics of littoral drift within the study area. Past behavior of the passes between the islands indicates a dominance of southward littoral drift with the net rate of drift being relatively small, particularly in the northern reaches of the study area. Sources of drift material are apparently eroding areas along the Gulf shore and adjacent offshore bottom.

The major beach changes appear to result from severe storms which occasionally sweep across the Gulf and cause pronounced erosion of the beaches in the study area, the beaches being only partially restored by normal wave action during the periods between storms. Survey information before and after the 1950 hurricane indicated an average recession resulting from the storm of about 25 feet, about 10 feet of which was restored by normal wave action during the next 1 1/2 years. During the 1950 storm the tide reached a level of 5 feet above mean low water. The data indicate that a beach having a 60-foot width above mean high water and maximum elevation of 6 feet above mean low water should adequately protect developed property from severe storm damage. The usefulness of groins in the area is probably limited to holding the south end of a fill area near a pass between islands or to preventing erosion of the south end of an island by tidal currents.

The Division and District Engineer and the Beach Erosion Board concluded that the most suitable protective plan consists of providing or restoring, by artificial placement of sand, protective beaches generally 60 feet in width above mean high water along portions of the frontage of each of the four islands in the study area, with groins at the southerly ends of the islands. They found that the benefits from prevention of damages, increased value of property, and recreational benefits resulting from the proposed work warrant the adoption of a project for protection and improvement. They recommended that the United States participate in the initial cost of the project to the extent of one-third of the initial cost of protecting the publicly owned portions of the shores of the islands within the limits of the project area, plus the entire cost of protecting the Federally owned frontage on Sand Key.

The Chief of Engineers concurred generally in the views and recommendations of the Beach Erosion Board.

COMPLETED COOPERATIVE BEACH EROSION STUDIES

LOCATION	COMPLETED	PUBLISHED IN HOUSE DOC.	PUBLISHED IN CONGRESS
MAINE			
Old Orchard Beach	20 Sep 35		
NEW HAMPSHIRE			
Hampton Beach	15 Jul 32		
" "	14 Sep 53	325	83
MASSACHUSETTS			
South Shore of Cape Cod (Pt. Gammon to Chatham)	26 Aug 41		
Salisbury Beach	26 Aug 41		
Winthrop Beach	12 Sep 47	764	80
Lynn-Nahant Beach	20 Jan 50	134	82
Revere Beach	12 Jan 50	146	82
Nantasket Beach	12 Jan 50		
Quincy Shore	2 May 50	145	82
Plum Island	18 Nov 52	243	83
RHODE ISLAND			
South Shore (Towns of Narragansett, South Kingstown, Charlestown & Westerly)	4 Dec 48	490	81
CONNECTICUT			
Compo Beach, Westport	18 Apr 35	239	74
Hawk's Nest Beach, Old Lyme	21 Jun 39		
Ash Creek to Saugatuck River	29 Apr 49	454	81
Hammonasset River to East River	29 Apr 49	474	81
New Haven Hbr. to Housatonic R.	29 Jun 51	203	83
Conn. River to Hammonasset R.	28 Dec 51	514	82
Pawcatuck River to Thames River	31 Mar 52	31	83
Niantic Bay to Conn. River	11 Jul 52	84	83
Housatonic R. to Ash Creek	12 Mar 53	248	83
NEW YORK			
Jacob Riis Park, Long Island	16 Dec 35	397	74
Orchard Beach, Pelham Bay, Bronx	30 Aug 37	450	75
Niagara County	27 Jun 42	271	78
South Shore of Long Island	6 Aug 46		
Selkirk Shores State Park	21 Oct 53	343	83
Fair Haven Beach State Park	18 Jun 54		

NEW JERSEY

Manasquan Inlet & Adjacent Beaches	15 May 36	71	75
Atlantic City	11 Jul 49	538	81
Ocean City	15 Apr 52	184	83
Sandy Hook to Barnegat Inlet	24 Mar 54		

VIRGINIA

Willoughby Spit, Norfolk	20 Nov 37	482	75
Colonial Beach, Potomac River	24 Jan 49	333	81
Virginia Beach	25 Jun 52	186	83

NORTH CAROLINA

Fort Fisher	10 Nov 31	204	72
Wrightsville Beach	2 Jan 34	218	73
Kitty Hawk, Nags Head & Oregon Inlet	1 Mar 35	155	74
State of North Carolina	22 May 47	763	80

SOUTH CAROLINA

Folly Beach	31 Jan 35	156	74
Pawleys Is., Edisto Beach and Hunting Island	24 Jul 51		

GEORGIA

St. Simon Island	18 Mar 40	820	76

FLORIDA

Blind Pass (Boca Ciega)	1 Feb 37	187	75
Miami Beach	1 Feb 37	169	75
Hollywood Beach	28 Apr 37	253	75
Daytona Beach	15 Mar 38	571	75
Bakers Haulover Inlet	21 May 45	527	79
Anna Maria & Longboat Keys	12 Feb 47	760	80
Jupiter Island	13 Feb 47	765	80
Palm Beach (1)	13 Feb 47	772	80
Pinellas County	22 Apr 53	380	83

ALABAMA

Perdido Pass (Alabama Pt.)	18 Jun 54		

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(1) A cooperative study of experimental steel sheet pile groins was also made, under which methods of improvement were recommended in an interim report dated 19 Sep 1940. Final report on experimental groins was published in 1948 as Technical Memo. No. 10 of the Beach Erosion Board.

MISSISSIPPI

Hancock County	3 Apr 42		
Harrison County - Initial	15 Mar 44		
Harrison County - Supplement	16 Feb 48	682	80

LOUISIANA

Grand Isle	28 Jul 36	92	75
" "	28 Jun 54		

TEXAS

Galveston (Gulf Shore)	10 May 34	400	73
Galveston Bay, Harris County	31 Jul 34	74	74
Galveston (Gulf Shore)	5 Feb 53	218	83
Galveston (Bay Shore)	19 Jun 53	346	83

CALIFORNIA

Santa Barbara - Initial	15 Jan 38	552	75
Supplement	18 Feb 42		
Final	22 May 47	761	80
Ballona Creek & San Gabriel River (Partial)	11 May 38		
Orange County	10 Jan 40	637	76
Coronado Beach	4 Apr 41	636	77
Long Beach	3 Apr 42		
Mission Beach	4 Nov 42		
Pt. Mugu to San Pedro BW	27 Jun 51	277	83
Carpinteria to Pt. Mugu	4 Oct 51	29	83

PENNSYLVANIA

Presque Isle Peninsula, Erie (Interim)	3 Apr 42		
(Final)	23 Apr 52	231	83

OHIO

Erie County - Vicinity of Huron	26 Aug 41	220	79
Michigan Line to Marblehead	30 Oct 44	177	79
Cities of Cleveland & Lakewood	22 Mar 48	502	81
Chagrin River to Fairport	22 Nov 49	596	81
Vermilion to Sheffield Lake Village	24 Jul 50	229	83
Fairport to Ashtabula	1 Aug 51	351	82
Ashtabula to Penna. State Line	1 Aug 51	350	82
Sandusky to Vermilion	7 Jul 52	32	83
Sandusky Bay	31 Oct 52	126	83
Sheffield Lake Village to Rocky River	31 Oct 52	127	83
Euclid to Chagrin River	25 Jun 53	324	83

ILLINOIS

State of Illinois	8 Jun 50	28	83

WISCONSIN

Milwaukee County	21 May 45	526	79
Racine County	5 Mar 52	88	83

PUERTO RICO

Punta Las Marias, San Juan	5 Aug 47	769	80

HAWAII

Waikiki Beach	5 Aug 52	227	83

AUTHORIZED COOPERATIVE BEACH EROSION STUDIES

MASSACHUSETTS

PEMBERTON POINT TO GURNET POINT. Cooperating Agency: Department of Public Works.

Problem: To determine the best methods of shore protection, prevention of further erosion and improvement of beaches, and specifically to develop plans for protection of Crescent Beach, the Glades, North Scituate Beach and Brant Rock.

CONNECTICUT

STATE OF CONNECTICUT: Cooperating Agency: State of Connecticut (Acting through the Flood Control and Water Policy Commission)

Problem: To determine the most suitable methods of stabilizing and improving the shore line. Sections of the coast are being studied in order of priority as requested by the cooperating agency until the entire coast has been included.

NEW YORK

FIRE ISLAND INLET AND VICINITY: Cooperating Agency: Long Island State Parks Commission.

Problem: To determine the most practicable and economic method of providing adequate material to maintain the shore in a suitably stable condition and an adequate navigation channel at Fire Island Inlet.

N. Y. STATE PARKS ON LAKE ONTARIO. Cooperating Agency: Department of Conservation, Division of Parks.

Problem: To determine the best method of providing and maintaining certain beaches and preventing further erosion of the shore at Fair Haven Beach and Hamlin Beach State Parks, and the Braddock Bay area owned by the State of New York.

NEW JERSEY

STATE OF NEW JERSEY. Cooperating Agency: Department of Conservation and Economic Development.

Problem: To determine the best method of preventing further erosion and stabilizing and restoring the beaches, to recommend remedial measures, and to formulate a comprehensive plan for beach preservation or coastal protection.

DELAWARE

STATE OF DELAWARE: Cooperating Agency. State Highway Department.

Problem: To formulate a comprehensive plan for restoration of adequate protective and recreational beaches and a program for providing continued stability of the shores from Kits Hummock on Delaware Bay to Fenwick Island on the Atlantic Ocean.

NORTH CAROLINA

CAROLINA BEACH. Cooperating Agency: Town of Carolina Beach

Problem: To determine the best method of preventing erosion of the beach.

CALIFORNIA

STATE OF CALIFORNIA. Cooperating Agency: Department of Public Works, Division of Water Resources, State of California

Problem: To conduct a study of the problems of beach erosion and shore protection along the entire coast of California. The current studies cover the Santa Cruz, Orange County and San Diego areas.

WISCONSIN

KENOSHA. Cooperating Agency: City of Kenosha.

Problem: To determine the best method of shore protection and beach erosion control.

MANITOWOC-TWO RIVERS. Cooperating Agencies: Wisconsin State Highway Commission, Cities of Manitowoc and Two Rivers.

Problem: To determine the best method of shore protection and erosion control.

TERRITORY OF HAWAII

WAIMEA & HANAPEPE, KAUAI. Cooperating Agency: Board of Harbor Commissioners, Territory of Hawaii.

Problem: To determine the most suitable method of preventing erosion, and of increasing the usable recreational beach area, and to determine the extent of Federal aid in effecting the desired improvement.