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The History of the Beach Erosion Board, U.S. Army, Corps of Engineers, 1930-63

by
Mary-Louise Quinn

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PREFACE

This report is published to provide an accurate record of the 35-year history of the Beach Erosion Board (BEB), predecessor of the Coastal Engineering Research Center (CERC). The report discusses the events which led to the creation of the BEB, and the significant effects these events had upon the BEB's course of direction. Also included are references to the many people who contributed to the formation and implementation of BEB programs and the major theoretical and technological advances in coastal engineering.

The report was prepared by Mary-Louise Quinn, University of California, Berkeley, under CERC Contract DACW72-74-C-0011. Minor editorial changes were made in the copy submitted by the author to comply with standardized format requirements.

Several terms used in this report, as well as the general format, require some clarification. The Beach Erosion Board is referred to as an "agency" throughout the text. This term is used based on the dictionary definition of the word "agency" and is intended to carry no legal or official connotation. The Beach Erosion Board was comprised of a seven-member Board and a supporting staff. In this report, "Board" is generally used where specific reference is made to the seven-man Board; "Board's staff" is used when referring to the staff; the full name, Beach Erosion Board, or the acronym, BEB, is used when discussing the agency as a whole.

Although the term "coastal engineering" appears in many places in the report, it did not come into general usage until the beginning of the Coastal Engineering Conferences, some 20 years after the establishment of the BEB. The first of these conferences was held in October 1950. Morrrough P. O'Brien wrote the preface for the published proceedings of that Conference in which he stated that "Coastal Engineering is primarily a branch of Civil Engineering which leans heavily on the sciences of oceanography, meteorology, fluid mechanics, electronics, structural mechanics, and others." To this definition he appropriately added, "However, it is also true that the design of coastal works does involve many criteria which are foreign to other phases of civil engineering, and the novices in this field should proceed with caution."

Within the body of the report, no personal titles (with the exception of military ranks) have been used, a practice adopted by the American Society of Civil Engineers. In regard to military rank, the rank an officer held at the time his name is mentioned in the history is the rank used. Thus, the ranks of several officers who are mentioned in the text at different periods, will vary accordingly. Others will be mentioned at a rank lower than that which they eventually attained during their military careers.

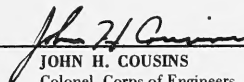
Numerous pieces of legislation and other documents related to the organization and functioning of the BEB are cited within the text; these items are quoted in full in Appendix A.

Over the years, many people have worked on the staff of the BEB. Unfortunately, there is no complete record of all former employees, so all their names could not be listed. Instead, organization charts are included in Appendix E which list as many names as possible. Moreover, charts were selected that best illustrate changes within the agency, such as increase in staff or reorganization.

Since the history could only have been written with the cooperation of many people, the author gratefully acknowledges some of those who were especially helpful. Mrs. Bennie Maddox and her staff in the CERC library assisted in obtaining source material. Mrs. Ellen Moore, CERC, also assisted in obtaining numerous useful items. Gerald Giefer, Water Resources Center Archives, University of California, Berkeley, allowed the use of their fine collection. The many people interviewed, whose names are listed in the report, all gave graciously of their time and provided a wealth of information, and a sincere thanks and appreciation are extended. The several people who reviewed sections of the paper while in draft form made many valuable suggestions, especially Joseph M. Caldwell, Martin A. Mason, Richard O. Eaton, Albert C. Rayner, and Ralph L. Rector. James J. Parsons, Geography Department, University of California, Berkeley, also offered constructive comments on parts of the draft. Thorndike Saville, Jr., Technical Director of CERC gave the author this opportunity and a free rein to write the history of the BEB as it unfolded through the research. For this freedom the author is truly grateful, but by the same token, accepts full responsibility for the format, content, and interpretation of this report. A special thank you is extended to Joe W. Johnson, George M. Watts, and Orville T. Magoon for their words of advice and encouragement.

Comments on this publication are invited.

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JOHN H. COUSINS
Colonel, Corps of Engineers
Commander and Director

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THE HISTORY OF THE BEACH EROSION BOARD, U.S. ARMY, CORPS OF ENGINEERS, 1930-63

by

Mary-Louise Quinn

1. Introduction.

This document presents the history of the Beach Erosion Board (BEB). Consisting of a seven-member Board and its staff, BEB was organized under the Federal Government's War Department (now the Department of Defense), U.S. Army, and was a part of the civil works program of the U.S. Army, Corps of Engineers. The life of the BEB spans a period of 33 years, beginning with its establishment in July 1930. In November of 1963, the BEB was abolished, and the Coastal Engineering Research Center (CERC) was created in its place. Thus, the history of the BEB ends with that date.

The purpose of this history of the BEB is to preserve for the future an accurate record of the evolution of the agency through time. The report consists of a discussion of the events which led first to the creation of the Board and thereafter guided or had significant effects upon the direction of its course. Also included in the history is reference to: The many people who contributed to the formation and implementation of BEB programs; and the major theoretical and technological advances made in the field of which the agency was such an integral part—that of coastal engineering.

Over the years, the BEB worked on a large number of beach erosion studies and research investigations. Rather than mentioning each one of these within the text itself, it was decided to single out a few of those deemed most illuminating in terms of the agency's development. (A list of all BEB official publications can be found in Appendix C.)

2. Early Developments which Preceded Establishment of the BEB.

Seldom does the history of a government agency begin on one specific date. While it is true that authorization in the form of an act of Congress or some other organizing action will indicate a day upon which all formal activities commenced, the real beginning may have been several months, years, or even decades before this official date.

The BEB was established in 1930. However, several separate but related developments which preceded the Board's formation laid the philosophical groundwork for the agency. These predecessor developments extend back varying lengths of time and fall under three general headings—seashore recreation, coastal theory, and organizational response to the erosion problem. These three topics are not mutually exclusive and by examining them one at a time, their interconnections will become more clear. The discussion of developments in each of these topical areas will be concerned largely with the State of New Jersey. This focus stems primarily from the fact that the New Jersey shoreline, being within reach of the large populations of the New York and Philadelphia metropolitan areas, was really the first to experience intense recreational development, with concomitant shore erosion problems.

As a result, New Jersey was the State most actively involved during those years when attention was becoming increasingly directed toward coastal matters. Massachusetts and North Carolina were also investigating the problem of erosion along their coastlines at around the same time, but did not assume comparative positions of leadership to the extent as did New Jersey.¹

a. The Growth of Seashore Recreation. The New Jersey coast was early recognized as a desirable place for seashore recreation. The first area to achieve prominence was Cape May in the latter half of the 18th century. Most of its early day visitors came from Philadelphia, traveling either by boat or across rough wagon roads. In later years, many of the leading families of Virginia and Maryland followed their Philadelphian counterparts to the beaches of Cape May. "By Civil War time," writes John Cunningham, "no resort in the nation matched the Jersey Cape—provided fashion and dignity and the fame of its guests were the criteria."²

The second location along the coast of New Jersey to become a popular seaside resort was Long Branch, some 10 miles south of Sandy Hook. Long Branch attracted its first summer vacationers in 1788.³ Early visitors to this resort came largely from New York.

A third and much later site was Atlantic City, a creation of the railroad, also with Philadelphia as its hinterland. The rail connection to Camden, New Jersey, just across the Delaware River from Philadelphia, was completed in 1854. Thenceforth, one of the Nation's most unusually located cities grew at an impressive rate. By the turn of the century, "the population of the island wasteland had soared from about 100 hardy beach squatters to about 28,000 full-time residents. Its real estate value—it was close to worthless in 1854—zoomed to more than \$50 million in 1900."⁴

After the Civil War, the New Jersey shore lost many of its southern patrons, but vacationers from other nearby areas replaced them. With the help of the extension of rail lines, especially from the north, the areas between Long Branch and Atlantic City and between Atlantic City and Cape May gradually became dotted with such resort communities as Beach Haven, Asbury Park, Sea Isle City, Wildwood, Bay Head, and many more. In addition to the railroad, another factor in this expansion of coastal development was the appearance of a new social group—the industrial millionaires of the post-Civil War era. Many of these people built large, expensive homes along the prestigious New Jersey shore. But some of the ocean-front communities established during this period had origins of quite a different kind—that of religious camp meeting grounds. One such town was Ocean Grove, some 6 miles south of Long Branch, which first attracted the attention of the Ocean Grove Camp Meeting Association in 1869.⁵

Thus, up to about 1900, the people enjoying the beaches of New Jersey were, with some exceptions, either: (a) Those who could afford it, both in terms of the financial expense and the time involved, or (b) those associated with religious groups. At that time, shore

recreation was a pleasure savored by a rather small segment of the U.S. population. One of the exceptions may have been those who traveled on the Sunday “Dollar Excursion” train which ran from Philadelphia to Atlantic City beginning in the 1890’s.

But life in America was undergoing many changes in the late 1800’s and these changes had a direct effect on the ocean front of New Jersey. One example was the shift from a predominantly rural to an urban society. In 1870, 25.7 percent of the 39,905,000 people in the United States lived in urban areas; in 1900 it was 39.6 percent of 76,094,000; and in 1920, 51.2 percent of 106,466,000 Americans lived in urban areas.⁶ With such a marked alteration in lifestyle, the out of doors acquired a connotation quite different from what it had been during the days of a largely rural society. Increasingly, a trip to the country, the mountains, or the seashore meant going on a pleasure trip—an excursion to take one away from the press of city life.

This shift to the city had been, in part, a result of the great expansion of industrialization which occurred in this country following the Civil War. The poor working conditions and low wages that existed during this postwar period prompted the growth of labor unions. Gradually, the number of working hours lessened and wages advanced. In time, an occasional day set aside for leisure became something other than the monopoly of the well to do.

But the real boon to shore recreation was the increased use of the automobile. Although the first automobiles were largely objects of sport for the wealthier groups, the efforts of industrialist Henry Ford helped breach this exclusiveness by introducing a low-cost car, which became available to more and more people after around 1910.⁷ This new mode of transport acted as an incentive for the improvement of roads and the construction of bridges to the barrier islands off the coast of New Jersey. The combination of these several events set the scene for the influx of many more vacationers to the beaches of New Jersey for a day, a weekend, or a summer in the sun and the surf. Moreover, the automobile allowed beach recreationists to fan out along the entire shoreline, rather than concentrate in a few specific locations. This encouraged the development of the then largely empty stretches of shore interspersed between the main resort cities. John Cunningham has written that, “the automobile democratized Barnegat Peninsula.”⁸ Indeed, the automobile democratized virtually the entire New Jersey shore, and many other coastal recreation areas as well.

More shore vacationers meant the growth of more permanent facilities along the coastline of New Jersey which, in turn, was accompanied by increased land values. Along this 130-mile-long coast, the interaction between ocean waves and beach had been occurring since time immemorial. The movement of sand, in accordance with wind, wave, and current conditions, had always resulted in both beach accretion and beach erosion at various points.⁹ Now, however, with the new and growing dollar value of shore sites, the latter process in particular—beach erosion—became a serious problem. Thus, by the 1920’s, and even considerably earlier in some areas, a different situation had evolved based upon the emergence of the following two important considerations.

(1) *A new interpretation of the shore.* It was not the physical factors operating upon the coastline which had undergone a dramatic change but rather man's perception of them. The beach was now more than an accumulation of sand. It was a recreational resource and a producer of profit. Increasingly, the ocean generally, and the waves in particular, became depicted as "enemies"—threats which had to be controlled to the greatest extent possible.¹⁰

(2) *The dollar value of permanent buildings and other facilities, and, later, of land itself.* The construction of roads, hotels, restaurants, pavilions, and boardwalks attracted additional vacationers and vacationers' dollars to a given stretch of beach. Such a combination resulted in even-greater values being placed on coastal land, e.g., in 1922 the assessed value of the ribbon of land along the entire New Jersey coast was over \$300 million.¹¹ The 10 years which followed saw tax rates for that same shore property exceed the \$550 million mark, or about \$4 million a mile of beach.¹²

As Cunningham so aptly stated, "Without giant hotels and boardwalks set rigidly in place, erosion wouldn't matter one bit. . . . Indians who visited the shore each summer centuries ago didn't worry about the shifting sand."¹³

b. Changes in Coastal Theory. The loss of valuable property as a result of beach erosion brought a great deal of attention to the problem. Newspapers of the time, as well as the more technical literature, were replete with articles and pictures describing the destruction which followed severe storms. Reference was often made to the paucity of basic knowledge of coastal processes, a situation which fostered dependence on the trial-and-error method in dealing with the problem.*

Efforts were made to find a reason which would explain why beach erosion had apparently become so severe over what seemed to be a short period of time, creating almost emergency conditions at some locations. As is sometimes the case when a natural process becomes a "problem" which has been culturally accelerated, many of the people immediately involved were too close to the situation to be able to take an objective view. Thus, rather than seeing coastal erosion as a natural phenomenon and taking full cognizance of this fact when developing shore sites, some other explanation was sought—some broad-scale alteration in nature—to account for this force which was now destroying valuable property. The explanation which became widely accepted was that of a general subsidence "at a rate of 1 to 2 feet per century" of the Atlantic coast of the United States, and in particular the coast of New Jersey.¹⁵ It was theorized that the slowly sinking coastline was allowing waves to impinge farther landward than they had been in earlier

*For example, an article by Henry S. Sharp appearing in *The Scientific Monthly* in July 1927, contained the following comment:

"Conditions vary so widely from place to place that rule-of-thumb methods are sure to give a large percentage of failures, and a structure successful at one place may be a dismal failure at another. On the other hand, the engineer who wishes to attack his problem scientifically finds that science has done very little to help him. He is almost entirely without trustworthy facts, and must work up his data from hasty studies of his own."¹⁴

decades. This reasoning freed Man from having to answer for his own participation in the problem at hand—he became just an innocent victim of the “caprices” of nature. Moreover, it is likely that it impeded an understanding of the basic factors involved in beach erosion.

An early opponent to the subsidence theory was Douglas W. Johnson, professor of geology at Columbia University and author of *Shore Processes and Shoreline Development* (1919). In a paper written jointly with Warren Smith dated May 1914, Johnson discussed what he believed to be the “fallacy of this reasoning.”¹⁶ Johnson, along with several others, later worked on the problems of sea level change and coastal stability as part of a study under the auspices of the National Research Council. In 1929, this group published a report¹⁷ which tended to discredit (but only temporarily) the theory of coastal subsidence.* This work may well have eased the way for development of a more realistic approach to the problem of coastal erosion.

To illustrate how the attempt to find a broad-scale explanation for shore erosion was related to efforts to combat the problem, a study (to be discussed more fully under the next heading) undertaken by the Engineering Advisory Board on Coast Erosion of the State of New Jersey in 1922, set out to answer two fundamental questions: First, “have there been changes in the conditions that are tending to erode the coast either along its entire length or locally?”²⁰ This group arrived at the following answer:

“In so far as can be seen we have no evidence of such changes if we consider the word change to mean a definite and permanent transition from one state to another, traceable to some clearly defined cause.”²¹

Thus, in this case, the idea of an overall change in coastal conditions had to be resolved before this study group could deal with the second question, “are there any key works such as heavy riprap jetties that could be placed at localities that would tend to correct any destructive currents along the coast?”²²

c. *Organizational Response to the Erosion Problem.* It was soon realized that the efforts of individual property owners were totally incapable of coping with the problem of coastal erosion—that a broader based approach was necessary. For example, a series of three severe storms struck the New Jersey coast in rather quick succession during the winter of 1913-14. Commenting on the situation in their article referred to above, Johnson and Smith concluded:

*Johnson’s conclusions on coastal subsidence were based on data that had been obtained during a period when the sea level fluctuations along the east coast of the United States, and especially in the New York area, did suggest general stability.¹⁸ His argument against coastal subsidence, therefore, seemed quite sound at the time. However, starting about 1930, a definite rise in sea level began, and the secular trend ever since has been that of a sea level which is slowly rising in relation to the land.

In regard to coastal erosion, this gradual increase in the level of the sea is now generally thought to be of lesser importance. (It must, however, be considered in the construction of coastal projects which are planned to extend over long periods of time.) As expressed by Steacy Hicks, “The dramatics of surf and longshore currents in the beach erosion process overshadows the small but relentless changes in sea level over years and decades.”¹⁹ Thus, Johnson’s basic belief was correct—that factors other than coastal subsidence accounted for the immediate problem of beach erosion.

“So long as the defence of the land is in a large number of hands and every landowner is practically free to do as little or as much as he pleases toward preventing the sea from gaining access to his property, many must suffer from the failure of a few to take proper precautions against marine erosion. As soon as the sea finds a point of weakness in the defences, it rapidly widens the breach and attacks adjoining property on either side. In some places where the bulkheads in front of one man’s property resisted the direct attack, the property was badly damaged by erosion from one or both sides after the sea had entered neighboring lots. Some method of government supervision of marine defences would seem to be the only satisfactory solution of this serious problem.”²³

Individual landowners, as well as local shore communities, were expending, in the aggregate, millions of dollars for uncoordinated and often totally inappropriate structures in an attempt to combat erosion. Furthermore, the effects of these structures were often either negligible at best or, as in many cases, even exacerbated the problem.

The New Jersey State Board of Commerce and Navigation was very much aware of the situation. For several years before 1922 this agency had stressed, in its annual reports to the State legislature, “the importance of the protection of the New Jersey beaches, realizing their tremendous value to the State and to the nation at large.”²⁴ In that year, the New Jersey Legislature appropriated money for a formal investigation of the changes taking place along the Jersey shore. It also called for a determination, “if possible, (of) the best means of preventing further encroachment. . . .”²⁵ This investigation marked one of the first organized and concerted efforts in this country to study coastal erosion on a regional basis.* It also included participation of the Federal Government including, to a minor degree, the U.S. Army, Corps of Engineers.

The Board of Commerce and Navigation delegated this task to a specially appointed group—the Engineering Advisory Board on Coast Erosion mentioned previously. The State of New Jersey sought and received the cooperation in this study of both the U.S. Department of Commerce and the U.S. War Department. The Department of Commerce permitted Comdr. Raymond S. Patton, then Chief of the Division of Charts of the U.S. Coast and Geodetic Survey, to both prepare maps of the New Jersey coastline and to be a member of this Engineering Advisory Board. The War Department provided records of coastal changes. It also permitted two U.S. Army, Corps of Engineer officers to meet with the Board in an advisory capacity.²⁷ These officers were Col. Earl I. Brown and Col. E. Eveleth Winslow; then upon Winslow’s retirement, Col. H.C. Newcomer.

The other members of the New Jersey Engineering Advisory Board, in addition to Comdr. Patton, were Charles W. Staniford, former Chief Engineer of the New York City Dock Department; B. F. Cresson, Jr., Consulting Engineer for the New Jersey Board of

*The New Jersey Harbor Commission, predecessor to the New Jersey State Board of Commerce and Navigation, had also investigated beach problems along that State’s coast, and in 1915, urged that some form of comprehensive plan be adopted to better deal with the situation.²⁶

Commerce and Navigation, who served as Board chairman; Victor Gelineau, Director of the New Jersey Board of Commerce and Navigation; Harrison P. Lindabury, Henry J. Sherman, and Edward J. Murphy, all of the New Jersey Board of Commerce and Navigation. Secretary for the group was Edward H. Russell, also of the same State agency. This Engineering Advisory Board performed its work in a systematic manner and after a year's time produced a thorough report entitled, "Report by Board of Commerce and Navigation on the Erosion and Protection of the New Jersey Beaches—1922."

The Board reconvened the next year (Victor Gelineau now served as chairman) and continued its study of coastal changes, including resurveys of beaches examined previously. This work resulted in a second publication, "Report on Erosion and Protection of New Jersey Beaches—1924."

In the meantime, Douglas Johnson was pursuing his interest in coastal matters, having been instrumental in the formation of a Committee on Shoreline Studies under the Division of Geology and Geography of the National Research Council in Washington, D.C. In addition to Johnson, who served as first chairman, the other initial members of this Committee were Isaiah Bowman, Director, American Geographical Society, and Nevin M. Fenneman, Professor of Geology and Geography, University of Cincinnati. By April 1923 this Committee had added to its study program "the general field of shoreline physiography and engineering."²⁸ A few years later, a fourth member joined the Committee—Comdr. Raymond S. Patton of the U.S. Coast and Geodetic Survey. This group's increased activity in shore erosion matters was based on three main considerations: "(a) The great social and economic importance of the beaches of our [the U.S.] Atlantic and Gulf coasts; (b) the constant attrition of valuable lands which in many localities is resulting in large economic losses, and in some cases threatened the continued existence of communities; and (c) the present empirical basis of engineering practice in shore protection, which has been found inadequate to meet the situation."²⁹

As part of its investigation, the Committee undertook a survey of opinion regarding some form of organized effort to deal with coastal problems. In May 1926, it

"sent out a circular letter to some two hundred addresses along the Atlantic and Gulf coasts, stating its conception of the problem, making certain specific inquiries regarding conditions along the different sections of the coast, and requesting an expression of opinion as to the feasibility of securing public support for the cooperative study which the Committee had in mind."³⁰

Although overall response was favorable, it was the officials from the State of New Jersey who "evidenced a keen and constructive interest in the Committee's inquiries."³¹ Mr. J. Spencer Smith, president of the New Jersey State Board of Commerce and Navigation took up the Committee's project with New Jersey Governor A. Harry Moore. The outcome was that "Governor Moore invited the Governors of the other Atlantic and Gulf Coast

States to appoint delegates to a meeting to consider the subject.”³² A group of 85 delegates, representing 16 states, met at Asbury Park on October 14 and 15, 1926. From this meeting and two others which followed shortly thereafter—one in Norfolk, Virginia, and the latter in Washington, D.C.,—emerged an organization known as the American Shore and Beach Preservation Association (ASBPA). This Association was thus a direct outgrowth of the efforts of the Committee on Shoreline Studies (by then known as the Committee on Shoreline Investigations of the Atlantic and Gulf Coasts) of the National Research Council. A going concern as of December 8, 1926, the new organization expressed its purpose in these terms:

“This Association is formed in recognition of the fact that our coasts and the shores of our lakes and rivers constitute important assets for promoting the health and physical well-being of the people of this nation; that their contiguity to our great centers of population affords an opportunity for wholesome and necessary rest and recreation not equally available in any other form.

“The purpose of the Association is to bring together for cooperation and mutual helpfulness the many agencies, interests and individuals concerned with the welfare of these lands, and in all legitimate ways to foster that sound, far-sighted and economical development and preservation of the lands which will aid in placing their benefits within the reach of the largest possible number of our people, in accordance with the ideals of a democratic nation.”³³

Officers for the first year were:

President

J. Spencer Smith, President, New Jersey State Board of Commerce and Navigation.
(Smith continued as president of the ASBPA until his death in 1953.)

Vice President

Marcel Garsaud, General Manager, Board of Commissioners of the Port of New Orleans.

Secretary

Comdr. Raymond S. Patton, then Chief, Division of Charts, U.S. Coast and Geodetic Survey.

One of the early objectives of the ASBPA, as stated by Comdr. Patton, was to “induce the states to accept the principle of public interest in these beaches,”³⁴ and to become actively involved in their preservation. This objective reflects the Commander’s thinking on the issue of responsibility for shore protection.* In an address before the ASBPA at its first official meeting on December 8, 1926, Patton expressed the view that the State was “the logical political unit through which our (the Association’s) purposes can best be

*Patton was aware of the need for basic data concerning coastal processes, and often, during his addresses to the ASBPA, stressed the importance of research.

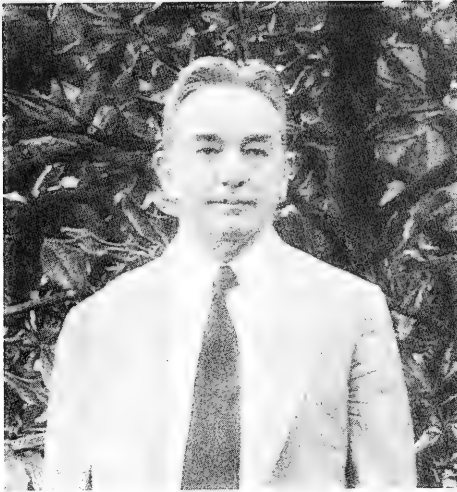


Figure 1. Douglas W. Johnson, a geologist at Columbia University who was greatly interested in shoreline processes.



Figure 2. Rear Adm. Raymond S. Patton, an officer in the U.S. Coast and Geodetic Survey who was actively involved in early efforts to understand, and cope with, the problems of coastal erosion.

accomplished.”³⁵ He believed that the Federal Government did not belong “prominently in the picture.” Furthermore, he considered erroneous the argument that if the Federal Government did assume this responsibility, the Association’s objectives would be accomplished “at a great reduction in the cost to the local communities.”³⁶ Rather, Patton believed that as a result of compromises and a desire on the part of Congress not to favor one section of the country over another, the Congressmen from the coastal States might get funding for coastal projects but only by agreeing to support equal amounts of funding for noncoastal States to finance *their* own projects. By such a process, there would be no savings.

Whether such an opinion on this issue was right or wrong is a moot question now. The point here is that, for a while, the ASBPA adhered to the general philosophy of State responsibility for shore protection but, in time, pursued a course based on quite a different viewpoint. The position later taken by the Association regarding the role of the Federal Government in coastal erosion problems was to have a direct effect on the BEB.

One further important organizational development preceded the formation of the BEB. In January 1929, the Chief of Engineers, by way of Special Order No. 6, set up a board composed of four officers of the U.S. Army, Corps of Engineers.* The purpose of this board was to “investigate and report on the subjects of sand movement and beach erosion at such localities as may be designated by the Chief of Engineers;”³⁸ hence, it became known as the Board on Sand Movement and Beach Erosion (BSMBE). The members of this Board were Col. William J. Barden, Senior Member; Col. George B. Pillsbury; Lt. Col. Elliott J. Dent; and Maj. Brehon B. Somervell, who served as recorder. Other officers from the U.S. Army, Corps of Engineers were authorized to attend meetings when discussion centered on problems in their Districts. The Board was also authorized to call upon the advice of qualified civilians involved in coastal work. Appointed for this purpose were Douglas W. Johnson of Columbia University, and Thorndike Saville, then of the University of North Carolina, who was also Chief Engineer for the North Carolina Department of Conservation and Development.

The BSMBE held periodic meetings, several of which were at the sites of particular coastal problems then under consideration, so as to allow field inspection (see Figs. 3 and 4). The shoreline problems that this Board examined were those related to, or stemming from, the coastal navigation works of the U.S. Army, Corps of Engineers, along with problems occurring on Federally owned shore property. A number of investigations thus involved military reservations along the Atlantic and Gulf coasts. The jetty at Fort Tilden near Rockaway Point on Long Island, New York, was one such case. The jetty had been designed to protect Ambrose Channel, the entrance to New York Harbor, from shoaling caused by extension of a sand spit. However, the area was still experiencing difficulties.

*The Chief of Engineers had been keeping informed of the activities of the ASBPA. Moreover, certain Corps officers had become actively involved in the study of beach erosion and were anxious to have set up a board of this type.³⁷



Figure 3. U.S. Army, Corps of Engineers, Board on Sand Movement and Beach Erosion examining jetty at Cold Spring Inlet (Cape May Harbor), New Jersey, 10 May 1929.



Figure 4. Lt. Col. Elliott J. Dent at Cold Spring Inlet (Cape May Harbor), New Jersey, 10 May 1929.

In keeping with its designated *raison d'être*, the Board authorized a number of field studies. The purpose of these efforts was to help overcome the lack of basic data on coastal phenomena. Douglas Johnson prepared the first plan for these field studies, which included some 30 different experiments.³⁹

Two field sites were set up along the coast of New Jersey—one at Long Branch and the other at Seaside Heights. These locations were selected because they met the experimental requirements for long, straight sections of beach, uninfluenced by tidal currents.* Morrough P. O'Brien, then Assistant Professor of Mechanical Engineering at the University of California, Berkeley,⁴⁰ and 1st Lt. Leland H. Hewitt were placed in charge of these projects. The fieldwork suggested by Johnson and agreed upon by the BSMBE was begun in May 1929 and extended through September 1930. This program included measurements of waves, winds, currents, tides, beach profiles, sand samples, and tracer studies. It was during these experiments that the current velocity meter designed by George B. Pegram of Columbia University was first used.⁴¹ (See Fig. 5.) Also, a catalog of the groins and other similar structures between Sandy Hook and Cape May was started. Surveys were made around a number of these structures to provide a base line for relating subsequent shoreline changes to waves and winds.

Members of the first field party were mostly engineering students seeking work during the summer months. Willing to tackle any assignment, they engaged in such activities as: Taking soundings using stadia boards in 10 feet of water; observing sand movement by sitting on the bottom wearing a diving helmet, with air pumped from above; sampling sand in suspension in the surf zone; and others. (See Fig. 6.) To quote O'Brien, "They were young, fearless, and motivated and much was done."⁴²

Semimonthly progress reports of these basic research activities were prepared and sent to the BSMBE for its review. This fieldwork provided much of the information which was later incorporated into the first research report of the BEB,⁴³ to be discussed subsequently. Moreover, these studies were among the first Federal program of research on the dynamics of coastal processes to be conducted in this country,⁴⁴ and helped place the United States in the forefront of what was to become a field of worldwide importance—coastal engineering.

Another part of the research performed under the auspices of the BSMBE was a study of sand origins along the New Jersey and south Long Island shores. This was done under contract by R. J. Colony, a professor in the Department of Geology and Mineralogy, Columbia University. His report, submitted in December 1930, established findings which still hold true today.⁴⁵

BSMBE members also recognized the need for an assemblage of the literature pertaining to coastal matters, a further reflection of the pioneering stage which the field was in at that time. Henry E. Haferkorn, librarian at the U.S. Army Engineer School, Fort Humphreys

*It was later discovered that the Seaside Heights location was affected by a shipwreck offshore.

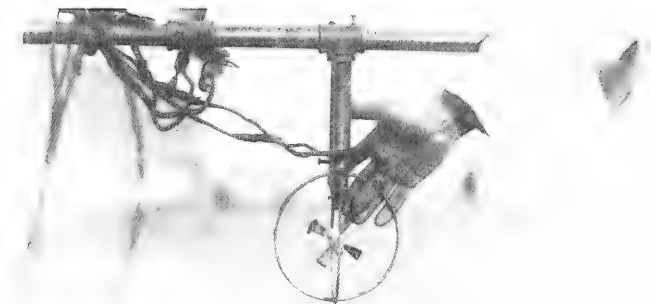


Figure 5. Early current velocity meter designed by George B. Pegram. Meter is shown here mounted on a brass rod.

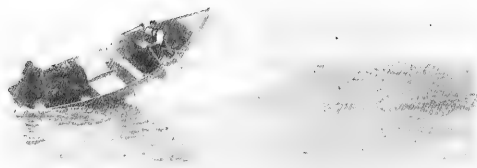


Figure 6. Surf boat and rodman participating in fieldwork performed under the auspices of the Board on Sand Movement and Beach Erosion, 28 June 1929.

(now Fort Belvoir), Virginia, provided an initial listing when, in 1929, he compiled a "Bibliography on Sand Movement and Beach Erosion." Copies of this listing were distributed to the members of the Board, as well as to other interested parties. Shortly thereafter, Haferkorn expanded this work into a 114-page book entitled, "Sand Movement, Beaches and Kindred Subjects—A Bibliography."

During the short period of its existence, this small Board, composed of Army engineers and civilian consultants, established a tradition of scientific inquiry that was continued and expanded by the BEB. These early investigators were true pioneers seeking knowledge on a new frontier. Moreover, a coterie of personnel had begun to form that was to lend both creativity and guidance to the youthful field which was to become known as coastal engineering.

3. The Beach Erosion Board—Its Creation and Formative Years.

Within a year after its organization in 1926, the ASBPA was seeking a way "to have the Federal government assume the function of unifying and coordinating the efforts of the several states."⁴⁶ Congressional supporters of the association were working on a bill that would provide this participation. Success came a few years later. Section 2 of Public Law 520, 71st Congress, approved on July 3, 1930, gave authority to the Chief of Engineers, U.S. Army, to have made, in cooperation with the appropriate agencies of the various coastal States, investigations and studies aimed at "devising effective means of presenting erosion of the shores of coastal and lake waters by waves and currents."⁴⁷ The funding provision for these investigations and studies was, "that no money shall be expended under authority of this section in any State which does not provide for cooperation with the agents of the United States and contribute to the project such funds and/or services as the Secretary of War may deem appropriate and require, . . ."⁴⁸ In this regard, the policy which was adopted was that the local group requesting the study supply one-half the expenses (in funds or services) and that the Federal Government would supply the other half. This was for the *study* only and did not include moneys for construction of shore protection structures.

This legislation also stated that:

"there shall be organized under the Chief of Engineers, United States Army, by detail from time to time from the Corps of Engineers and from the engineers of State agencies charged with beach erosion and shore protection a board of seven members, of whom four shall be officers of the Corps of Engineers and three shall be selected with regard to their special fitness by the Chief of Engineers from among the State agencies cooperating with the War Department."⁴⁹

This board was to furnish technical assistance in the conduct of the above studies, review the reports of the investigations made, and where deemed necessary, make firsthand examinations of the localities under study.

On September 18, 1930, in accordance with Special Order No. 72, issued by the Office of Chief of Engineers, this board came into official existence and was given the name, Beach Erosion Board. Its original membership consisted of the following: (Corps officers*) Col. William J. Barden, Senior Member; Col. Earl I. Brown; Lt. Col. Elliott J. Dent; Maj. Gordon R. Young; (State agency engineers) Richard K. Hale, Associate Commissioner, Department of Public Works, Massachusetts; Victor J. Gelineau, Chief Engineer, New Jersey State Board of Commerce and Navigation; and Thorndike Saville, Chief Engineer, Department of Conservation and Development, North Carolina. (A list of these and all subsequent members of the Beach Erosion Board can be found in Appendix B.) 1st Lt. Leland H. Hewitt was assigned to act as Recorder for the Board. (Fig. 8 is a picture of the members of the first BEB.) The names of most of these first BEB members have been mentioned previously in this history, suggesting a continuity among the concerned with beach problems. This continuity, particularly of Board members from State agencies, persisted throughout the BEB's entire existence and proved to be a factor of great importance.

With the creation of the BEB, the BSMBE ceased to exist. The BEB continued the BSMBE's work on basic shore processes; the BSMBE's other function—examination of shore problems on Federal property and problems related to the coastal navigation works of the Corps of Engineers—was assumed by a second new board, the Shore Protection Board. The Shore Protection Board was also created by Special Order No. 72, and its four all-military members were the same men as the four military members of the BEB. Although the scope of the work of these two Boards differed to some degree, there was a general interchange between them regarding basic problems of mutual concern. They also shared the same staff. The Shore Protection Board continued as a separate entity until May 1946 when it was abolished and the BEB absorbed its function.⁵²

The establishment of the BEB was, therefore, the result of action taken by the ASBPA which, in turn, owed its formation to the activities of a committee of the National Research

*Coastal engineering, as in later years the field came to be known, was in an experimental stage at the time the Beach Erosion Board was organized in 1930. Knowledge concerning coastal processes and shoreline problems was not only quite limited *in toto* but was also restricted in its general distribution among professional people. During these early years, the military members of the Board were closely involved in the scientific aspects of coastal inquiry. The same had been true of the all-military membership of the Board on Sand Movement and Beach Erosion. This fact can be exemplified by citing a few of the published works of several of these early U.S. Army, Corps of Engineer officers.

Col. Earl I. Brown's "Inlets on Sandy Coasts," which appeared in the *Proceedings of the American Society of Civil Engineers* in 1928, has been referred to as "apparently . . . the first analytical treatment of the hydraulic regimen of inlets on sandy coasts."⁵⁰ Brig. Gen. George E. Pillsbury published in November 1939 a book entitled, *Tidal Hydraulics*. This work is still regarded as a basic reference on that subject. Col. Elliott J. Dent had long been an astute observer of shore processes. As early as 1916, he published an article in the *Transactions, American Society of Civil Engineers*, entitled, "The Preservation of Sandy Beaches in the Vicinity of New York City." This article reveals Dent's appreciation of the need to discover the *causes* of beach erosion, in order to devise effective means of prevention. He stated, "Some explanation as to why existing structures have failed should be forthcoming before we are asked to place our faith in additional work so nearly like the old that we are unable to see any essential difference."⁵¹

In the decades that followed, interest in coastal processes became more dispersed, especially among the various universities and research institutions. Thus, the civilian component began to play a greater role in the field of coastal engineering than it had during these formative years.

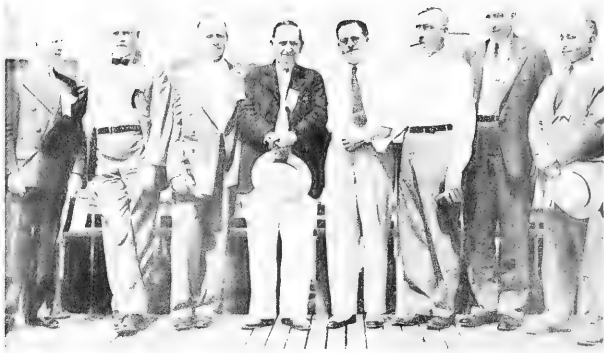


Figure 7. Delegates attending meeting of American Shore and Beach Preservation Association in New Jersey, July 1935. Left to right: Col. E. D. Ardery, U.S. Army, Corps of Engineers, New York; Col. Elliott J. Dent, Member, Beach Erosion Board; Senator Charles C. Reed, Cape May County, New Jersey; Victor Gelineau, Member, Beach Erosion Board; F. E. Schmitt, editor of *Engineering News-Record*; J. Spencer Smith, President, ASBPA; and Lt. Col. John Schulz, U.S. Army, Corps of Engineers, New York.

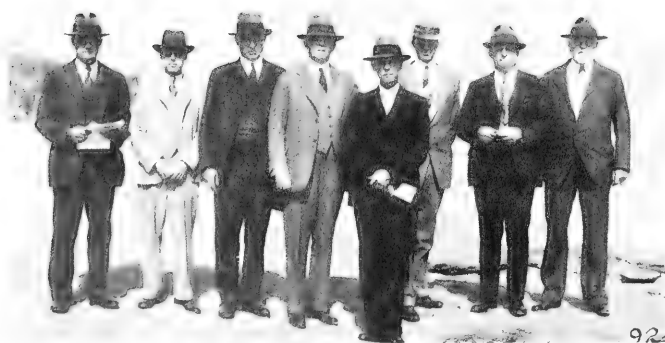


Figure 8. Members of the first U.S. Army, Corps of Engineers, Beach Erosion Board on an inspection tour at Fort Fisher, North Carolina, October 1931. Left to right: 1st Lt. Leland Hewitt (at that time serving as Recorder for the Board but was not a member); Thorndike Saville; Richard K. Hale; Col. Earl I. Brown; Col. William J. Darden; Maj. Gordon Young; Victor Gelineau; and Lt. Col. Elliott Dent.

Council's Division of Geology and Geography. In fact, in its annual report for 1930-31, this National Research Council Committee on Shoreline Investigations of the Atlantic and Gulf Coasts commented on the creation of the BEB and expressed the hope that "a solution of the engineering problems is now in sight."⁵³

It is interesting to note how the ASBPA described its reasons for supporting efforts to create the BEB. An Association brochure dated January 1939 states that the Association's early studies concluded:

"That a centralized agency of high authority must be set up, an agency endowed with resources for general and particular studies, an agency possessing a highly trained scientific and engineering personnel; that this must be a federal body; that the United States Corps of Engineers had these qualifications, as no other body had, but that they were limited by law to consideration of harbor works and aids to navigation; therefore, that new legislation must be obtained, extending the province of that Corps to include the field of shore protection."⁵⁴

This excerpt illustrates the Association's departure from the concept of State responsibility, to that of Federal responsibility for shore protection commented upon earlier. Moreover, the ASBPA suggests here that the U.S. Army, Corps of Engineers possessed special qualifications in coastal engineering *per se*. While it is certainly true that for many years the Corps of Engineers had been closely involved with harbor and navigation works and even in some shore protection works, and had developed considerable expertise in these activities, yet in 1930, many of the scientific aspects associated with coastal engineering were still largely in an experimental stage. Few realized this fact better than the members of the BEB, and this realization accounted for their intense desire to continue the basic research begun by the BSMBE. It seems, therefore, that the ASBPA had begun to see the BEB as other than a "unifying and coordinating" centralized agency. Rather, the Association gradually came to regard the BEB (and the Corps of Engineers generally), as a possible source of Federal funding to assist in the construction of shore protection structures at public beaches.

The ASBPA's position in this matter was based on the fact that it viewed public beaches as a resource of all the people of the Nation, and a resource that was now being increasingly used by vacationers who lived beyond the boundaries of the coastal States. Thus, by the early 1930's, the ASBPA had come to believe that the responsibility for protecting and preserving these beaches should be shared by the Federal Government rather than leaving it solely to the individual States where the beaches were located.⁵⁵ To meet this responsibility, the Association felt that the Federal Government should provide financial assistance for construction of the necessary protective structures. In the years following the formation of the BEB, the ASBPA worked steadily toward attaining this goal, and its efforts had a definite effect on the history of the Board.

As stated in Special Order No. 72, the BEB was to “assemble at such times and places as may be designated by the Senior Member, . . .” It held its first meeting on December 22, 1930, in the Army Building in New York City. During the period 1931 through 1939, the Board met a total of 55 times, with an average of some six meetings per year. The Board set up headquarters in the Navy Building, Washington, D.C., initially being housed with the Corps’ Washington District,* “in order to facilitate administrative support.”⁵⁶

The BEB’s early years were rather frugal ones. Funds to cover operating expenses came from appropriations “for examinations, surveys and contingencies for rivers and harbors.” By June 1937, 7 years after its formation, the BEB had been allotted a total of only \$160,900.21,⁵⁷ and part of these funds was shared with the Shore Protection Board. The three civilian members of the seven-man Board, as engineers from State agencies and thus salaried employees in this capacity, received no compensation from the Federal Government, except for travel expenses connected with Board duties. (This provision was changed in 1960.) Because research work was not specifically included in the 1930 legislation, funding for this activity had to be secured indirectly through the Shore Protection Board,⁵⁸ which, because it had been created by the Chief of Engineers rather than by Congress had somewhat more flexibility.

One of the initial organizational tasks was the employment of a small civilian staff for the BEB. This staff was to carry out the various technical activities for the Board and to render assistance in coastal matters to the echelons of the Corps of Engineers in behalf of the Board. In mid-1931, this staff consisted of two engineers and a stenographer. The Board’s first civilian engineer was Jay V. Hall, Jr., who joined the agency in January 1931.⁵⁹ During this early period, Mr. Hall worked primarily at the wave tank facility, first at Fort Humphreys (now Fort Belvoir) and then at the Dalecarlia Reservation. (The Dalecarlia Reservation is a U.S. Army, Corps of Engineers reserve located at the western corner of Washington, D.C. It consists of lands adjoining the Dalecarlia Reservoir, the main water supply reservoir for Washington, D.C.) Mr. Hall remained on the BEB staff during the agency’s entire 33-year existence. After 1963, Hall continued to work for the BEB’s successor agency, the Coastal Engineering Research Center, until his death in 1966.

The position of senior civilian engineer was first held by Ralph G. Davis. Davis transferred to the BEB from the Wilmington, Delaware District of the U.S. Army, Corps of Engineers in July 1931.⁶⁰

Ethyl L. Sweet was the Board’s first stenographer. Miss Sweet came to the BEB in December 1930⁶¹ and remained on the staff for the next 12 years.

Up to about 1940, the military officer who served as Recorder for the seven-member Board was also administratively in charge of the Board’s staff, serving as coordinator between the two. From October 1930 to August 1934, 1st Lt. Hewitt was assigned these dual responsibilities. The title of the officer who headed the staff was eventually changed to Resident Member. After 1940, there were several occasions when the Resident Member of

*The Washington District of the Corps of Engineers has since been abolished and its work absorbed by the Baltimore District.

the staff was also the Senior Member of the seven-man Board.* From its inception, therefore, the BEB and its staff was composed of both military and civilian personnel, with a military officer in charge.

Another early requirement for the new Board was the establishment of general policies in regard to its assigned activities as stated in Public Law 520. As with many working groups set up by way of a legislative act, it was the interpretation of duties which proved to be a key factor. The "investigations and studies," conducted in cooperation with requesting State agencies, were begun almost immediately.** Moreover, the BEB gave prompt attention to the continuation of several of the experiments begun by the BSMBE, along with a summation of the findings of those already completed. As was mentioned previously, this work resulted in the BEB's first research publication, *Interim Report of Beach Erosion Board*, April 15, 1933. This report was

"to place the information obtained . . . up to the present time, in such form that it may be conveniently referred to by those interested in the subjects of beach erosion and shore protection; to summarize the investigations already made; and to provide a guide for the future studies of the boards."⁶³

The publication of this first *Interim Report* was an important event for it helped establish the BEB as an early leader in the field of coastal research. It was distributed both in the United States as well as abroad.*** The report was additionally noteworthy for the fact that it was written personally by the members of the Board who, at that time, were the original seven appointees.

BEB members also worked to broaden the search for basic data. Upon the recommendation of Col. Dent, the Shore Protection Board, at its first meeting, authorized expenditure of approximately \$1,500 to construct a wave tank facility at Fort Humphreys (now Fort Belvoir), Virginia, some 30 miles south of the Capital.⁶⁵ When completed in October 1932, this tank measured 24 feet long, 12 feet wide, and had an effective depth of 18 inches⁶⁶ (Figs. 11 and 12). A number of experiments were run using this facility. However, as early as 1934, the Board realized the need for a larger wave tank and one more conveniently located to its Washington office. In 1937, permission was obtained to construct on property at the Dalecarlia Reservation, a new concrete tank 85 feet long, 14 feet wide, and 4 feet deep. The tank was equipped with a wave generator and housed in a metal building 112 by 24 feet⁶⁷ (Figs. 13, 14, and 15).

*During the period when Maj. Gen. Glen Edgerton held the office (July 1948 to April 1949), the title of Senior Member was changed to President of the Board.⁶²

**The various Corps of Engineers District offices assisted the BEB in these studies by providing data, but in these early years, the Board's staff, with the assistance of Board members, prepared the actual reports.

***What has been referred to in this paper as the "internationalism of coastal engineering" is discussed more fully at a later point. However, it should be made clear that the BEB, even in the 1930's, was attuned to the worldwide aspects of shore protection and was in contact with individuals abroad who had similar interests. Moreover, an effort was made, during this early period, to have translated all recent papers on erosion subjects written in languages other than English.⁶⁴



Figure 9. Jay V. Hall, Jr., the first civilian engineer to join the staff of the BEB. He worked for the BEB from January 1931 until it was abolished in November 1963.



Figure 10. Ethyl L. Sweet, the first stenographer on the staff of the BEB. She was actually the first civilian employee, joining the staff in December 1930.

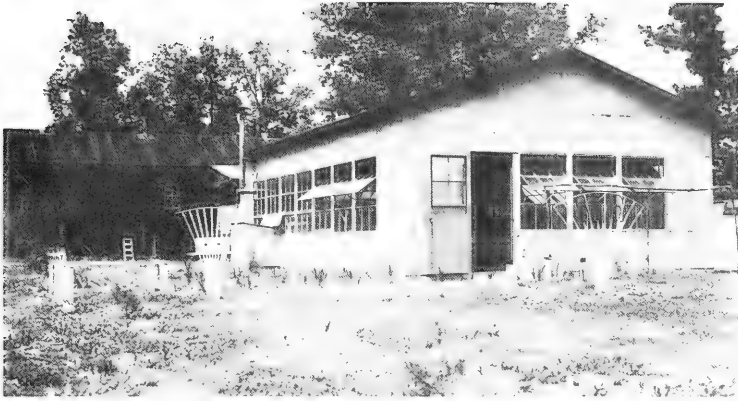


Figure 11. Metal building at Fort Humphreys (later Fort Belvoir), Virginia, housing the BEB's first experimental wave tank.



Figure 12. Another view of metal building at Fort Humphreys (later Fort Belvoir), Virginia, housing the BEB's first experimental wave tank.



Figure 13. Plumbing for the BEB's 85-foot wave tank on the Dalecarlia Reservation, Washington, D.C., 16 August 1937.



Figure 14. Completed building housing the new 85-foot wave tank of the BEB, located on the Dalecarlia Reservation in Washington, D.C.



Figure 15. Another view of the building housing the BEB's 85-foot wave tank in Washington, D.C., shortly after completion. This initial building remained the central point around which offices and other facilities were later constructed. Compare, for example, Figures 17 and 20.

In 1930, the BSMBE had employed Morrrough P. O'Brien to make a reconnaissance of the beaches, inlets, and harbors of the Pacific coast from the Strait of Juan de Fuca at the Washington-Canadian border to the Tijuana Slough at the California-Mexican border. O'Brien continued this field study under the auspices of the new BEB. A seven-volume report on these investigations issued in March 1931 is entitled, "A Report on Sand Movement and Beach Erosion Along the Pacific Coast of the United States." One specific result of this work was the discovery of the existence of a definite relationship between the tidal prism of inlets and estuaries and the flow area.⁶⁸ Another was confirmation, by way of observations at Santa Barbara, California, and elsewhere, of the fact that the littoral drift is essentially a stream of sand which moves in a rather narrow belt close to, and generally parallel with, the shore.⁶⁹ (In the BEB's 1933 *Interim Report*, this same concept is referred to as a "river of sand.")⁷⁰

The durability of certain construction materials used in shore protection structures, especially steel, had been a matter of interest to the BSMBE.⁷¹ The BEB continued investigation on this important topic. At the Board meeting on November 1, 1935, held at the Moriches Coast Guard Station on Long Island, New York, Col. Earl I. Brown, "outlined the proposed study of the condition of steel sheet piling along the Atlantic and Gulf Coasts."⁷² Ralph F. Rhodes of the Savannah District, Corps of Engineers, was designated to make this study. Mr. Rhodes' report, issued on July 13, 1936, covered 11 localities—7 on the east coast of Florida and 4 on that State's west coast. He included numerous photos in his study, showing conditions of the material at the various sites. In the years that followed, the BEB staff continued to work on this important subject, resulting in several additional reports.

The adoption of a uniform terminology for coastal engineering was another early undertaking of the BEB. Col. Brown first brought this matter to the Board's attention at a meeting in September 1931. When the BEB published its *Interim Report* in April 1933, it included a short glossary of terms, as did the first manual, *Manual of Procedure in Beach Erosion Studies*, published in 1938. In the years that followed, the BEB continued and expanded this work on coastal terminology.

a. *The BEB Study of Fort Fisher, North Carolina.* Although not the first site to receive the BEB's attention, Fort Fisher, located 16 miles south of Wilmington, North Carolina, is a good example to discuss here for several reasons. First of all, this study resulted in the BEB's first Congressional Document No. 204, 72d Congress, 1st session, dated December 29, 1931. As such, it caught the attention of the National Research Council and was mentioned in their Annual Report for 1931-1932:

"Attention is directed to House of Representatives' Document No. 204, of the Seventy-second Congress, First Session, containing a report on investigations of beach erosion at Fort Fisher, North Carolina, made by the Beach Erosion Board of the United States Army Engineers, in cooperation with the North Carolina

Department of Conservation and Development. The report is interesting not only as an example of detailed shoreline studies undertaken in connection with an important engineering project, but also as the product of a board which may properly be considered, in some measure at least, an outgrowth of the activities of this committee exerted especially through its former chairman, Captain R. S. Patton. The activities of the American Shore and Beach Preservation Association, in the organization of which Captain Patton played an important role, directed public attention to the desirability of scientific study of shore problems as a prerequisite to the execution of shore protection and other similar engineering projects. The public interest thus aroused in shore studies in our seaboard states was one of the factors leading to the formation of the new Beach Erosion Board in the Corps of Engineers of the United States Army.⁷³

Secondly, Fort Fisher had the additional color of being a site of considerable historic interest. Local preservation groups appeared before the Board during one of its meetings held in Wilmington and expressed their concern for the Fort's future.

More importantly, though, the Fort Fisher study illustrated a situation which was to cause some misunderstanding on the part of those of the general public who were concerned with problems of beach erosion. The matter of issue was that of Federal financial aid for an investigation of a shore protection project versus Federal financial aid for actual construction of a shore protection project.

At the second BEB meeting held on March 18 and 19, 1931, Thorndike Saville informally presented a request from the Board of County Commissioners of New Hanover County, North Carolina. This local group wanted the Board's help in protecting the shoreline adjacent to the Fort. The property at the site was "stated to be Federal property"⁷⁴ and thus thought qualified for protection using U.S. Government funds.* The County Commissioners had set aside \$1,000 and were requesting that the Board provide the same sum, "The entire amount to be used in construction of an experimental groin in the vicinity."⁷⁵ In the discussion that ensued, Col. Barden pointed out that this appropriation would not be for an investigation, as required by Public Law 520, but rather for actual construction. Therefore, he doubted that the "Chief of Engineers would approve the allotment of any funds for this purpose. . . ."⁷⁶ It was decided to advise the local group to work through a State agency, the North Carolina Department of Conservation and Development.

A formal application was submitted, and on June 1, 1931, the BEB recommended the approval of an investigation of the Fort Fisher site, in cooperation with the North Carolina Department of Conservation and Development. The study was to be funded by the \$1,000 of the Board of County Commissioners of New Hanover County, plus an allocation of a like

*Actually, the property in question at Fort Fisher appears not to have been owned by the Federal Government. However, this fact would not have made any difference, because at the time of the Fort Fisher study, the BEB was authorized to make studies *only*.

amount by the Federal Government. The Chief of Engineers gave his approval for the study and the final result was the BEB report referred to above—a thorough investigation of the area, its problem, the causes of the problem, and suggestions as to the best possible manner in which it might be handled.* The wording of Public Law 520 did not allow the BEB to allot Federal moneys for anything other than an investigation. At this early stage of its history and for a number of years thereafter, the BEB was, in essence, a board of consultants whose services could be obtained upon request by a State agency which agreed to pay 50 percent of the cost of the survey.⁸⁰

b. Public Law 409 (1935). As was mentioned earlier, the U.S. Army, Corps of Engineers had for many years been engaged in river and harbor projects. This responsibility was given to the Corps as keeper of the Nation's navigable waterways, and derived its constitutionality from the Commerce Clause, contained in Section 8, Article I, of the United States Constitution. As a result of this function, the Corps became involved in the construction of jetties at various inlets and river mouths along the Nation's coastline, the chief purpose usually being to maintain and stabilize the navigation channel. In some instances, local interests constructed the initial structures, with assistance from the Corps of Engineers beginning at a later date. Depending on the case in point, Corps involvement may have been due to the fact that some coastal problem eventually became too complex for the local people to handle. On the other hand, the advent of both World War I and World War II had necessitated the Federal Government assuming responsibility at a number of harbor entrances for purposes related to the military effort.⁸¹

An ancillary effect of most jetty construction is an accumulation of sand behind the updrift jetty, accompanied by erosion of the beaches downdrift. In the earlier days before the boom of seashore recreation, these side effects had not posed too serious a problem. However, rapid development along the coastline cast a new light on the situation. The classic example of the problem is the jetties completed in 1911 at Cold Spring Inlet⁸² (now called Cape May Harbor), the inlet immediately northeast of Cape May, New Jersey. Sand accumulating behind the northern jetty widened the resort beach at Wildwood, while the erosion on the southern side of the south jetty severely diminished the famous Cape May beaches.

Section 5 of Public Law 409, 74th Congress, approved August 30, 1935, was an attempt to better handle situations of this kind by predicting, in advance, possible problems that might accompany certain proposed construction. Section 5 of this law required that all reports dealing with improvements at a river mouth or inlet contain "information concerning the configuration of the shoreline and the probable effect thereon" that might

*The estimated cost of the structures recommended by the BEB study was \$71,600.⁷⁷ This adds substance to a statement made a few years later by a BEB member when he commented that, "The Board has been most handicapped by the lack of understanding of what proper shore protection costs."⁷⁸ It is additionally interesting to compare the \$1,000 the county agency had planned to expend for a coastal structure, to the \$10,000 a local historical society was spending for a monument at the Fort.⁷⁹

result if the improvements under consideration were built. Particular reference was to be given to erosion and accretion “for a distance of not less than ten miles on either side of the said entrance.”⁸³ Because of its concern with erosion problems on Federal property, as well as those associated with the Corps of Engineers’ harbor activities, responsibility for this new legislative directive was given to the Shore Protection Board by order of the Office, Chief of Engineers.⁸⁴ However, it was a matter of general interest to the BEB as well.

c. *The BEB Study of Old Orchard Beach, Maine.* In 1935, the BEB conducted an investigation of beach conditions at Old Orchard Beach, Maine. Located 20 miles southwest of Portland, Old Orchard Beach was a popular seashore resort, the largest percentage of its vacationers coming from Canada. The area was not subject to erosion except temporarily during severe storms. With the advantage of hindsight, the events associated with this BEB study make it of special historical interest.

Maine Representative Simon M. Hamlin introduced a bill (H.R. 5539) in February 1935 requesting an appropriation of \$500,000, “out of any sums available for the emergency construction of public works.” This money was to be used to build a 3-mile-long seawall and promenade at Old Orchard Beach, Maine. The bill was reviewed by the Committee on Rivers and Harbors, which concluded that the matter should be given to the BEB for its consideration. In a letter to President Franklin D. Roosevelt dated March 11, 1935, Maine Governor Louis J. Brann stated that “alarming changes and great loss of property” had been occurring at Old Orchard Beach during the past few years. Brann asked that the President expedite the BEB survey and concluded his letter by saying:

“I am very anxious to have this matter decided because it will be a tremendous factor in solving our unemployment situation in Western Maine, a situation which I assure you is very critical.”⁸⁵

Governor Brann’s main intent seems to have been to create jobs for the unemployed in the area, this being during the Depression, and he hoped to do this by way of construction of a large, Federally financed, shore protection project. In late May, the Governor sent a telegram to BEB civilian member Richard K. Hale, inviting the Board to come to Old Orchard Beach for a personal inspection of the site.

On June 24, 1935, the Maine State Planning Board, acting as the cooperating State agency, filed a formal application to the BEB for the Old Orchard Beach study. The Chief of Engineers approved the application on 17 July. In the meantime, however, the proposed seawall had received publicity in the local newspapers, and many of the area residents became strongly opposed to the idea. As early as March 6, 1935, the BEB began to receive letters protesting against the construction of the structure.⁸⁶

During the next 2 months, work on the study gradually progressed, with individual members of the BEB or its staff making trips to Old Orchard Beach to secure needed information. Then in late August, as a result of the continuing protests, it was decided that

the BEB would hold a public hearing to allow open discussion of the proposed plan. Thus, on September 4, 1935, six of the seven members of the BEB went to Old Orchard Beach and conducted a public hearing on the proposal.* Those BEB members who went were Col. Earl I. Brown, by then Senior Member; Col. Elliott J. Dent; Maj. Charles H. Cunningham; Richard K. Hale; Victor Gelineau; and Thorndike Saville; plus Capt. Frank O. Bowman, at that time Board recorder. Lt. Col. Brehon Somervell was the one member unable to make the trip. Some 300 local residents attended the public hearing. The BEB members attempted to clarify the fact that the Board's function was purely advisory; that it was not connected with the disposition of funds for construction nor with the construction itself. However, "the opposition was under the impression that if the Board recommended any protective works these would immediately be built and they (the opposition) would be taxed to pay for them."⁸⁷

The final BEB report on Old Orchard Beach dated September 20, 1935, included the comment that, "there are other matters than purely engineering ones to be considered in the location of protective works at this site, . . ."⁸⁸ This marked the close of the Board's first "controversial" study. (To this date, no seawall has ever been constructed at Old Orchard Beach, Maine.⁸⁹)

d. Effects of the Depression. At the first official meeting of the American Shore and Beach Preservation Association on December 8, 1926, Comdr. Raymond S. Patton had made the following prophetic statement:

"Just at present we are at a high tide of national prosperity, and it is that rising tide which during the past few years has resulted in the unprecedented development of our shores. That tide will ebb; doubtlessly the future will bring those alternating periods of depression and prosperity which in the past have characterized our economic life."⁹⁰

During another address to the same association in April 1935, by then Capt. Patton, who, in the intervening years, had become Director of the U.S. Coast and Geodetic Survey, commented upon the depression he had foreseen some 9 years earlier. He believed that a contributing factor to the Depression was "our national failure to realize that man's wishful thinking cannot influence the operation of those natural laws and forces, . . . which control man's destiny." We went plunging ahead, "thinking in terms of today or tomorrow instead of with reasonable regard for future generations, . . ." Patton saw these conditions as being somewhat analogous to the situation which, "in a much smaller way, had gradually developed along our coasts and which created the shore and beach problem of a decade and more ago."⁹¹

During the mid-1930's, efforts were made to encourage Federal spending in the form of support for an increased program of coastal research. In August 1934, Thorndike Saville, a civilian member of the BEB, was appointed to the National Water Resources Survey. This

*This was the first and only public hearing the BEB ever held.

survey was to participate in the water resources studies for the National Resources Board (later the National Resources Committee). In one of its early reports, the National Resources Board devoted a section to the problem of coastal protection. It called for a "reasonable program of research and investigation" which would provide the required basic data, as well as supplying "employment for many of the present unemployed."⁹² It further recommended that the BEB be given \$250,000 for making these necessary studies of erosion problems.⁹³ However, funds for the program were never received.

A similar theme appeared in the National Resources Committee's revised report in 1937. It stated:

"There is an evident need for careful planning by States and beach communities for the best development of their beach-recreation areas. Serious mistakes entailing heavy losses have been made in the past. It is believed that the Federal Government, through the Beach Erosion Board, can render material assistance to the States and communities in avoiding similar mistakes in future."⁹⁴

The report discussed the need for a 6-year program of field and office work at an estimated total cost of \$300,000 and remarked that "erosion-control work costing approximately \$13,782,000 merits construction during the next 6 years."⁹⁵ Again, no financial aid from the Federal Government for this work was forthcoming.*

Nor did the Depression years, so often epitomized by a great expansion of various public works programs, provide much of a stimulus for extensive Federal funding for the construction of shore protection structures. This, despite the fact that in Section 202, Clause (b) of the National Industrial Recovery Act passed in June 1933, it stated that the "prevention of soil and coastal erosion" was to be considered as a part of the comprehensive program of Public Works.⁹⁶

The comparison to government expenditures on other projects, especially flood control, did not go unnoticed. As F. E. Schmitt, then editor of the *Engineering News-Record*, observed, "It appears that flood protection has a strength of appeal lacking to shore protection, an appeal that led to more positive legislation and more decisive action."⁹⁷ Others believed the paucity of Federal support was attributable to the public's seasonality of perception of the coast. Most people saw the beaches only in the summer when waves were generally gentle and the beach well supplied with sand. Therefore, they were not aware of the changes which occurred in winter. Then too, the relative newness in this country of the appreciation for an increased program regarding coastal matters, combined with a rather small group of advocates, were also seen as deterrents to more decisive Federal action in this regard during the Depression years.

But another important point which must not be overlooked was that some people believed that construction of beach protection structures was not, and should not become, a

*However, some of the research concepts contained in these several reports were revitalized after World War II when new legislation was passed which specifically authorized Federal support for coastal research.

realm of Federal funding. For example, in a letter dated February 4, 1936, and addressed to the Honorable Royal S. Copeland, Chairman of the Committee on Commerce, U.S. Senate, Secretary of War George H. Dern expressed these thoughts:

“This Department is unable to find a justification, however, for the establishment legislatively of a policy looking to the expenditure of Federal funds in the construction of shore protection works along our coast. The property to be protected is in general privately owned, and its improvement and protection at public expense appears to be unwarranted. Certain localities are in the ownership of States and municipalities and are used for the recreation and enjoyment of the public at large; but it is not clear that Federal participation in the cost of the improvement and protection of these beaches has greater justification than the Federal participation in the improvement of the municipal and State parks. Special cases may justify a different view, but should be regarded individually.”⁹⁸

In April of that same year, Col. Earl I. Brown, a member of the BEB, also echoed sentiments disapproving Federal financing of the construction of shore protection structures. He stated:

“At this time when it is becoming more and more the habit of promoters of every conceivable scheme to look to the federal government as the source of easy money, there is developing an increasing tendency for local interests to concert together to force the federal government to assume the burden of shore protection, or at least the greater portion of such load.”⁹⁹

He believed that proponents of such action were really asking the Federal Government to save and/or protect the property on the beach rather than the beach itself. Concerning the private businessman at the shore, it was Brown’s opinion that:

“He (the businessman) has deliberately placed his structure in a dangerous location near the sea, with a view to seeking the profits to be derived from the facilities which he affords to the seacoast visitors, that is, he deliberately chooses a location to exploit the visitors and if he has made a bad choice, he should not expect those visitors to be taxed to save him from his dilemma.”¹⁰⁰

Such was the mixture of opinions on shore protection and the role of the Federal Government.

e. The Beach Improvement and Protection Act of 1936. This key issue of Federal funding for the construction of shore protection structures was intricately involved in attempts to pass new beach erosion legislation. The ASBPA played an active role in these efforts. In February 1934, Representative Isaac Bacharach from the State of New Jersey introduced H.R. 7590, which would have declared it to be “the policy of the United States to assist in the construction, but not the maintenance, of works for the improvement and

protection of the beaches along the shores of the United States, . . .”¹⁰¹ This bill was not passed. One of the questions that troubled several members of the House of Representatives Committee on Rivers and Harbors, which was reviewing the bill, was that if the Federal Government was to begin providing financial assistance for beach protection, how far would it go? Where would the line be drawn?*

In June 1936, a somewhat similar bill (S. 3505) did become law. This was Public Law 834, 74th Congress, entitled, “An Act for the Improvement and Protection of the Beaches Along the Shores of the United States.” The bill had been initiated by the ASBPA and received backing from Senator A. Harry Moore, former governor of New Jersey, and Senator Barbour of New Jersey, along with Representatives Isaac Bacharach and William Sutphin also from New Jersey.¹⁰³ The legislation somewhat broadened the activities of the BEB, but again, it was the Board’s interpretation of its duties that was the determining factor, especially in regard to Federal financial aid for construction of shore protection works.

On this important question, Public Law 834 declared it to be the policy of the Federal Government to assist in the construction, but not maintenance, “of works for improvement and protection of the beaches along the shores of the United States” where Federal interests were involved. The Chief of Engineers and the BEB interpreted “Federal interests” to mean only where Federal property or Federal investment required protection.¹⁰⁴ As a result of this interpretation of the legislation, only very small amounts of Federal funding were allocated to construction of shore protection works, much to the disappointment of those who had supported the bill.**

In addition to this “construction clause,” Public Law 834 contained, among others, the following stipulations: (1) It maintained similar provisions for the conduct of cooperative studies as contained in Public Law 520 (1930). Regarding financing of these studies, the new law stated that, “not more than 75 per centum of the cost of any specific investigation shall be borne by the United States.” However, as requested in an Executive Order from President Franklin D. Roosevelt, dated June 27, 1936 (the day after he signed the bill into

*During the hearing on H.R. 7590, there was a discussion between Mark Wilcox, Congressman from the State of Florida, and John McDuffie, a Committee member from Alabama. Mr. Wilcox was explaining how important the topic of coastal protection was to his State. He added, “If our (Florida’s) shore line was straightened out and extended along the Atlantic Coast, it would reach from the northeast corner of Maine to Charleston, S.C.” To this Mr. McDuffie responded, “You are not going to ask us to straighten it?” “No,” said Mr. Wilcox.¹⁰² McDuffie’s question is more than amusing. Indeed, it conveys a subtle message.

**Consideration of the study of St. Simon Island, Georgia, done in cooperation with the Commissioners, Roads & Revenue, Glynn County, Georgia, clearly illustrates this interpretation. The matter came up during the Board meeting of March 18, 1940, which was held in the Savannah Engineer Suboffice, Post Office Building, Brunswick, Georgia, following inspection of St. Simon Island. The Board minutes read as follows:

“A question was raised as to a finding of federal interest in the recommendation, in view of the fact that the U.S. Lighthouse Reservation occupies 300 feet of the 5,000 feet of frontage to be protected under the recommended plan. The Board approved a finding of Federal interest in direct proportion to the frontage involved, whereby the United States would be justified in bearing three-fiftieths of the total cost of shore protection works as provided in the recommended plan.”¹⁰⁵

This funding recommendation was then included in the final report, H. Doc. No. 820, 76th Cong. ¹⁰⁶

law), this provision was disallowed and the past policy of 50-percent local and 50-percent Federal funding for the investigations was continued; (2) the law authorized the BEB to publish whatever information concerning beach protection it considered to be useful to the people of the Nation; (3) it stipulated that all projects having to do with shore protection were to continue to be reviewed by the BEB and not the Board of Engineers for Rivers and Harbors (BERH) (BERH is an all-military Board set up in 1902 to review all proposed Corps of Engineers river and harbor improvement projects); (4) it required the BEB to include in its reports comments on three items: "(a) the advisability of adopting the project, (b) what Federal interest, if any, is involved in the proposed improvement, and (c) what share of the expense, if any, should be borne by the United States;"¹⁰⁷ and (5) Public Law 834 defined the geographical areas of "beaches" as applicable to the act.

But with all these provisions, the 1936 legislation did not specify research as a BEB function. Moreover, it precluded a comprehensive approach to the shoreline problems of the United States by retaining the general policy of the past, i.e., that each study be requested by some local group. As explained by Thorndike Saville, "... the Board has to wait for a request before such a cooperative investigation can be undertaken; such requests naturally are sporadic, located in communities widely separated along the sea and lake coasts of the United States; quite unrelated in time, and wholly incapable of being coordinated into any comprehensive study of the general problem for the United States as a whole."¹⁰⁸ Thus, from several points of view, Public Law 834 left room for improvement. Due to World War II, however, it was not until 9 years later that any new legislation concerned with BEB activities was passed.

f. Personnel Losses. The late 1930's and early 1940's brought the loss of several early leaders in the beach erosion movement, Rear Adm. Raymond S. Patton died on November 25, 1937. Although never a member of the BEB, Patton's concern for, and scientific interest in, beach erosion played an important role in exposing the great need for work on this problem. A few months later, on January 22, 1938, Victor Gelineau died suddenly. His death left a vacancy on the seven-member BEB among the State agency engineers. By Special Order No. 73 dated July 27, 1938, Morrrough P. O'Brien, by then chairman of the Department of Mechanical Engineering of the University of California, Berkeley, was appointed to fill this position. During his previous associations with both the BSMBE and the BEB, O'Brien had made numerous contributions of new knowledge based on field and laboratory investigation. Moreover, he had developed a graduate study and research program in coastal engineering at the University of California which had become preeminent in the field. O'Brien was to serve as a member of the BEB for the remainder of the agency's existence.*

*Since 1963, O'Brien has been a member of the Coastal Engineering Research Board of the U.S. Army, Corps of Engineers.

The BEB's staff suffered the loss of its senior civilian engineer, Ralph G. Davis, when he died on February 21, 1939. Another important figure in the coastal field, Geologist Douglas W. Johnson, died a few years later, on February 24, 1944.

4. World War II.

With the expansion of the Navy Department toward the end of the 1930's, the BEB made plans to move its office which, up to that time, had been in the Navy Building in downtown Washington, D.C. Work was begun on an addition to the building housing the wave tank at the Dalecarlia Reservation (Figs. 16 and 17). In late 1939, the BEB set up temporary quarters in a facility at 21st Street and Virginia Avenue, N.W., Washington, D.C. In March of the following year the agency, which by then had a staff numbering about 20, moved into its new office on the U.S. Army's Dalecarlia Reservation on Little Falls Road, N.W., Washington, D.C. (Figs. 18, 19, and 20). This was to be the BEB's home for the next 23 years, or for the remainder of the agency's existence.

In the late 1930's, beach erosion brought continuing and increasing property losses along the Nation's shores, and this state of affairs stimulated the development of a greater awareness of the problem at hand. To better meet the situation, the BEB began a small increase in its engineering and support personnel. From the North Atlantic Division of the Corps of Engineers came Forrest E. Byrns in 1938. The next year, Byrns succeeded Ralph Davis as senior civilian. Richard O. Eaton, formerly of the Los Angeles District of the Corps, joined the BEB staff in June 1939. Then in late spring of 1940 came Martin A. Mason from the National Bureau of Standards. The Senior Member of the Board at this time was Col. Jarvis J. Bain, while the Resident Member of the BEB staff was Maj. Albert C. Lieber, Jr.

With this expansion of effort, it was decided that some formal policy should be established in regard to publications. At the May 20, 1940 Board meeting, a motion was passed to divide BEB studies into three groups: Board Papers, Technical Reports, and Technical Memorandums. In May 1941, the BEB published Technical Report No. 1, "A Study of Progressive Oscillatory Waves in Water," by Martin A. Mason, with Technical Report No. 2, "A Summary of the Theory of Oscillatory Waves," by Morrrough P. O'Brien and Martin A. Mason, appearing in November of that same year. 1st Lt. William C. Hall was the author of Technical Memorandum No. 1, "A Model Study of the Effect of Submerged Breakwaters on Wave Action," dated May 15, 1940.¹⁰⁸

A further development during this period was the formation of a small library. The collection grew quickly and soon became a vital part of the agency. Iris R. Tomasulo, who joined the BEB in 1943, was one of the agency's early librarians. (Mary Nell Wrenn and Ebba C. Everett served as librarian in subsequent years).

This new era of growth for the BEB had barely begun, however, when the Nation found itself in the throes of World War II. The war syphoned off much of the BEB personnel, both military and civilian. When both Byrns and Eaton left the Board's staff for service in the



Figure 16. Jim Mason and Frank Erwin laying brick foundation for the first addition to the BEB laboratory building (seen in background). The addition was to provide office space for the Board's staff, 27 October 1939.



Figure 17. Walls going up on the addition to the BEB's facility on Dalecarlia Reservation, Washington, D.C., winter, 1939-40.



Figure 18. Office and laboratory of the BEB, Washington, D.C., 17 May 1940.



Figure 19. Another view of office and laboratory of the BEB, 17 May 1940.



Figure 20. BEB office and laboratory some time later. The initial structure housing the 85-foot wave tank is seen on the right of the building.

military, Mason became the agency's senior civilian. As a result of the war, civil BEB functions were greatly decreased. The question then was whether the BEB would become essentially dormant or whether there was some contribution it could make to the war effort. The latter course was taken, and the BEB began the phase of its history which was to make it an asset unique to the United States during World War II.

It was speculated, by Mason and others, that the BEB staff, with its knowledge of various shore processes, might be able to supply useful information regarding foreign beaches, especially those slated for amphibious landings of troops, tanks, and other military equipment. Brig. Gen. John J. Kingman, who had become Senior Member of the Board and Resident Member of the BEB staff in December 1941,¹⁰⁹ also saw the potential value of such data. A preliminary investigation was begun on the coast most likely to be used as a beachhead for such a landing—the coast of the English Channel. Then in June 1942, a conference was held to discuss the BEB's possible role in beach intelligence. Among those attending this meeting were Lt. Col. Joseph E. McCaffrey and Mark P. Connaughton of the Strategic Intelligence Branch, Military Intelligence Division of the Office of the Chief of Engineers, together with Gen. Kingman, Martin Mason, and Morrough O'Brien of the BEB. As a result of this conference and by order of the Chief of Engineers, the BEB completed in July 1942 its first intelligence study, "Landing Area Report: Cherbourg to Dunkirk."¹¹⁰ The report came to the attention of the Joint Chiefs of Staff, and they, along with their European counterparts, quickly appreciated the enormous military value of such information. The study was promptly classified and security restrictions applied to the entire staff and to all ensuing beach intelligence work of the BEB during the remainder of the war.

The road to action—a road which was to entirely transform the BEB—was now open. Gen. Kingman and Martin Mason, with the assistance of several of the Board members, set out to bring skilled scientists and other personnel to augment their depleted staff and to advance the agency's vital military program. They were successful in this endeavor. Among those recruited were Garbis H. Keulegan, specialist in wave mechanics, who came on a loan basis from the National Bureau of Standards in 1942 and assisted the Board's staff until 1946, and William C. Krumbein, noted geologist then of the University of Chicago, who joined the BEB in July 1942 and stayed until mid-1945.¹¹¹ These four men—Kingman, Mason, Keulegan, and Krumbein—plus Jay Hall, who had worked for the BEB since it was established, formed the nucleus of the agency's staff during the war. They were supported by several engineers, geologists, and draftsmen, plus maintenance personnel and a secretarial staff, the latter headed by Josephine Rowzie. Throughout the course of the war and for varying lengths of time, talented people trained in fields associated with beach and wave phenomena, and military personnel from the Allied Forces frequented the unpretentious facility on the outskirts of Washington, D.C., and provided additional expertise and knowledge, as well as problems to be solved.

The BEB military program had two main divisions of effort. One division, headed by Krumbein, involved the preparation of beach landing reports. Assignments would be received from the Strategic Intelligence Branch of the Office, Chief of Engineers. The job of Krumbein and his associates was then to gather together all available information on beach sites at which military landings were anticipated. This would include such facts as beach slope, sand characteristics, tidal fluctuations, coral reef locations if any, as well as wave and surf conditions. The data would then be transferred to maps of the area in question and a detailed report written, accompanied by charts and photos. The staff usually had just 1 month to prepare complete reports for three designated sites, one of which was to be used for an amphibious operation.¹¹² Eleanor Tatge, a member of Krumbein's group, played an important role in both data interpretation as well as actual report preparation.

The first general location which was studied was the coast of North Africa, extending from about Casablanca to the vicinity of Tangiers. This report was completed in September 1942, with an Allied landing taking place in the area in November of that year.¹¹³ This study was followed by work on Sicily and the southern half of Italy.

About mid-1943, attention turned to the islands of the Pacific. Work began on the north coast of New Guinea and proceeded generally northward along the island chains. Included were such island clusters as the Solomons, the Carolines, and the Philippines.

Another related activity which was part of this group's responsibility was the preparation of brief graphic reports used more for strategic planning rather than actual operations. These were requested by the Joint Chiefs of Staff usually on short order, with deadlines ranging from 24 to 72 hours. Such reports or "quickies," as the staff called them, were often assigned to Clara Edmunds, a geologist-chemist from the University of Chicago, who worked at the BEB for 3 years during the war.¹¹⁴ The purpose of the strategic planning reports was to present, as concisely as possible, the major layout of terrain of a fairly large area, often an island or peninsula, "and to indicate where men and equipment could or could not be landed."¹¹⁵

The second division of activity involved work in wave research. It was with problems of this orientation that Garbis Keulegan worked, assisted by Jay Hall, who was also associated with the map intelligence group. Experiments were run almost continually in the 85-foot wave tank which had been constructed a few years previously. In addition, a smaller wave tank, 42 feet long, 1.5 feet wide, and 2 feet deep, was built in the early 1940's to increase research capacity.¹¹⁶ (In 1958, the length of this tank was increased to 72 feet.)

A variety of problems posed by the needs and conditions of the war were investigated. These included such items as: Improvement of landing craft, with emphasis on beaching and retraction characteristics; determination of water depths over bottom discontinuities (e.g., offshore bars); and the development of movable breakwaters, e.g., "breakwaters which could be fabricated in one locality and towed to the site of operations."¹¹⁷ In this regard, the BEB researchers studied various shapes of concrete caissons for both their effectiveness

and tow characteristics, i.e., certain shapes towing quite erratically when pulled by a boat. Tests were also run to determine the effectiveness of sunken Liberty ships for possible use as breakwaters.

Still another wave research project studied at the BEB during World War II was that of a proposed seadrome, known as the Armstrong Seadrome. The idea was to maintain in the mid-Atlantic Ocean a floating landing field some 5,000 to 6,000 feet long where planes could stop and refuel. A number of tests were run to determine the forces upon, and the stability of, such a structure under wave action.¹¹⁸ However, the plan was never put into operation for, as the war progressed, planes were improved to the point where such a refueling stop became unnecessary.

Knowledge of the depth of water along a potential landing beach was a vitally important piece of information, but one equally difficult to secure. Then it was hypothesized that depths could be determined by using aerial photography of the wave conditions at the beach site. It was known that the wavelength decreases as a wave moves into shoal water. By calculating from photos this change in wavelength, the water depth could then be found. For a period during which the Board's staff, especially Mason, was working on this particular problem, they were assisted by a British Intelligence officer, Maj. W. W. Williams. Maj. Williams, a professor of geography at Cambridge University in civilian life, stayed with the Board for a number of weeks.¹¹⁹ With the development of this technique, the BEB staff became more and more involved in aerial photography and its interpretation.

To better coordinate the military intelligence work, the Joint Army-Navy Intelligence Service (JANIS) was set up in late 1943. Under this arrangement, the BEB was specifically assigned the task of preparing all beach reports. This not only avoided duplication of effort but also encouraged development of a standard report format.

During the course of the war, the BEB maintained close liaison with other Federal agencies. For example, starting in the early spring of 1944, they took part in a program to train personnel, largely from the Military Branch of the U.S. Geological Survey, in coast and landing beach intelligence. After spending several months at the BEB, these men would then be assigned to various military locations, largely in the Pacific theater, to act as consultants and to gather additional data. On occasion, they were required to study a beachhead just a few days following an actual landing to determine how accurate the landing report had been, and to suggest methods for improvement.¹²⁰ Among those who were at the BEB for a period of time in this capacity were: A. Lincoln Dryden,* John Rodgers, and Robert M. Garrels.

It is an undisputed fact that, during the years of World War II, the BEB bore a great responsibility involving the lives of many thousands of men. Its small staff, with a wartime average number of some 30 to 35 people, prepared well over 50 highly valuable reports

*Dryden also authored one of the Board's wartime publications, "Surface Features of Coral Reefs," Technical Memorandum No. 4, dated May 1944.



Figure 21. Jay V. Hall, Jr., involved in research work during World War II, using the BEB's 85-foot wave tank.

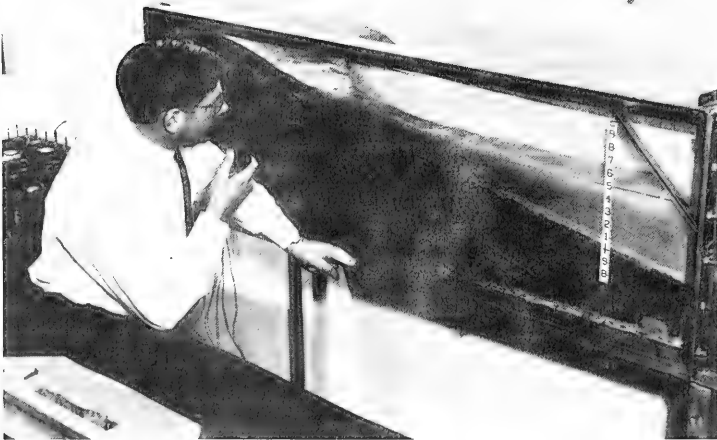


Figure 22. Martin A. Mason working on a wave experiment during World War II, using the BEB's 42-foot wave tank.

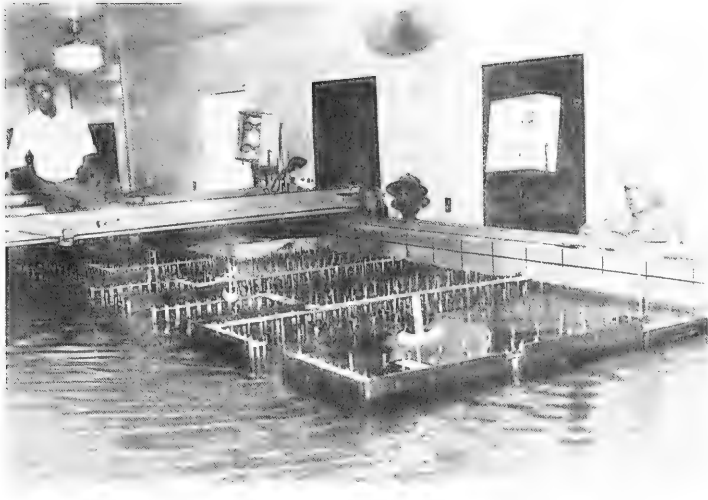


Figure 23. Left to right: Jim Mason, Leroy Harris, and Gen. John J. Kingman working on an experiment in the BEB's 85-foot wave tank, August 1943.

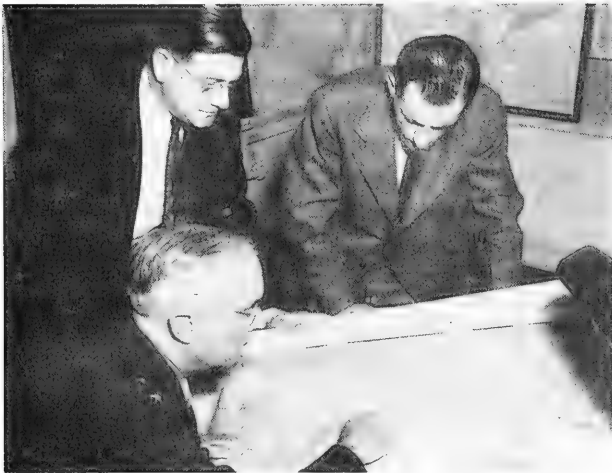


Figure 24. Gen. John Kingman (seated), Martin A. Mason (left), and William C. Krumbein studying a map in connection with the BEB's intelligence work during World War II.

related to beach intelligence.¹²¹ In recognition of its contribution to the war effort, the BEB staff received a number of commendations. In March 1945, the War Department (now the Department of Defense) paid special recognition to Martin Mason and William Krumbein. Mason received the highest honor that could be bestowed by the War Department on a civilian employee—the Exceptional Civilian Service Award. Krumbein received the Meritorious Civilian Service Award.¹²²

Gen. Kingman, too, had played a vital role. While it had been the efforts of the BEB staff working together which had provided the technical answers to wartime problems, the entire group's guiding light through those dark years was Gen. Kingman. Moreover, Kingman's wide acquaintance among other military officers in the Washington area enabled him to facilitate the BEB's contributions by opening communication channels with other agencies also engaged in related war work.

5. Post-War Activities.

As prospects for an end to the war gradually increased, the BEB began to prepare for a renewed involvement in civil works activities. Essentially, this meant picking up the threads of the program which had barely started just before the outbreak of hostilities and weaving it back together again, this time to meet the needs of a society quite different from its prewar counterpart.

a. New Legislation. One of the first steps which had to be taken involved certain changes in legislation. Up to this time, the BEB had been largely an advisory-type agency. The initiating 1930 legislation had directed the Board to make studies of areas experiencing beach erosion problems at the request, and with the financial cooperation, of an appropriate local agency. The 1936 legislation had declared it to be the policy of the United States to assist in the construction of shore protection and improvement works, but only where Federal interests were involved (Federal interests being interpreted as Federal property or Federal investment). The program that had ensued from these Congressional directives had been somewhat limited. Furthermore, the Board's research role had never been specified.

Thus, Gen. Kingman and Martin Mason worked with others to draft legislation which would give the BEB the authority to undertake a more effective research program and also permit Federal assistance in financing the construction of shore protection structures. These efforts eventually took the form of House of Representatives Bills No. 2032 and 2033, introduced in the fall of 1944.¹²³ The ASBPA gave its full support to these bills. In July 1945, the 79th Congress, 1st session, passed H.R. 2032 and it became Public Law 166, entitled, "An Act Authorizing general shoreline investigations at Federal expense, and to repeal an Act for the improvement and protection of the beaches along the shores of the United States, approved June 26, 1936." This legislation maintained the cooperative studies as part of the work of the BEB but also greatly increased the Board's scope by authorizing it to make "general investigations" of the shorelines of the United States. The Federal

Government was to cover the entire cost of these general investigations. The difference between the cooperative studies and the general investigations, in terms of content, was that the former were to “result in a report containing specific recommendations to remedy a situation at a particular locality,”¹²⁴ whereas the latter were to involve work on more broadly based problems. Because of this provision to study broadly based problems, Public Law 166 is credited with formally establishing the research and development activity of the BEB.

Public Law 166 differed in still another way from the 1936 legislation, Public Law 834 (which was now repealed). This difference involved one of the three opinions the Board was to include in its reports (see pages 38 and 39 where these opinions are listed). In the 1936 Act, opinion (b) called upon the Board to indicate “what Federal interest, if any, is involved in the proposed improvement.” The 1945 legislation changed this to “what public interest, if any, is involved in the proposed improvement.” This change of the word “Federal” to “public” cleared the way for a much broader interpretation of “interest.”* It would no longer be restricted to cases where only Federal property or Federal investment was involved.

The 1945 legislation also retained as a function of the BEB the review of “all projects having to do with shore protection.”¹²⁵ This provision kept shore protection in a special category, apart from Corps projects involving river and harbor improvements. Such action, which had begun with the 1930 legislation, was largely a reflection of the still rather limited diffusion of knowledge on coastal engineering, a situation which was to change in the years ahead.

An intervening event which took place during this period of readjustment following World War II was the abolishment of the Shore Protection Board. This move was indicative, in part at least, of the melding of Federal and public interest in shore protection. Up to this time, it had been the task of this four-member, all-military Board to consider “shore protection of Federal property or problems relating thereto as assigned by the Chief of Engineers.”¹²⁶ However, as authorized in General Orders No. 8 issued by the Chief of Engineers and effective May 10, 1946, the Shore Protection Board was abolished, and its duties became the responsibility of the BEB.¹²⁷ These duties included the directive contained in Public Law 409 (passed in 1935) that required examination of the possible effects that proposed navigation improvements might have on the adjoining shoreline.

House of Representatives Bill No. 2033 was still pending in Congress. This bill was to provide for Federal aid in the construction but not maintenance, of works for “the improvement and protection against erosion by waves and currents of the shores of the United States that are owned by States, municipalities, or other political subdivisions.” The Federal Government’s contribution was not to exceed one-third of the total construction cost of the protective works of an approved project.

*William Sutphin, Representative from New Jersey, had attempted to change this wording as early as August 1937 when he introduced in the 75th Cong. 1st sess. H.R. 8205.

The ASBPA, a strong supporter of the measure, published in the proceedings of its meetings, a number of discussions regarding this bill and its progress in Congress. The argument heard back in the 1930's is echoed here—that shore protection has never received its fair share of Federal concern or Federal appropriations. For example, Association President J. Spencer Smith remarked in April 1946, “. . . what's hard for me to reconcile is the fact we are willing to spend . . . a great deal of money on flood and soil and irrigation purposes and yet we hesitate to authorize the Congress to appropriate money for the protection of our beaches. . . .”¹²⁸ Smith also brought out another point which the ASBPA had long stressed, i.e., that “there are relatively few voters on the beaches. The people who enjoy the beaches come from all over the United States, but they are not there when the damage is being done, and they do not know the need for appropriations to protect those beaches.”¹²⁹

Thorndike Saville, who had been a member of the seven-man Board since its inception in 1930, attended this April 1946 meeting of the ASBPA. Saville, who recognized some inequities in the status of shore protection in relation to other Federal water programs, made these comments on the subject:

“The Bureau of Reclamation has a 5-year program of about \$1,000,000,000, all of which is to be expended, naturally, in the irrigation states. The flood control work and River and Harbor works again have a 5-year plan of roughly \$1,000,000,000. The main objections to H.R. 2033 from the Budget Bureau is from the standpoint of economy; they have to balance the budget. They naturally are opposed to new Federal policies which involve additional expenditure of Federal funds which will reflect against balancing the budget.

“But from the standpoint of logic it never seemed sensible to me to adopt policies reflecting enormous expenditures, running up to \$2,500,000,000 over the next 5 years, when a majority of that cost, probably a pretty big majority, upwards of 70 per cent I would guess, is going to be paid for by the taxes of the coastal states—New York and the other eastern coastal states, plus California. I am guessing that up to about 75 per cent of the tax money which is expended for these billions of dollars worth of non-coastal projects will be expended outside of the states from which most of the tax money is derived. It seems to me this might well be an added strong argument for the adoption of H.R. 2033, or rather for the underlying policy; that the coastal states do put up very large amounts of money for Federal construction programs in the water field, that by and large they do not benefit proportionately from these moneys, and therefore it is logical that the Government should adopt a policy which would enable such states to secure some of their tax money in the form of Federal structures to protect the coast line. . . .”¹³⁰

In August of that year (1946), the 79th Congress, 2nd session, passed H.R. 2033 and it became Public Law 727, entitled, "An Act Authorizing Federal participation in the cost of protecting the shores of publicly-owned property." In the October 1946 issue of *Shore and Beach*, its official publication, the ASBPA commented as follows concerning passage of this new legislation:

"The goal it has sought for almost two decades was achieved by the American Shore and Beach Preservation Association on August 13, . . . when President Truman signed Public Law No. 727, of the 79th Congress, 2d Session, which authorizes federal financial assistance for as much as one-third of the cost of new beach development and shore erosion prevention projects affecting public property."¹³¹

This quotation substantiates the ASBPA's interpretation of the role of the Federal Government in matters of shore protection at public beaches, an interpretation that was slow to win advocates within the Federal Government itself.

For many years, one of the major restraints concerning the possibility of Federal financial assistance for shore protection projects on non-Federal property had been that it would allow private property owners to reap large benefits from the expenditure of Federal funds. In the eyes of Congress, shore protection carried this stigma far more than did flood control or irrigation. Under these latter two programs, Federal expenditure, often for the "total" cost of projects (and not just one-third as authorized in 1946 for shore protection) commonly resulted in major benefits to owners of private property. But the inclusion in Public Law 727 of the provision that "the plan of protection shall have been specifically adopted and authorized by Congress after investigation and study by the Beach Erosion Board . . .,"¹³² could be interpreted as an additional precautionary measure to prevent the accrual of private benefits from Federal shore protection projects.¹³³

The passage of these two pieces of legislation marked an important turning point in the history of the BEB. For the agency as a whole, Public Law 166, the "research" law, in the long run had the greater effect.

b. The Research Program and its Implementation. In the planning of the actual research program and the test facilities which would be needed, Martin Mason, Gen. Kingman, Thorndike Saville, and Morrough O'Brien were the main guiding forces. As early as October 1944, Kingman had discussed with the seven-member Board the need for the BEB to acquire a larger wave tank.¹³⁴ It was realized that the existing 85-foot-long tank with a maximum workable wave height of 8 inches, although a useful facility, was not able to meet the agency's needs. This was especially true if the BEB was to increase its research capacity. Thus, plans were made to design and construct a large outdoor, prototype wave tank to be located near the BEB's office on the Dalecarlia Reservation. It was the desire of the Chief of Engineers that this new prototype wave tank also be utilized for the study of riprap

protection for earth dams, as well as to provide information on wave runup on reservoir shores.¹³⁵ These additional uses partly determined the tank's final dimensions of 635 feet long, 15 feet wide, and 20 feet deep. The other design details of the wave tank and wave generator were worked out under the direction of Joseph M. Caldwell, both analytically and through use of one of the smaller BEB wave tanks as a scale model for the proposed large facility.

The concrete tank proper was built in late 1949 to early 1950,¹³⁶ Figures 25 to 30 show the construction work under way. But the Korean War, which began in the fall of 1950, resulted in a cutback of financial support to the BEB's research program. This, in turn, curtailed for several years the procurement and installation of the remaining equipment needed for the facility, particularly the large wave generator. During this interim period, however, the staff was able to utilize the tank to some degree by using a small, portable wave generator¹³⁷ (Fig. 32). Then in the spring of 1954, the BEB received the funds needed to finish the project; the large generator was obtained and installed, and in October 1955 the completed large wave tank facility was officially dedicated. Waves up to 6 feet in height could be generated with this equipment, and the wave period could be varied from 3 to 16 seconds. Figures 34 and 35 show the facility being demonstrated to U.S. Army, Corps of Engineers officials, shortly after completion. This wave tank was then, and as of this writing still is, the only one of such proportions in the world.

A second major addition to the research facilities of the BEB which was planned at the same time was the shore processes test basin. The idea for such a basin had first been put forth back in August 1943.¹³⁸ Designs and estimates were prepared at that time but no money was allotted.¹³⁹ The concept was revitalized during this post-World War II period. Construction of the test basin, alongside the 635-foot-long wave tank, was also slowed by the Korean War. However; the facility, which consisted of a 3-foot-deep concrete basin measuring 300 by 150 feet, and equipped with 10 movable wave generators, was available for partial operation in 1953¹⁴⁰ (Figs. 37 and 38). The shore processes test basin allowed the BEB staff to carry out original work on a number of studies, particularly those pertaining to floating breakwaters and to beach processes, the latter involving the use of movable bed materials.*

The hiatus between passage of the research legislation in 1945 and start of construction of the BEB's new test facilities is attributed, in part, to the innovative character of the action. No program in coastal research of this scope and magnitude had ever been undertaken before, either by the Corps of Engineers or any other research group in the country. Thus, time was required for interpretation, staff reorganization, planning, and design. Then too, these years immediately following World War II were a period of great flux for American society. The entire country was experiencing a major readjustment.

*The main problem encountered with this facility was that it was out of doors and thus exposed to the vicissitudes of the weather. This curtailed its usage more than had been expected. Experiments in the 635-foot-long wave tank were of a different nature and were less affected by weather conditions.



Figure 25. Martin A. Mason and William Herron, Jr., looking over site for the BEB's proposed 635-foot-long wave tank at the agency's facility on the Dalecarlia Reservation, Washington, D.C., 8 July 1949.



Figure 26. Grading in preparation for the BEB's new 635-foot wave tank, 24 August 1949.



Figure 27. Pouring concrete for the bed of the 635-foot wave tank, 30 September 1949.



Figure 28. Sides of the 635-foot tank beginning to take shape. To the right, grading for shore processes test basin is underway, 5 November 1949.



Figure 29. View looking down the 20-foot-deep, 635-foot tank toward area where generator will be located. On the right, shore processes test basin is under construction.



Figure 30. Another view of construction of BEB research facilities, 10 January 1950.



Figure 31. Completed large wave tank but without generator (this was later installed at the far left end of the tank). Shore processes test basin in background.

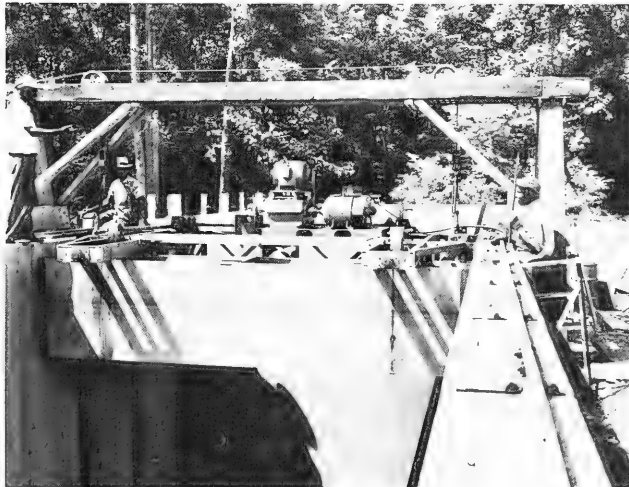


Figure 32. Installation of small, portable wave generator used in the BEB's 635-foot-long wave tank during interim period of the early 1950's before the large generator was secured. Left to right: Jim Mason, unidentified, and unidentified.



Figure 33. Large wave generator on the BEB's 635-foot wave tank.



Figure 34. Demonstration of the world's largest wave tank, BEB, Washington, D.C., October 1955.



Figure 35. Officials from the U.S. Army, Corps of Engineers, together with representatives of the Board's staff, viewing a demonstration of the BEB's 635-foot wave tank.



Figure 36. Breaking wave in the BEB's 20-foot-deep, 15-foot-wide, and 635-foot-long wave tank.



Figure 37. The BEB's shore processes test basin in February 1953. Observation tower on left.



Figure 38. Waves being generated in the shore processes test basin. The 10 wave generators could be operated independently or synchronized electronically to operate as a single, long generator.

By the fall of 1948, the BEB was ready to submit its request for funding of the test facilities to the Bureau of the Budget. Maj. Gen. Glen E. Edgerton, who had become President (the office formerly known as Senior Member) of the seven-member Board and Resident Member of the BEB staff in July 1948, made this presentation. As a result of his efforts, the BEB received its first direct appropriation to support the agency's research program. This was in the amount of \$350,000 for fiscal year 1950.¹⁴¹

One additional hurdle had to be cleared before the BEB could build the large wave tank and shore processes test basin. This involved negotiation with the National Capital Park and Planning Commission, which by law, had to approve all new Federal construction in Washington, D.C. The Dalecarlia Reservation, where the Board office and laboratory were located, was on the outskirts of the city near a neighborhood of expensive homes. Again, it was Gen. Edgerton who convinced the Commission that the test structures would not look unsightly.¹⁴² The BEB agreed to leave a 50-foot-wide strip of woods between the road and the construction site so as to obstruct the facilities from view.¹⁴³

Gen. Kingman had left the BEB in October 1945, after serving 4 years as an able and foresighted leader. By that time too, much of the wartime civilian personnel had begun to disband, and by January 1946, the BEB staff had been reduced to approximately 20 people.¹⁴⁴ Thus, with the expectation of increased research responsibilities, the BEB began to gradually acquire new skilled people to undertake the work. For example, Joseph M. Caldwell, who had been with the Strategic Intelligence Division, Office of the Chief of Engineers, during the war and had worked quite closely with the BEB, joined the Board staff in April 1946. Caldwell played a leading role in the development of the agency's research program. In the same year came Donald F. Horton and Albert C. Rayner, both of whom became largely involved in the work associated with the beach erosion reports. Figure 39 is a picture of the BEB staff in the fall of 1946. Other personnel who joined the BEB staff between 1946 and 1951 were: William J. Herron, Jr., Ralph L. Rector, George M. Watts, Thorndike Saville, Jr., and Rudolph P. Savage. It was also during this same period that Richard O. Eaton returned to the BEB staff. Since his departure from the agency some 10 years earlier, Eaton had served in the military and then resumed his work on coastal problems, first with the Corps of Engineers, Los Angeles District and after 1946 with the Corps' South Pacific Division Office in San Francisco. These men were to be key figures in the BEB's program in the years ahead.

To house the anticipated increase in staff which, by June 30, 1947, numbered about 35, a second wing was added to the BEB office building. The agency's own support personnel were largely responsible for the construction of this addition which was built in 1948-49.¹⁴⁵ Figures 40, 41, and 42 show this construction in its various stages of completion. The downstairs section of the wing provided new laboratory space, which was soon equipped with a much-needed third indoor wave tank measuring 96 feet long, 1.5 feet wide, and 2 feet deep.

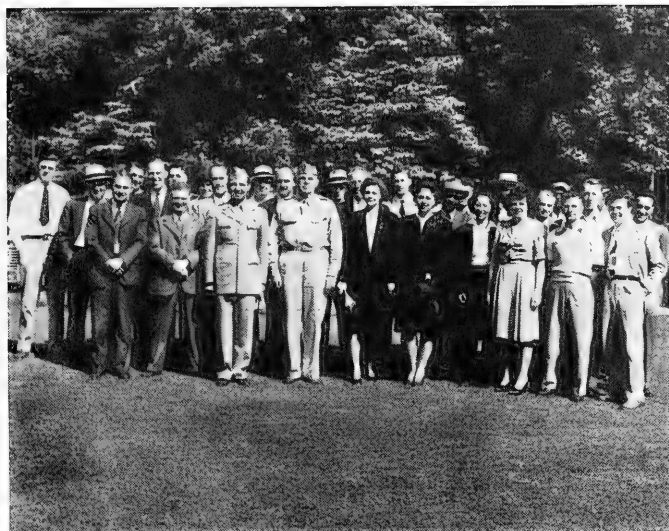


Figure 39. Staff of the BEB, fall 1946. (Picture taken by Richard H. Allen.)

Left to right:

Martin A. Mason	Ellen Moore
Charles Moyka	W. Clark Iseminger
Albert C. Rayner	Carol Rock Murray
Gene Dedick	Ralph C. Moody
Joseph M. Caldwell	William H. Vesper
Francis J. Service	Iris Tomasulo
Rand Segal	Leonard Madison
Lisle H. Senser, Jr.	Helen Keiser Zacker
Donald Horton	Harold A. Ward
Lt. Col. William Stelzenmuller	James W. Mason
Leo C. Williams	unidentified
Louis C. Spencer	Wendel Reece
Col. Charles L. Hall	unidentified
D. G. "Jimmy" Dumm, Jr.	Donald W. Sheehan
Culbertson Ross	Hugo Buonagurio

[Identifications provided by Ellen Moore.]



Figure 40. BEB staff workmen preparing foundation for another addition to provide increased office and laboratory space. Left to right: Frank Erwin, Jim Mason, and unidentified.

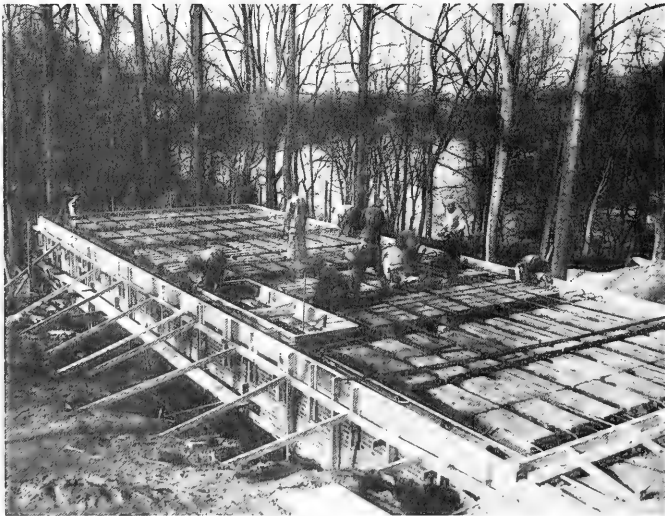


Figure 41. Addition to BEB office begins to take shape. Dalecarlia Reservoir is in the background.



Figure 42. Completed new wing which provided the BEB staff with added office and laboratory space, 1949.

The establishment of field groups was also part of the BEB's new research program of the postwar 1940's.* Originally, it was envisioned that there would be four such groups: One each for the Atlantic, Gulf, and Pacific coasts, and the fourth for the shores of the Great Lakes and other areas where needed. Their work was to include hydrographic surveying, beach research, and data collection, as well as involvement in the wave gage program which had commenced about the same time. Although this entire plan was not put into operation due to lack of sufficient funding, two field groups, with Jay V. Hall, Jr., in charge, were organized under the Field Research Section of the Engineering and Research Branch of the agency. These operated effectively for several years.

In early January 1947, the first group was sent to Pensacola, Florida,¹⁴⁶ where it remained for several months on Santa Rosa Island. This initial field activity at Pensacola involved a proof test of the water transparency method of depth determination and thus differed from the work done at other locations by the field groups. In the year that followed, these men worked at several sites along the Atlantic coast, including Manasquan, New Jersey, and Hollywood Beach, Florida. In February 1948, the group was sent to the west coast to set up operations at Long Beach, California. They remained in this general area for about the next 3 years, gathering a variety of data at beaches along a 130-mile stretch from Santa Monica to San Diego, California.¹⁴⁷

In the meantime, a second field group was created in mid-March 1948. These men were sent to Long Branch, New Jersey, and worked there until November of that same year. This group, using the BEB office as a home base, continued to engage in field activities at several beach locations along the east coast during 1949 and 1950.¹⁴⁸

These field operations required a large amount of various kinds of equipment, much of which was war surplus. This included such items as: large, amphibious vehicles known as DUKW's used for plying the surf zone; a tractor-trailer, which served as an office while in the field; jeeps; echo-sounding gear, along with other surveying, measuring, and sampling instruments (Figs. 43 and 44). At the peak of the field program, the BEB had a fleet of 10 DUKW's.¹⁴⁹ The operation and maintenance of the field equipment was the responsibility of several men including George P. Magill, Adrian D. Wrenn, and Clyde Shepherd. Field crew chiefs were William J. Herron, Jr. and later Robert L. Harris. Figure 45 is a picture of one of the field crews while at Long Branch, New Jersey.

The field groups were a rather expensive undertaking. It is not surprising, therefore, that with the effects of the Korean War being felt in other areas of the BEB research program, these activities were also curtailed. In May 1951, for example, the work in California was terminated.¹⁵⁰

Gradually, the Corps' District personnel were assigned the responsibility for performing the hydrographic surveying. The BEB field researchers continued to work at various beach

*The field group activity is one example of an idea that had been proposed during the mid-1930's but for which financial support had not been forthcoming at that time.



Figure 43. Equipment used in coastal fieldwork—DUKWs, tractor-trailer, and jeep.



Figure 44. DUKW coming through surf zone.



Figure 45. Field crew of the BEB on location at Long Branch, New Jersey, 25 June 1948. Left to right—top row: Magill, Cowley, Fuchs, and Edmonds. Left to right—bottom row: Shepherd, Wrenn, Harris, and Mathews. Note BEB emblem on the DUKW.

sites along the east coast into the early 1950's, but these later operations were usually associated with the installation and maintenance of wave gages.¹⁵¹ As a result of this alteration of function, the BEB began to distribute much of its field equipment to those Corps Districts where it was needed most, particularly those in New York and Los Angeles. The last DUKW was transferred about 1960.

Another integral part of the BEB's increased effort to secure greater knowledge concerning shore processes was the agency's sponsored research at various universities and institutions. In a very real way, the BEB had always consulted with members of the academic community, e.g., the early work of Douglas Johnson and O'Brien, among others. However, after World War II, when a greater amount of funding became available for the BEB's now officially recognized research program, it was decided that a more formal policy should be adopted in this regard.¹⁵² Negotiations were begun in 1948, and three contracts for the conduct of investigatory work were let the following year.¹⁵³ The first contractors under this arrangement were Scripps Institution of Oceanography, La Jolla, California; the University of California, Berkeley, California; and New York University, New York, New York.¹⁵⁴ These three were selected because of faculty expertise in coastal matters. The contract program enabled the BEB to supplement its own staff research by utilizing the highly qualified talent available in the academic community. The practice proved most successful and was expanded in the years that followed.*

The BEB also began to enter into contractual arrangements with the U.S. Army Engineer Waterways Experiment Station located at Vicksburg, Mississippi. One of the early collaborative efforts carried out at Vicksburg was a model study on the effects of uncontrolled tidal inlets on adjacent beaches.¹⁵⁶

The activation of the BEB's expanded research program had begun with the passage of Public Law 166 in the summer of 1945. Construction of test facilities, organization of the field groups, acquisition of skilled people, and contractual arrangements with universities and institutions were four key steps. The fifth was to decide upon which problems the Board's staff would pursue in its own laboratory. This required a careful evaluation of available funds, equipment, and trained personnel. The first research topics which were thus under investigation by spring of 1947 were: life of steel sheet piling, equilibrium beach profiles, model-scale effects, wave reflection, settling velocities of beach sand, and depth determination by use of the water transparency method.¹⁵⁷ The number of projects increased over the next few years as the program advanced.

At its December 1949 meeting, the seven-member Board had an extended discussion of the agency's research activities, including accomplishments to date, as well as long-range plans. It then adopted the following resolution of commendation:

*Other institutions which later participated in the BEB's contract program included: The Agricultural and Mechanical College of Texas, Massachusetts Institute of Technology, University of Florida, Virginia Institute of Marine Science, University of Miami, and University of Southern California.¹⁵⁵

“The Beach Erosion Board takes this opportunity to commend its technical staff on the preparation of a far-sighted program of research, on the formulation of experiments within this program, and on the progress made to date both in the field and in its laboratory.”¹⁵⁸

c. Other Developments and Changes. An interesting sidelight which resulted from the field group activity was the creation of the BEB symbol. It was decided that the field vehicles should carry some identifying emblem. Various members of the group collaborated with the drafting section which, at that time, was headed by Harold A. Ward, and devised the symbol shown in Figure 46. The Board gave its approval for the use of the symbol at a meeting on December 11, 1946.¹⁵⁹ The insignia was placed on all DUKW's and other field equipment, and soon became an integral part of the agency.

Because of the success of the BEB's wartime program, military beach intelligence was retained as an agency function. In the latter part of the 1940's, this work was grouped under the Studies and Reports Section. W. Clark Iseminger, who transferred to the BEB in January 1946 from the Corps of Engineers' Buffalo District, headed this postwar beach intelligence activity. When the BEB staff was reorganized in 1951, a separate Military Intelligence Division was set up with Iseminger as head. In time, this Division became the agency's largest, with a staff of about 30 civilians, plus 12 military personnel. Its financial support came from military funds, allocated by the Engineer Intelligence Division, Office of the Chief of Engineers.¹⁶⁰

This postwar period of change at the BEB also brought the revision of some agency procedures. One major change was the transfer of the responsibility for the preparation of the reports on beach erosion studies from the BEB staff to the engineers of the Corps' District offices. (Up to this time, the District offices had assisted the BEB by providing needed field data and other information. However, the actual compilation of the reports was done by the BEB staff.) This reassignment was made as of July 1946¹⁶¹ and was partly in response to the anticipated changes which were expected to accompany passage of House of Representatives Bill No. 2033 then pending in Congress. The main alteration that resulted from this bill which did become law the following month, was that the Federal Government was to participate in the actual financial recommendations concerning the construction of shore protection structures. This involvement, in turn, required a somewhat different type of beach erosion report than had been the case in the early years when Federal funding of construction was not a consideration. An economic analysis was now needed to justify Federal expenditures, and it was felt that this analysis could be more easily handled at the District level. Moreover, closer contacts with local governmental and civic groups were required and again, the District personnel were in a better position to establish and maintain these working relationships.

Under the new policy, the BEB staff maintained close liaison with the staffs of the District and Division engineers, provided technical advice and assistance when requested, and coordinated project arrangements. Additionally, they thoroughly reviewed all the beach



Figure 46. Identifying emblem of the BEB, adopted December 11, 1946.

erosion reports prepared in the District offices before their formal transmittal to the seven-member BEB for final consideration and action. To further assist the Districts in this transfer of assignment, the BEB also conducted classes "to train technical personnel in the establishment and latest techniques in coastal engineering."¹⁶² Not only did engineers from both the Corps' Districts and Divisions attend these classes but so too did new employees on the BEB's own technical staff, plus several engineers from State agencies. One of the valuable results of this procedural change in report preparation was that it helped to spread both interest in, and knowledge of, coastal problems among a far larger group of people.

The quest for greater expansion of the BEB's contribution to the field of coastal engineering, a quest which epitomized the postwar years, brought two further developments. The first of these was involvement of the agency in both overseas consultation on beach-related problems, as well as participation in international meetings. Although overseas consulting had really started during World War II, Jay V. Hall, Jr., and Harold A. Ward's trip to Puerto Rico in 1945 is generally considered as the beginning of these efforts.¹⁶³ (A listing of BEB staff and members' overseas consulting work and attendance at international meetings can be found in Appendix D.) This activity was expanded in the 1950's and will be discussed further in the section dealing with that period, as well the subject of international meetings.

The second development was the issuance of the "Bulletin of the Beach Erosion Board" which began in April 1947. This event should not be regarded as a direct result of the publishing provision of Public Law 166 of 1945, for legislation passed 9 years previously had also contained a similar directive. Rather, the publication of the BEB Bulletin is perhaps better explained by the fervor of the times. As stated in the Foreword of the first issue:

"It was felt by the Board that a quarterly bulletin* should be included among the publications of the Board, in order to disseminate timely information regarding research activities, cooperative beach erosion studies, and other items of interest to agencies concerned with the problem of beach erosion."¹⁶⁴

The contents of the Bulletin clearly demonstrate the Board's desire to do what it said—disseminate timely information on coastal matters. For example, up to about 1953, the Bulletin contained a listing of recent acquisitions to the BEB's library. These publications were available on a 30-day loan basis. Significant items from the scientific literature on coastal matters written in languages other than English and which had been translated, were also printed in the Bulletin. A case in point was the work of Ramon Iribarren Cavanilles. Several papers written by this prominent Spanish coastal engineer were obtained through the efforts of Richard O. Eaton, with the actual translation made at the University of California, Berkeley.¹⁶⁵ Then beginning in April 1952, the Bulletin began to carry progress reports of the research which was being done under the BEB contract program, as well as reports concerning its own in-house research activities.

*In 1956, the Bulletin was changed from a quarterly to an annual publication, with distribution in July of each year.

Beach erosion was now more than the concern of a handful of people. It had become a matter of national concern, and the BEB was working diligently to meet the challenge.

6. The Decade of the 1950's.

Several key personnel changes occurred within the BEB as the decade of the 1950's began. The first of these involved one of the three civilian members of the seven-man Board. Richard K. Hale, who had been a member since the Board was formed in 1930, resigned as of April 1, 1950. At its 86th meeting held May 2 and 3, 1950, the Board paid tribute to Hale for his long and faithful service. Hale's successor was Lorenz G. Straub.¹⁶⁶ Straub had many years experience in experimental wave work and had been director of the University of Minnesota's Saint Anthony Falls Hydraulic Laboratory, Minneapolis, Minnesota, since 1938. His membership brought to the Board a civilian representative of the Great Lakes area, one of the four major coastal regions of the country.* Straub continued as a member of the BEB until his death in October 1963.

The second change occurred in October 1950. Col. Earl E. Gesler replaced Col. Dabney O. Elliott as President of the Board and Resident Member of the Board's staff. Gesler occupied this position for the next 2½ years and took an active role in the agency's activities. Also in late 1950, Donald F. Horton, who had been head of the Studies and Reports Branch, transferred to the Office of the Secretary of Defense. This vacancy on the BEB staff was filled by Richard O. Eaton upon his return in January 1951.

Then in September 1951, Martin A. Mason resigned from the staff of the BEB to accept the appointment of Dean of Engineering at George Washington University. During his 11 years as head civilian, Mason's contribution, both as a scientist and as an administrator, had been of great importance to the agency.

One of Col. Gesler's first actions was the reorganization of the staff of the BEB, which now numbered some 77 people. Immediately prior to this time, the agency had been set up under four branches: Studies and Reports Branch, Engineering and Research Branch, Drafting and Reproduction Branch, and Administrative Branch. The new organizational arrangement consisted of five divisions: Research Division, Engineering Division, Reports and Publications Division (which later became the Project Development Division), Administrative Services Division, and Military Intelligence Division. The revised system also established the new position of Chief Technical Advisor, and this was first held by Martin Mason. Although there were several changes in the years that followed, this staff organization generally prevailed for the remainder of the BEB's existence.¹⁶⁷

After Mason's departure, Richard Eaton became Chief Technical Advisor. He occupied this position until December 1963, i.e., for the remaining period of the BEB's existence and for 1 month thereafter, under the new Coastal Engineering Research Center. Together with the advisory responsibilities associated with this office, that of liaison between staff and

*The other six Board members at that time were: Col. Dabney O. Elliott, President; Col. Earl E. Gesler; Col. Walter D. Luplow; Col. Richard W. Pearson; Thorndike Saville; and Morrrough P. O'Brien.

Board was also important. Moreover, the Chief Technical Advisor provided continuity for the Board's staff in the face of generally biennial changes in military staff administrators, a practice which began after World War II.

Reference has already been made to the effects of the Korean War on the new research program of the BEB. Not only was there a dwindling of funds for the construction of test facilities, but a considerable part of staff attention was again diverted from the civil functions to the military effort. Fortunately, this situation did not long prevail, and normal staff operations were resumed within a number of months.

In the meantime, coastal engineering was coming into its own, for the year 1950 marked the establishment of the Engineering Foundations Council on Wave Research. This Council was the result of conversations between Boris A. Baklmeteff of Columbia University and Morrough P. O'Brien, concerning the need for a nongovernmental group to coordinate research on waves and related matters.¹⁶⁸ O'Brien became Council Chairman and J. W. Johnson, then associate professor of engineering at the University of California at Berkeley, became Secretary.

In October of that same year, the Council on Wave Research, together with the University of California, sponsored an Institute on Coastal Engineering which was held in Long Beach, California. This 3-day-long meeting, the purpose of which was to summarize the existing knowledge related to design and planning of coastal works, was an important catalyst to the still somewhat fledgling field of coastal engineering. The 35 presented papers, a number of which were by BEB personnel, were later published in a volume entitled, "The Proceedings of the First Conference on Coastal Engineering."

Because of the success of the Long Beach Conference, various societies and universities extended invitations to the Council on Wave Research to cosponsor other meetings to continue discussion of coastal-oriented matters. Thus by 1963, the year of transition for the BEB, seven additional coastal conferences had been held in the following locations: Houston, Texas, 1951; Cambridge, Massachusetts, 1952; Chicago, Illinois, 1953; Grenoble, France, 1954; Gainesville, Florida, 1957; The Hague, Netherlands, 1960; and Mexico City, Mexico, 1962. An effort was made to hold the U.S. conferences in the various coastal areas and to focus on problems in those respective areas.¹⁶⁹

These coastal conferences not only stimulated activity in the field of coastal engineering, but also helped to coalesce both concern for, and interest in, shore matters. Moreover, extension into the international arena greatly aided the exchange of information and new knowledge. The BEB was represented at all these meetings and thus expanded its own horizons and, at the same time, gained wider recognition.

It was also in the early 1950's that the BEB contributed its first paper to the Permanent International Association of Navigation Congresses (PIANC). (The U.S. Army, Corps of Engineers is the United States Government representative.) This paper, on rubble-mound breakwater design, was presented by Col. Earl E. Gesler at the September 1953 meeting held in Rome, Italy.¹⁷⁰

a. *The Research Program.* By 1951, the BEB's research activities were divided into two broad groups. The first consisted of an attempt to isolate and then investigate the main physical factors involved in the understanding and solution of beach erosion problems. The following nine factors were selected for study:

- (1) Waves in deep water,
- (2) waves in shallow water,
- (3) currents in shallow water,
- (4) factors affecting supply and movement of beach material to the littoral zone,
- (5) significance of natural formations,
- (6) beach processes,
- (7) functional design and effects of manmade structures,
- (8) structural design of manmade structures, and
- (9) supporting investigations and activities.

Each of these subjects was divided into several subtopics. This compilation was "considered to be a fairly permanent statement of the factors involved in the solution of shore protection problems."¹⁷¹ There was also established a Priority Table which contained a list of the 10 most pressing problems for a given fiscal year. This Table was to be revised annually in order to better meet current needs.

The second of the two broad groupings of activity was a program to gather, and compile on a regional basis, existing data on the coastline of the United States. Increasingly, it was realized that an important element in better dealing with shore problems was the application of the physiographic unit, a concept emphasized by Martin Mason during World War II. Thus, it was felt that with data compiled for the various regions of the coastline, local problems within those regions could be handled more quickly. Moreover, if all existing information were gathered and evaluated, then the needs for any additional fieldwork could be clearly pinpointed. Each regional report was to have five chapters: Geomorphology, Littoral Forces, Littoral Materials, Littoral Measurements, with the final chapter consisting of a Summary and Conclusions.

b. *Technical Report No. 4.* For a number of years, there had been appreciation of the need for some form of manual for the design of shore protection structures. Although much knowledge had been gained on the subject, there existed no compilation of data representing the current state-of-the-art. The engineer faced with a coastal problem had no basic source to which he could refer. To meet this need which, by the late 1940's, had become acute, the BEB decided in October 1948 to prepare such a publication.¹⁷² Format planning and the collection of data were initiated. The Board's staff and library were ideally suited for an undertaking of this kind.

Thus, the first major BEB project following Eaton's appointment as Chief Technical Advisor was the actual preparation of what was to become the agency's fourth technical

report. The task group initially assigned to work on the project was headed by Kenneth P. Peel, whom Eaton recruited from the Corps of Engineers' South Pacific Division to come temporarily to the BEB for this purpose, and Kenneth Kaplan of the Board's staff. Other BEB personnel who participated in the task group were R. H. Allen, C. T. Fray, R. L. Harris, W. J. Herron, Jr., T. Saville, Jr., W. H. Vesper, and L. L. Watkins. Although virtually all members of the technical staff worked on the project, the basic responsibility for producing the document was assigned to the Board's Engineering Division under the direct supervision of Jay V. Hall, Jr., and the general supervision of Col. Earl Gesler and Richard Eaton.

The first fruits of this extensive undertaking were published in March 1953 as Special Issue No. 2 of the BEB Bulletin. This draft report was distributed to all coastal District and Division offices of the Corps of Engineers, and to select universities and engineers for review and criticism. Robert A. Jachowski and George M. Watts of the BEB staff then made revisions based upon the comments and suggestions which were received; Albert C. Rayner and Ralph L. Rector edited the report for publication. The final draft was reviewed and approved by the seven-member Board, the members of which, at that time, were: Col. Leland H. Hewitt, President; Col. Wendell P. Trower; Col. Herman W. Schull, Jr.; Col. John U. Allen, Resident Member; Thorndike Saville; Morrough P. O'Brien; and Lorenz G. Straub¹⁷³ (Fig. 50). The document, entitled "Shore Protection Planning and Design," was issued in June 1954 as Beach Erosion Board Technical Report No. 4 (TR-4).

This 390-page publication of the BEB represented a major step forward for the field of coastal engineering. For the first time, it presented in one report "techniques currently used in the solution of shore protection problems."¹⁷⁴ The term *shore protection* (as used in TR-4) was to apply "primarily to works designed to stabilize seacoasts and shores of large bodies of water where wave action is the principal cause of erosion."¹⁷⁵ The report was divided into two parts—Functional Planning and Structural Design—and included six appendixes.¹⁷⁶ One of these was a 39-page glossary of terms, while another contained an example of a beach erosion control study, with a detailed presentation of the functional and structural features of the plan of improvement. TR-4 which, by 1956 had been translated into French and Spanish,¹⁷⁷ was destined to receive worldwide distribution. This global interest in the BEB's work helped to further establish the BEB as the Federal Government's leading agency in the now international field of coastal engineering.

In terms of the agency itself, TR-4 was more than a publication. The needs which had created the report in the first place were continually changing as new advances in knowledge were made. Thus, work on updating became a major, ongoing responsibility of the staff of the BEB. The first revision was issued in August 1957, and incorporated into the report new material on hurricane waves, along with a section on wind setup and storm surge.¹⁷⁸ Then in May 1961, a second edition was issued.*

*The BEB's successor agency, Coastal Engineering Research Center, has continued this work. A third edition was issued in June 1966. TR-4 has been replaced by the "Shore Protection Manual."



Figure 47. Maj. Gen. Samuel D. Sturgis, Chief of Engineers, talking with BEB President and Resident Member Col. Earl E. Gesler, at the BEB's office in Washington, D.C., 5 February 1953.



Figure 48. Gen. Sturgis and Board members discussing aspects of the agency's research program with BEB staff. The BEB's 85-foot wave tank is in the foreground. Left to right: M. P. O'Brien, Thorndike Saville, Richard O. Eaton, Lorenz G. Straub, George M. Watts, Thorndike Saville, Jr., Maj. Gen. Samuel D. Sturgis, Col. Earl E. Gesler, Herman P. Van Eckhardt, and Morrison Essick.

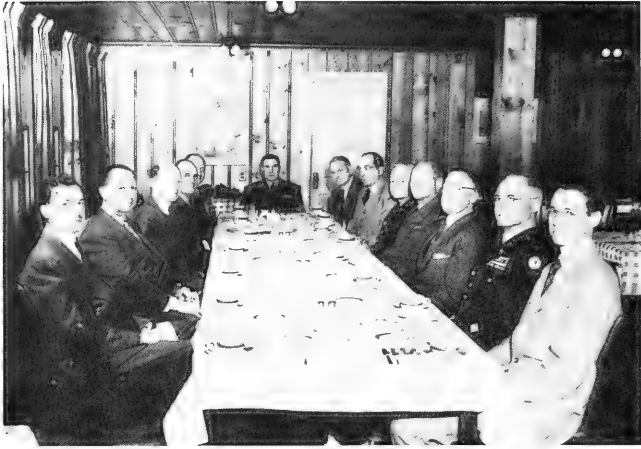


Figure 49. Group at luncheon the day of Gen. Sturgis' visit to the offices of the BEB, 5 February 1953. Left to right: W. C. Iseminger, Richard O. Eaton, Lorenz G. Straub, Col. H. W. Schull, Jay V. Hall, Jr., Maj. Peter Somers, Albert C. Rayner, Morrrough P. O'Brien, Col. Earl E. Gesler, Maj. Gen. Samuel D. Sturgis, Thorndike Saville, Col. Leland H. Hewitt, and Thorndike Saville, Jr.



Figure 50. Membership of the seven-man Beach Erosion Board at the time BEB Technical Report No. 4, "Shore Protection Planning and Design," was approved. Photo dated 10 February 1954. Left to right: Col. H. W. Schull, Col. Wendell P. Trower, Thorndike Saville, Col. Leland H. Hewitt, President of the Board, Lorenz G. Straub, Morrrough P. O'Brien, and Col. John U. Allen, Resident Member.

c. *The BEB's 635-Foot-Long Wave Tank.* The 635-foot-long wave tank of the BEB proved to be a valuable tool for assessing scale effects and for determining solutions to shore protection problems. Because of its unique qualities, it is fitting that, within a discussion of the history of the BEB, there should be some elaboration regarding the application of this research facility.

Dedicated at ceremonies held 18 October 1955, the 635-foot-long tank brought a considerable amount of attention to the BEB. A number of newspapers and magazines carried articles describing this large wave tank which, when filled to test level held approximately 1 million gallons of water.¹⁷⁹ Photos of manmade 6-foot breakers (Fig. 36) were usually included in the news items. This notoriety extended well beyond the borders of the United States, and attracted visitors from abroad.*

From an actual research point of view, the facility became the center of constant activity as soon as it was fully completed. The first test run in the large wave tank was on beach equilibrium profiles. This was a research topic that had been studied at the BEB for a number of years, and these tests added unique data at prototype scale. While this experiment was underway, additional information was also obtained concerning sand suspension in breaking waves for comparison with field data from Mission Bay, California, and small-scale laboratory data.¹⁸⁰ If secondary experiments could be carried out in this way in conjunction with a primary experiment but in no way interfering with the primary test, this practice was done to assure optimum use of the facility.

A second experiment run in the 635-foot tank was concerned with wave runup and overtopping. These tests were begun in connection with a study for the Corps of Engineers' Jacksonville District, and involved proposed levee construction at Lake Okeechobee in Florida. The Lake Okeechobee study was an example of particular answers being provided for a particular problem through research, but which information could then also be interpreted and used in broader terms for a wide range of problems. The end product was the determination of a lower levee height than had been considered, "at a saving of about four million dollars per foot of levee elevation."¹⁸¹ The tests also provided data used, together with small-scale laboratory data, to develop the generalized curves for wave runup and overtopping which appeared in the 1957 revision of TR-4.

Additional work done in the BEB 635-foot-long wave tank included rubble-mound stability tests; an investigation related to the proposed construction of a perched beach in conjunction with an offshore causeway at Santa Monica, California; wave forces on pilings; and development and testing of various types of field instruments. Leo C. Williams, for many years chief of the BEB's Instrumentation Branch, was closely involved in this latter activity. Through his efforts, such equipment as the step-resistance wave gage and the analog wave spectrum analyzer were perfected at the BEB.¹⁸²

On several occasions, tests were run in the large tank for other government agencies as well as for private companies. (Testing for private firms was very limited, being conducted in

those instances where the BEB's 635-foot tank was the only adequate facility available in the United States and where results would be of general public benefit. Moreover, the Chief of Engineers had to grant approval.) This work was done on a reimbursable basis and included tests for the U.S. Navy, the U.S. Army Engineer Waterways Experiment Station, and Humble Oil Company.

d. The Hurricane Studies. In 1954, the eastern and southern coasts of the United States experienced severe damage from several hurricanes, particularly the ones which struck in late August (Hurricane Carol), early September (Hurricane Edna), and mid-October (Hurricane Hazel) of that year. On June 15, 1955, Congress responded to this series of calamities by passing Public Law 71, which authorized the Secretary of the Army, "in cooperation with the Secretary of Commerce and other Federal agencies concerned with hurricanes,"¹⁸³ to make an examination and survey of the eastern and southern seaboard with respect to these tropical storms.

In accordance with this directive, the Office of the Chief of Engineers set up a Hurricane Study Coordinating Committee to organize and coordinate a study program. Two BEB staff members, Joseph M. Caldwell and Thorndike Saville, Jr., were appointed to this Committee. Because of its experience in the field of wave research, the BEB was assigned that part of the program which involved wave and wind tide* determinations.¹⁸⁴ The agency incorporated this assignment into its own research activity through both in-house and contract efforts.

The Hydrometeorological Section of the Weather Bureau, which is supported by the U.S. Army, Corps of Engineers, established guidelines for identification of hurricane characteristics in the Gulf of Mexico and Atlantic Ocean. The BEB then used these parameters to predict both the increased water levels that would accompany a given design hurricane, and also the wave heights as well as the forces induced by these waves to which shore structures would be subject.¹⁸⁵ Among the researchers who made significant contributions to this hurricane program were Robert O. Reid, Texas A & M; Charles L. Bretschneider, who did contract work for the BEB while at Texas A & M, and later joined the BEB staff; Thorndike Saville, Jr., of the BEB staff; and Basil W. Wilson of Texas A & M.

The hurricane legislation had an effect on the review procedure for beach erosion reports. Up to this time, the seven-man Beach Erosion Board reviewed all Corps of Engineers District-prepared project reports which dealt with beach erosion. Those concerned with other Corps responsibilities, such as flood control and navigation, were reviewed by the Corps' Board of Engineers for Rivers and Harbors (BERH). Since July 1946 when the Districts were assigned the task of preparing beach erosion control reports, there had been occasions where one report would involve beach erosion along with, for example,

*Wind tide also referred to as storm surge, is a rise above normal water level on the open coast due to the action of wind stress on the water surface. With a hurricane, there is an added water level rise due to atmospheric pressure reduction.

**This work has proven valuable in other respects as well. For example, it is presently used to determine maximum water levels for nuclear powerplant sitings in the coastal zone.

navigation. Both Boards would then have to review this report, but instances of this kind were few. However, after the hurricane work became a responsibility of the Corps of Engineers, the need for both the BEB and the BERH to review the same reports became increasingly frequent. This dual review requirement resulted from the fact that shore protection became more and more an integral part of projects for hurricane protection. Furthermore, while the BERH reviewed that section of reports which focused on hurricane-related proposals, the BEB was legislatively assigned the review responsibility in regard to shore protection. The ramifications of this development will be discussed later.

e. New Techniques in Shore Protection. Through World War II, the main approach to the beach erosion problem was structural.* That is, if beach erosion had become a problem at a valuable resort, structures of one kind or another would generally be built in an effort to impede the erosion and protect the shoreline. The object of many of these early structures was to attempt, in some way, to lessen the impact of the waves on the beach and/or to prevent sand losses. These structures (seawalls, revetments, bulkheads, groins, or breakwaters) met with varying degrees of success. By the 1920's and 1930's, they had proliferated along certain resort sections of the Nation's coastline, especially the New Jersey shore, to such an extent that these structures actually impeded the recreational use of the beaches they were built to protect¹⁸⁶ (Figs. 51, 52, and 53).

In some instances, structures built along the coastline for navigation purposes were the primary cause of a downdrift beach erosion problem. This development was associated in most cases with jetties. As was stated earlier, the purpose of jetty construction was usually to maintain a navigable channel at an inlet so that boats of a given size could pass through safely. The effects of such structures on adjacent shorelines have also been discussed previously.

As a result of World War II, technology had taken a giant stride forward. Machines for altering the physical features of the landscape were now much bigger; power-driven equipment enabled man to handle quantities of rock and earth in a time frame never before thought possible; improved construction materials were available. Based on these considerations, one might expect that many of the less substantial shore protection structures built before the war would have been replaced with larger and stronger structures. Generally speaking, however, this was not the case. The main reason was that an important change in thinking had evolved.

Rather than using the traditional coastal structures of the past, which generally worked against the forces of the ocean waves, it was increasingly realized that, in many situations, beaches would be more successful if techniques were used which worked *with* these forces. This line of thought placed emphasis on the beach itself and on that vital commodity, sand. It was found that beaches were more effective as dissipators of wave energy than were fixed structures.¹⁸⁷ Additionally, beaches were also more desirable from the esthetic as well as recreational point of view.

*The term *structural* here is used in its purest sense, i.e., it refers to "fixed" coastal structures which have been built by man.



Figure 51. A series of groins and wooden revetments impede recreational use of beach at Deal, New Jersey, 13 August 1936.



Figure 52. Groins, timber breakwaters, and a jetty detract from the esthetics of this beach at Longport, New Jersey, 26 August 1933.



Figure 53. Groins and breakwaters interrupt this beach at Long Branch, New Jersey (south of the pier), 6 August 1933.

It had been established that if the configuration of a given stretch of beach remains basically the same over a period of years (allowing for seasonal variation), then it is generally considered to be in equilibrium. Because a beach is always changing, equilibrium means that the amount of sand moving into the stretch of beach is the same as the amount of sand being carried away by wave or current action (viewing the stretch of beach in this instance as an open system).

If, for some reason, the sand supply moving into the same system is decreased, then erosion of the existing shoreline will occur. This is because the material available for the waves to transport is now of a lesser amount, while the energy of the waves has remained the same. Consequently, this energy is utilized in eroding the beach.

Based on these fundamental principles of nature, two innovative shore protection techniques became increasingly common in the years following World War II. The first of these is known as sand bypassing. This technique has most often been used where jetties and/or breakwaters have been built. These structures, by either extending into the nearshore zone or altering wave conditions, can interrupt the natural movement of sand which occurs along the coastline generally in one predominant direction, by means of the longshore current. Sand bypassing is a technique by which sand is transferred, using one of several mechanical methods, from the accreting side of the structure to the eroding side. In this way, the sand is again made available for transport by the waves along the downdrift shore, and the beach along this downdrift shore can thereby be regained and stabilized.

One of the first places in the United States (and perhaps in the world) where this concept was actually applied was at Santa Barbara, California, in 1935 where an erosion problem had arisen after local interests had constructed a breakwater a few years previously. This first effort of sand bypassing at Santa Barbara was not completely successful in that the transferred sand was placed in about 22 feet of water—too deep to be picked up by the longshore current.¹⁸⁸ Later work, including studies and field inspection by the BEB, corrected the situation by having the sand placed directly on the downdrift beach. With periodic repetition of this bypassing operation, the seriousness of the erosion problem east of the Santa Barbara breakwater gradually eased. Some 8 miles of eroding beach along the downdrift shoreline were stabilized.

After World War II, continued improvement in equipment facilitated greater use of sand bypassing. This was combined with increasing knowledge of shoreline processes and more factual data concerning the amount of sandy material that annually moved along a given unit of beach. A considerable part of the research effort of the BEB staff was directed toward this important topic, and helped provide some valuable answers.

The second shore protection technique which became more common starting around the late 1940's, is what is known as beach nourishment or beach replenishment. This involves the periodic placement by mechanical means of a given amount of sand (which is obtained from outside the coastal unit in question) onto a beach to either: (a) Provide protection by

way of an expanded beach to an already existing shore protection structure, and/or (b) to counteract the gradual wearing back of a shoreline. In this latter instance, a stretch of beach is, for some reason, not receiving as much sand as the waves are transporting away. In cases where beach nourishment is applied, however, the problem being corrected is generally not man-induced, as is usually the case where sand bypassing is required.

The idea of placing sand onto a shoreline was not new.* Pumped sand had been used in the 1920's, for example, to enlarge and/or create several recreational beaches near the New York metropolitan area such as Rye Beach¹⁹⁰ and Coney Island.¹⁹¹ What was different about these early efforts in New York and those following World War II was essentially one of purpose.¹⁹² Sand had been pumped onto Rye Beach to enlarge the beach and thereby enable it to accommodate more people for recreation. Beach nourishment, on the other hand, was a "protective" measure.¹⁹³ By periodically adding more sand to the "supply" end of a unit of beach, the input into the system would more closely balance the amount of sand moving out of the system. The intended result would be to create a new equilibrium and thereby stabilize that segment of shoreline.

Studies had begun to illustrate that beach nourishment was feasible from a purely economic point of view. A second consideration was one of esthetics—periodic beach replenishment normally did not require an array of sometimes unsightly shore protection structures. But more importantly, and to quote Jay V. Hall, Jr., from a paper he wrote on the subject in 1952, "there has developed a growing recognition of the fact that preventing erosion by means of protective structures is a dangerous practice, in the sense that in many cases such protection is secured at the expense of producing an ever-expanding problem area."¹⁹⁴ To elaborate on Hall's statement, when a coastal structure is built to protect a stretch of beach from erosion by retaining sand or decreasing wave action in the area, that particular stretch of beach is generally preserved. However, the adjoining downdrift segment of shoreline is then exposed to the same wave conditions as before, but these waves are now denied the sand source which had come from the previously unprotected area. This leads to erosion of the adjoining beach. The wave-sand system is still out of balance and as long as this situation prevails, erosion will continue. Beach nourishment deals directly with this problem of imbalance rather than with its symptoms.

A greater amount of BEB research became concerned with the problems related to beach nourishment. It was found, for example, that the grain-size and size distribution of the material to be placed on a beach were important parameters in a beach replenishment program. The need to know both the gross and the net volume of sand per unit of time moving alongshore was also vitally important. Furthermore, greater emphasis on beach replenishment began to raise questions regarding sand reserves. Well into the 1950's, the opinion was that the back-bay areas (i.e., lagoons, estuaries, and sounds) along the Nation's coastline could adequately provide all the material that would be needed for beach nourishment projects.

*As early as 1916, Elliott J. Dent made the following observation, "The writer knows of no means by which exposed sandy beaches for surf bathing may be preserved, except by feeding fresh beach material to them as rapidly as the old material is carried away."¹⁸⁹

Beach nourishment also affords a good illustration of another important aspect of the BEB staff's research activity. The BEB was really a pioneer in the advancement of periodic beach replenishment as a means of stabilizing a beach. Projects using the technique were undertaken even while there were still a number of unknowns related to it. Gradually, more and more was learned about the reactions of waves and beach to the periodic placement of sand.

One of the key sources of such information has been the followup study. These studies were undertaken to evaluate the beach nourishment project in question, to see how the beach fill behaved over a period of several years, to determine whether the placed sand was too fine or too coarse, to compare techniques used in different projects, and also to establish differences related to wave and beach conditions at various coastal locations. The Board's staff conducted followup studies of this kind at Ocean City, New Jersey; Harrison County, Mississippi; Virginia Beach, Virginia; Prospect Beach, New Haven, Connecticut; Seaside Park, Bridgeport, Connecticut; and Presque Isle, Pennsylvania (along the shore of Lake Erie).¹⁹⁵

The followup procedure was not limited to beach nourishment projects. Other types of completed Corps of Engineers shore protection projects were also reexamined to judge performance of various structural components. These studies provided a wealth of useful information which, in turn, was utilized in plans for new projects so as to apply the benefits learned from past experiences.

But up until 1956, there was a major stumbling block to encouraging local agencies, who were sponsoring cooperative beach erosion control projects, to use beach nourishment rather than building a structure. This stumbling block was related to legislative interpretation. The periodic pumping of sand onto a beach was interpreted as being a form of maintenance. By law, the Federal Government was allowed to provide financial assistance toward the first costs of construction of shore protection structures but was prohibited from providing any funding for purposes of project maintenance. Thus, Federal funds were unavailable for beach nourishment projects, and local interests, sensing high periodic costs for which they would be fully responsible, were therefore either unable or unwilling to utilize this form of shore protection.¹⁹⁶

To rectify the situation, legislation was sought which would permit beach nourishment to be considered as deferred "construction" rather than as maintenance. In Public Law 826, approved July 28, 1956, this adjustment was made. The result was an expansion in the number of beach nourishment projects.

f. Public Law 826 (1956). Public Law 826 was an amendment to Public Law 727, passed in August 1946. The importance of this new legislation went beyond the provision which would allow Federal assistance for periodic beach nourishment. Regarding the funding of the local share of construction costs of shore protection projects, Public Law 826 clarified the matter of responsibility. It stated that, "the Federal contribution in the case of

any project . . . shall not exceed one-third of the cost of the project, and the remainder shall be paid by the State, municipality, or other political subdivision in which the project is located.”¹⁹⁷ The practice that was generally established was that the remaining two-thirds of the costs would be distributed in some fashion between the local community, county, or State. The agency sponsoring the project could be from any one of these governmental levels.

Up to this time, no Federal moneys had been available under any authorized program to help in the protection of privately owned shorelines. In fact, Congress had gone out of its way to prevent the establishment of such a policy. In terms of adequately dealing with shore erosion, however, this ruling had presented numerous problems of its own. For example, the ruling made it difficult to apply in the field the concept of the physiographic unit of beach. Part of that might be privately owned, part Federally owned, and part owned by a State or other political subdivision. Theoretically, any funds allotted by the Federal Government could not be used in such a way as to provide shore protection for that section of the beach in private ownership.

Public Law 826 attempted to deal with this situation in a more realistic, yet equitable, fashion. It stated several conditions under which “shores other than public” would be eligible for Federal financial assistance. One of these conditions was “if there is benefit such as that arising from public use or from the protection of nearby public property.” Another was if the benefits to the private shore were “incidental” to a project protecting public property. However, there was the stipulation that the Federal contribution to projects that provided benefits to other than public shores was to be adjusted “in accordance with the degree of such benefits.”

If, for example, the shorelines to be protected were all publicly owned, and the total first costs of the approved project was \$3 million, then the Federal financial aid, at that time, would have been one-third of these first costs, or \$1 million. Now consider the case where one-half of the property is publicly owned and one-half of the property is privately owned. Assume that it has been determined that of the benefits that would be developed from the protection of this private section, one-quarter of them would, in some way, accrue to the general public, while the remaining 75 percent would be private benefits. For comparative purposes, it is also assumed that the proposed project costs \$3 million and that this cost is proportioned exactly 50-50 between the public and private property. Barring any complicating factors, the Federal share for the public section would now be one-third of \$1.5 million or \$500,000. The Federal share toward the private section would be \$1.5 million multiplied by one-third times the ratio—public benefits in private section, total benefits in private section. Thus, the adjusted rate for Federal cost-sharing in the privately owned segment would be one-third times one-fourth, or one-twelfth. One-twelfth of \$1.5 million is \$125,000. The “total” Federal contribution for the entire \$3 million shore

protection project would therefore amount to \$625,000. This straightforward, illustrative case shows how increasingly complex Federal funding of shore protection projects became once it was decided to allow the inclusion of privately owned property.¹⁹⁸

g. Proposed Mergers and Relocations of the BEB. The postwar 1940's were years of readjustment and change. It was during this period that there first began to be discussions of possible organizational and locational alterations involving the BEB and its staff.¹⁹⁹ These discussions were usually in connection with the Board of Engineers for Rivers and Harbors, another agency within the U.S. Army, Corps of Engineers. The BERH was, at that time, without a permanent office location.

In the late 1940's it was suggested that there be a consolidation of the staffs of the BEB and the BERH. Discussion on the matter continued into the early 1950's. One of the purposes of the proposed merger was to better coordinate the work of the two Boards, as well as to strive for more economical use of administrative personnel.²⁰⁰ It was recognized, however, that the BEB, with its research-oriented staff, and the BERH were both unique unto themselves. The matter was resolved in the spring of 1955 when a decision was made to keep the BEB and the BERH as two separate entities.²⁰¹ Two alternative proposals, to construct on the Dalecarlia Reservation a new, larger office building to house the two Boards and their staffs, and to construct on the BEB's office building an addition for the BERH, were also set aside at different times, largely because of building restrictions in that area.

In keeping with the Corps of Engineers' efforts to maximize the efficiency of its various groups, it was also suggested at one time that the research functions of the BEB be consolidated with the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi. After a thorough investigation of this proposal, it was concluded that the interests of the public could best be served if the research activities of the BEB were retained by that agency.²⁰²

In 1957, the first serious consideration was given to relocating the entire installation of the BEB at Fort Belvoir, Virginia.²⁰³ At that time, a parcel of land adjoining the acreage where the BEB office and laboratory were located was being discussed as a possible site for a new hospital. These discussions brought attention to the fact that the BEB was situated on lands bordering the Dalecarlia Reservoir, the main source of water supply for the District of Columbia.²⁰⁴

The matter was carefully evaluated from many points of view, with the decision being that the BEB should remain at its location on Little Falls Road, N.W.

7. Events of the Final 4 years of the BEB.

One of the factors that had been discussed in regard to various proposed changes in BEB office facilities was the fact that the agency's library needed more space. The BEB was, by this time, an internationally known organization. Yet, its library did not have room to

expand in order to better meet not only the needs of the staff but also the public, which used the library as a major resource. Thus, in May 1960, an addition to the BEB office building was completed, just to the west of the 85-foot wave tank.²⁰⁵ The library was moved into this new section, and a program was begun to enlarge the collection. The addition also provided a much-needed conference room.

a. *Public Law 645 (1960)*. In July 1960, Public Law 645, 86th Congress, was passed. Section 103 of this law made several amendments to Section 2 of Public Law 520 passed July 1930, the authorizing legislation for the BEB. First of all, it listed the States of Alaska and Hawaii, and the Commonwealth of Puerto Rico as being areas where cooperative beach erosion studies and investigations could be made. Prior to this time, these locations had come under the category of “territories and possessions.”

Secondly, the requirements for the non-Corps of Engineers members of the seven-man BEB were changed to read, “. . . and three shall be civilian engineers selected by the Chief of Engineers with regard to their special fitness in the field of beach erosion and shore protection.”²⁰⁶ The original wording had been, “and three shall be selected with regard to their special fitness by the Chief of Engineers from among the State agencies cooperating with the War Department” (in the conduct of beach erosion studies).²⁰⁷ As these three members no longer had to be associated with a State agency, Public Law 645 also provided for payment to them by the Federal Government, in addition to travel expenses.

Starting in the late 1950’s and extending into the 1960’s, there was begun in this country a major Federal program to expand our knowledge of the oceans. The impetus for this program was generated by a report of the National Academy of Sciences.²⁰⁸ It was based on the belief that the oceans represented an enormous reserve of both food and natural resources which, up until then, had not received adequate attention.

Several governmental committees and other investigatory groups were set up to study the situation. One of these was the Interagency Committee on Oceanography, and Joseph M. Caldwell and Thorndike Saville, Jr., of the BEB represented the Corps of Engineers in the workings of this Committee. It was a few years before this oceanographic program was actually put into operation. One result, however, was an augmentation of available research funds for the various Federal agencies engaged in oceanographic-related work. The BEB was one of these agencies. This increasingly favorable financial situation prevailed through the latter half of the 1960’s and gave the BEB’s successor agency a strong research footing.

The growing internationalism of coastal engineering during the two preceding decades has been commented upon previously. As the 1950’s had progressed, the world’s political climate began to change, and this change had direct implications for the BEB. Just as Board members and staff increased their activity in coastal problems abroad, so did more engineers from other nations begin to visit the Board (Figs. 54, 55, and 56). Some came for inspection tours, while others attended weekly training courses in the various aspects of coastal engineering.²⁰⁹



Figure 54. Liberian officials conferring on a coastal engineering problem with two members of the BEB, and the Board's Chief Technical Advisor, 1954. Left to right: Richard O. Eaton, BEB Chief Technical Advisor; Morrough P. O'Brien, BEB Member; President Tubman of Liberia; Col. Wendell Trower, President of the BEB; and Richard Jones, Liberia Mission Director for the International Cooperation Administration. (Photo by Henry Pratt, Monrovia, Liberia.)

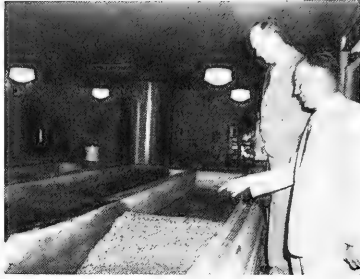


Figure 55. In the early 1950's, Sir Claude C. Inglis, Director of the Hydraulics Research Station, Wallingford, Berkshire, England, was one of the numerous visitors from abroad to tour the facilities of the BEB. Here Joseph M. Caldwell of the BEB staff is showing Sir Claude Inglis the results of a series of tests run in the 85-foot wave tank to determine the effect of the size of beach material on beach slope.



Figure 56. Joseph M. Caldwell and Sir Claude C. Inglis examining a wave record. Col. John U. Allen, BEB Resident Member, looks on.

The BEB's international role is further reflected by the agency's participation in a number of programs involving other countries. In 1958 there was the International Geophysical Year Program, for which the BEB provided wave data. When the Third International Course in Hydraulic Engineering was held in Delft, The Netherlands, from October 1959 to September 1960, Rudolph P. Savage of the BEB's staff attended. Sixteen nations were represented at this year-long course.²¹⁰ Then in the early 1960's a cooperative study was undertaken between the BEB and the Hydraulics Research Station in Wallingford, Berkshire, England.²¹¹ This study involved the use of fluorescent tracers in model testing. Duplicate tests were run at small scale in England and at large scale in the BEB's 635-foot-long wave tank.

The BEB's Military Intelligence Division was also affected by the easing of international tensions. The work of this group, which initially consisted of gathering and evaluating data on foreign coastal conditions, had originated during a period of world turmoil and hostility. When John R. Vogler succeeded W. Clark Iseminger in the fall of 1959 as head of the Division, efforts were expanded to include such things as the analyzing of foreign scientific literature dealing with coastal engineering generally, and making this information available to coastal engineers and scientists in the United States. Volger suggested that the Division name be changed to the International Division. This was done in April 1961.²¹²

In 1962 it was decided that the various segments of the U.S. Army which were engaged in intelligence work, including parts of the Corps of Engineers, should be united into one group. The U.S. Army Area Analysis Intelligence Agency (USAAAIA) was organized in July of that year. The International Division left the BEB, physically as well as organizationally, in the fall of 1962 and became a part of this new agency.²¹³ Thereafter, beach intelligence was no longer a function of the BEB.

b. The March 1962 Storm. In early spring of 1962, the Atlantic seaboard of the United States experienced a storm that was destined to have a considerable effect on the BEB (as well as its successor agency). This moderately intense, extra-tropical storm, with winds of 40 to 45 miles an hour, had several unusual behavioral features. Most storms of this type move out over the North Atlantic Ocean and gradually dissipate. The March 1962 storm moved slowly out over the Atlantic, but in the meantime, a high-pressure system had come down from the north and impeded the storm's northeastward course. This forced the storm to slowly drift east-northeast and also resulted in its developing an elongated shape. This elongation gave the northeasterly winds a 1,000-mile fetch of open water. Thus, the prolonged high seas that struck the east coast of the United States resulted from both the storm's slow movement and the long fetch.²¹⁴

Winds generated from the storm forced the ocean waters to "pile up" against the shores of the eastern seaboard States, especially the area between Cape Hatteras, North Carolina, and southern New England. This increased water level lasted through four complete tidal cycles, during which five high tides occurred. These tides also happened to be perigee

springtides.* It was this prolongation of superelevated water which was the critical factor as far as the destruction of the coast and the built-up areas along the coast were concerned. The raised water level allowed the waves to cut into the backshore of the beaches; along the various reaches of barrier islands, numerous breakthroughs and washovers occurred. Moreover, the high waves removed to offshore locations an enormous amount of material from the beaches and dunes, only a part of which was subsequently returned to the beaches by normal wave action. Total damage was estimated at over \$200 million and 28 lives were lost.²¹⁶

The March 1962 storm was one of the most physically destructive and monetarily costly storms to ever hit the eastern coastal zone of the United States. While the States of New Jersey, Delaware, Maryland, Virginia, New York, and North Carolina were declared disaster areas, actual shore damage extended from northeastern Florida to New England.

Immediately following the storm, an emergency program was put into operation, and the BEB was intimately involved in the work. The BEB staff was organized into teams and each team went to the various Corps of Engineers' District offices located in the stricken areas. Damage to beaches was examined and technical advice given regarding remedial measures.

One of the first concerns was to provide some form of beach protection in the event another storm should soon strike the area. The best solution was to replenish with sand those beaches which were in poorest condition. To assist in this effort, the BEB staff, under the direction of Joseph M. Caldwell, then Chief of the Research Division, utilized data obtained from an experiment on shore erosion by storm waves²¹⁷ run a few years previously in the 635-foot-long wave tank. Additional emergency tests were conducted in the large tank between April and August 1962.²¹⁸ Based on these two sources of data, guidelines were developed for the amount of sand to be placed along a given stretch of eroded beach to protect that beach from a storm with a recurrence interval of once in 10 years. These guidelines became known as the Caldwell Section.²¹⁹ The North Atlantic Division Office of the Corps of Engineers then applied the Caldwell Section to poststorm emergency operations in the field.** As a result, some 11,800,000 cubic yards²²⁰ of sandy material were transferred from back-bay areas and pumped or otherwise placed on the shoreface to restore eroded beaches.

This enormous demand for quantities of sand for beach nourishment made increasingly evident an important fact that had already been realized at the BEB. This fact was that the material which accumulates in estuaries and lagoons was less satisfactory for beach

*Springtides are tides which occur about twice a month at new moon and at full moon. Due to the earth's position in relation to the sun and the moon at these two lunar phases, springtides are about 20 percent greater than the average tide.

When the moon is at perigee, it is in its orbital position closest to the earth. This fact also increases the average height of tides by 15 to 20 percent. Thus, the combination of springtide plus perigean tide (an infrequent coincidence) results in abnormally high tides.²¹⁵

**Joseph M. Caldwell, of the BEB staff, was awarded the Meritorious Civilian Service Award for the advice and guidance he provided in the wake of the March 1962 storm.

replenishment purposes than had originally been thought. Sands found in these areas tended to be of too fine a grain size, as well as being mixed with even finer silts and clays. Although this back-bay material was used in the 1962 emergency operations, it was recognized that a better sand source would have to be located for future beach nourishment projects. These poststorm recovery activities, then, stimulated the exploration for sand deposits offshore, on the eastern Continental Shelf.²²¹

There were other factors, too, involved in the development of the need for new sand sources. One was the increasing use by industry of available sand, while a second was expansion of coastal communities into areas of sand deposits along the shore. Both of these factors, by decreasing the supply, resulted in the increased cost of sand for beach nourishment projects. A third consideration was the impact of the growing environmental movement. The removal of material from lagoons and other similar locations for purposes of beach nourishment was being subject to increasing ecological objections.²²²

A few months after the March 1962 storm, the BEB initiated the important Sand Inventory Program, the objective of which was to locate sand reserves in the offshore zone. This program was expanded by the BEB's successor, the Coastal Engineering Research Center, and later became known as the Inner Continental Shelf Sediment and Structure (ICONS) program.

c. *Public Law 874 (1962)*. In October 1962, Public Law 727, passed in August 1946, was amended for the second time. Whereas the 1946 law had permitted Federal funding for up to one-third of the total construction costs of shore protection projects at public beaches, Public Law 874, 87th Congress, now changed this allotment to one-half of the total first costs.

A second provision of this new law allowed the Federal participation in the first construction costs of certain projects to go as high as 70 percent. These projects had to involve the "restoration and protection of State, county, and other publicly owned shore parks and conservation areas," when such areas:

"Include a zone which excludes permanent human habitation; include but are not limited to recreational beaches; satisfy adequate criteria for conservation and development of the natural resources of the environment; extend landward a sufficient distance to include, where appropriate, protective dunes, bluffs, or other natural features which serve to protect the uplands from damage; and provide essentially full park facilities for appropriate public use, all of which shall meet with the approval of the Chief of Engineers; . . ."²²³

One of the intents of this provision was to discourage housing and other backshore developments from encroaching too near the beach.

Thirdly, Public Law 874 essentially abolished the cooperative study as a means of investigation of a beach erosion problem. Since the BEB was established, the cooperative study, which could be undertaken with the approval of the Chief of Engineers and for which

the Federal Government paid 50 percent of the cost and the local political entity involved paid the other 50 percent, had been an integral part of the agency's activity. It reflected, in part, the emphasis on State participation in beach erosion problems, common in the earlier days. But as of the passage of Public Law 874, all studies of coastal areas were to be financed completely by the Federal Government. The Corps of Engineers' investigation of shore protection problems was thus placed on a basis similar to that of flood control and navigation problems.

Public Law 874 contained several other Federal cost-sharing provisions pertaining to shore protection which are not discussed here. However, these provisions, as well as those mentioned, reflect the changing and more complex role of the Federal Government in matters concerning the care and protection of the Nation's coastline.

d. Stages and Trends Since 1930. In retrospect, it is possible to identify five stages of development and change during the life of the BEB. Stage one was the period of the 1930's. During these years the BEB's function was largely as an advisor to the States with coastal erosion problems. Cooperative beach erosion studies with State agencies were financed on a 50-50 basis, with the BEB staff writing the reports. Research work was undertaken but remained limited. Operating budgets were small, the staff was small, and the seven Board members actively participated in all aspects of agency activities. After 1936, there was Federal money made available for construction of shore protection structures but only where Federal interests were involved.

Stage two included the years of World War II. The BEB's primary function was made secondary in order that the wartime needs of the Nation could be met. Many new people participated in the war program and brought with them new ideas, new problems, and a new outlook. Moreover, the internationalism of shore interests was greatly enhanced.

The postwar 1940's constituted stage three. Research was emphasized, as well as officially recognized. The BEB staff and office facilities on the Dalecarlia Reservation were expanded. Contracts for research were let to several leading educational institutions. Although cooperative beach erosion studies with State agencies were continued, report preparation was transferred to the Corps' District offices. Federal financing became available for up to one-third the cost of construction of shore protection structures at public beaches. These years of vigor, enthusiasm, and expansion were a key period in the agency's history.

Stage four was the decade of the 1950's. The Coastal Engineering Conferences were begun, and the internationalism of the field continued to expand. The BEB's research program received a big impetus with the completion of the shore processes test basin and the 635-foot-long wave tank. Beach Erosion Board Technical Report No. 4 was published. Techniques for shore protection oriented more toward natural beach processes were refined and their application encouraged. Military beach intelligence became, in terms of number of personnel, the agency's largest division. The hurricane work brought new investigatory responsibilities to the BEB staff, and resulted in dual report review for the BEB and the BERH by requiring that they both examine the same reports.

The period 1960-64 represented the fifth stage. Beach intelligence ceased to be part of the BEB. Research became the overriding activity. Although the seven-man Board remained vital, the Board's staff had assumed an increasingly larger part of the agency's functions. The State-Federal cooperative studies were ended, with the latter assuming all costs for Federal coastal investigations. Federal assistance in the financing of shore protection construction had increased to one-half project cost for public property, even higher in certain cases, and private property could now receive Federal monetary aid.

In this brief recapitulation, the following continuing trends are clearly discernible: (a) The decreasing participation and involvement of local and State agencies directly with the BEB; (b) the greater role of the Federal Government both in construction and in research; (c) research, always a factor, becoming increasingly more important; (d) the spread of interest in, and concern for, coastal problems among the engineering and academic communities, both here and abroad; and (e) the altered relationship between the seven-man Board and its staff. Thus, just as developments in the early years had laid the groundwork for the BEB's establishment, at this later time the groundwork had also been laid for an alteration in this very establishment.

In early 1962, the Chief of Engineers appointed an *ad hoc* committee to study the matter. The members of this committee were Richard O. Eaton, Chief Technical Advisor of the BEB staff; Col. Carl H. Bronn, Resident Member of the BERH; Henry C. Weinkauff, of the Office of the Chief of Engineers; and Lt. Col. Ira A. Hunt, Jr., of the Chief of Engineers' Planning Unit. It was realized that the Board's examination of beach erosion control reports was still important. By this time, however, knowledge of coastal engineering was far more widespread than it had been in earlier years. As members of the BERH were now generally equipped to make the necessary decisions regarding coastal projects, the need for BEB review was lessened. Moreover, the dual review which had resulted from the inclusion of the hurricane work, as discussed previously, now contributed only cumber and inefficiency, as well as repetition for those Corps officers who were serving simultaneously on both Boards.

e. Public Law 172 (1963). After careful consideration of all the various aspects involved in the matter, by both the above *ad hoc* committee as well as by others, it was decided that an organizational change was needed. The plan that was finally approved by the Chief of Engineers was to abolish the seven-member BEB and its staff, and to create a different form of organization.

Accordingly, the 88th Congress approved on November 7, 1963, Public Law 172, "An Act to make certain changes in the functions of the Beach Erosion Board and the Board of Engineers for Rivers and Harbors, and for other purposes." The BEB and its staff were abolished. In its place there was established a new research agency which was to be known as the Coastal Engineering Research Center (CERC). In essence, CERC was to consist of the staff of the former BEB, and was to be, in fact and in theory, what the BEB staff had become over the years—a center for research in coastal engineering. The office and laboratory facilities of the new agency were to be those of its predecessor.

Section 2 of Public Law 172 established a new Board on coastal engineering research, the membership of which was to be "constituted by the Chief of Engineers in the same manner as the present Beach Erosion Board." (The members of the BEB as of 20 September 1963, the date of the Board's 122d and final meeting, were: Maj. Gen. Robert G. MacDonnell, President; Brig. Gen. Arthur H. Frye, Jr.; Brig. Gen. John C. Dalrymple; Brig. Gen. Peter C. Hyzer; Thorndike Saville; Morrrough P. O'Brien; and Lorenz G. Straub.*) This new Board was to act in an advisory capacity to the CERC. The review function of the seven-member BEB was transferred to the BERH. All other functions of the BEB, plus "such additional functions as the Chief of Engineers may assign," were transferred to CERC.

The Beach Erosion Board had been a useful and productive agency. It was now being replaced by another agency which, organizationally, was more suited to the needs of the time. The 33-year history of the BEB had ended, and the history of the CERC begun. But the history of coastal engineering, so closely connected with the growth and development of the BEB, was to continue. And those who had devoted so much of their lives to the work of the BEB, either as members or as staff, would continue their dedicated service to the Coastal Engineering Research Center.

* * * * *

*Lorenz G. Straub died in October 1963.

REFERENCES AND OTHER NOTES

1. In a paper entitled, "Coastal Erosion Problems and Planning," presented at the Annual Meeting of the American Society of Civil Engineers, Waterways Division Session, Jan. 1942 and later reprinted in *Shore and Beach*, Oct. 1942, Vol. 10, No. 2, p. 36, Dean Thorndike Saville stated, "The first really large scale attempt to study the underlying factors concerning the causes of coastal erosion, and means for controlling it, was undertaken by the State of New Jersey between 1922 and 1930."
2. JOHN T. CUNNINGHAM, *The New Jersey Shore*, 1958, p. 114.
3. Ibid, p. 50.
4. Ibid, p. 101.
5. Ibid, p. 52.
6. *Historical Statistics of the United States, Colonial Times to 1957*, prepared by the U.S. Bureau of the Census with the cooperation of the Social Science Research Record, Washington, D.C., 1960, pp. A1-A16.
7. This date was verified in a discussion with Prof. James E. Vance, Jr., Geography Department, University of California, Berkeley.
8. JOHN T. CUNNINGHAM, op. cit., p. 80.
9. Since 1835, records of shoreline changes showed that, in fact, there had been a net loss of land totaling some 2,000 acres. See **NEW JERSEY BOARD OF COMMERCE AND NAVIGATION**, *Report on the Erosion and Protection of the New Jersey Beaches*, 1922, p. 5.
10. The "enemy" symbolism has not disappeared. **COASTAL ENGINEERING RESEARCH CENTER**, "Land Against the Sea," MP 4-64, U.S. Army, Corps of Engineers, Washington, D.C., May 1964, concludes with the following statement: "Our campaign against the encroachment of the sea must be waged with the same care that we would take against any other enemy threatening our boundaries." (p. 43).
11. **NEW JERSEY BOARD OF COMMERCE AND NAVIGATION**, *Report on the Erosion and Protection of the New Jersey Beaches*, 1922, p. 5.
12. VICTOR GELINEAU, "Save the Golden Band of Ocean Beaches," *Engineering News-Record*, Vol. 110, No. 24, June 1933, p. 765.
13. JOHN T. CUNNINGHAM, op. cit., p. 18.

14. HENRY S. SHARP, "Artificial Beach Construction in the Vicinity of New York," *The Scientific Monthly*, Vol. 25, July 1927, p. 34.
15. DOUGLAS W. JOHNSON and WARREN S. SMITH, "Recent Storm Effects on the Northern New Jersey Shoreline, and their Supposed Relation to Coastal Subsidence," *Annual Administrative Report of the State (New Jersey) Geologist*, Bull. No. 12, 1913, p. 32.
16. *Ibid*, p. 40.
17. DOUGLAS W. JOHNSON, "Studies of Mean Sea-Level," *Report of the Committee on Shoreline Investigations*, Bull. No. 70, National Research Council, July 1929.
18. For example, in "Sea Level Changes Along the Coasts of the United States in Recent Years," H. A. Marmer stated, "Taking New York, for which we have the longest series of observations, it is seen that from 1893 to about 1930 there was relatively little change in sea level." *Transactions, American Geophysical Union*, Vol. 30, No. 2, Apr. 1949, p. 202.
19. STEACY D. HICKS, "On the Classification and Trends of Long Period Sea Level Series," *Shore and Beach*, Apr. 1972, p. 20.
20. NEW JERSEY BOARD OF COMMERCE AND NAVIGATION, *Report on the Erosion and Protection of the New Jersey Beaches*, 1922, p. 14.
21. *Ibid*.
22. *Ibid*.
23. JOHNSON and SMITH, *op. cit.*, p. 44.
24. NEW JERSEY BOARD OF COMMERCE AND NAVIGATION, *Report on the Erosion and Protection of the New Jersey Beaches*, 1922, p. 5.
25. *Ibid*.
26. B. F. CRESSON, Jr., in discussion of, "The Preservation of Sandy Beaches in the Vicinity of New York City," by ELLIOTT J. DENT, *Transactions American Society of Civil Engineers*, Vol. 80, 1916, p. 1816.
27. NEW JERSEY BOARD OF COMMERCE AND NAVIGATION, *Report on the Erosion and Protection of the New Jersey Beaches*, 1922, p. 6.
28. *Annual Report for the Year 1922-1923*, National Research Council, Division of Geology and Geography, App. A, p. 5.

29. *Annual Report for the Year 1927-1928*, National Research Council, Division of Geology and Geography, App. C, p. 6.
30. *Annual Report for the Year 1926-1927*, National Research Council, Division of Geology and Geography, App. F, p. 3.
31. *Ibid.*
32. *Ibid.*, pp. 3-4.
33. "The History and Program, Constitution and By-Laws, American Shore and Beach Preservation Association," Jan. 1939, p. 11.
34. *Annual Report for the Year 1926-1927*, National Research Council, Division of Geology and Geography, App. F, p. 5.
35. CAPT. R. S. PATTON, "The Purposes of the American Shore and Beach Preservation Association," paper presented in Washington, D.C., Dec. 8, 1926, reprinted in *Shore and Beach*, Oct. 1934, p. 136.
36. *Ibid.*, p. 135.
37. This information was obtained from conversations with Richard O. Eaton on Nov. 8, 1972 and Dr. Martin A. Mason on Nov. 15, 1972. Also, the articles written by several of the members of this first Board reflect their deep interest in the problems of shore protection.
38. Special Order No. 6 issued by the War Department, Office of the Chief of Engineers, Jan. 23, 1929.
39. These experiments are listed as Exhibit C, "Summary of Experiments Proposed," as part of a report prepared by Douglas Johnson. This and numerous other related documents are contained in a looseleaf notebook in the library at the Coastal Engineering Research Center, Fort Belvoir, Va.
40. Dean O'Brien has stated in correspondence that, at the time of this assignment, he was unaware of the nature of the work but had thought it would probably be connected with the establishment of a national hydraulic laboratory. Only upon his arrival in Washington, D.C. did he learn "that the subject was sand movement and beach erosion—about which he knew absolutely nothing." This was completely intentional on the part of the Corps as they wanted someone free from the influence of past knowledge on the subject.

41. The use of this current velocity meter is discussed in several of the semimonthly progress reports prepared by either O'Brien or Hewitt. See especially the reports dated May 31 and July 31, 1929. As an additional note, almost 25 years later, the Bureau of Reclamation, Denver office, slightly modified the original Pegram meter, and thereby extended its application. See, "Tidal Current Meter," *The Bulletin of the Beach Erosion Board*, Vol. 8, No. 2, Apr. 1954, pp. 1-8.
42. Notes of Dean Morrrough P. O'Brien on the early years of the BEB, pp. 3-4.
43. This first research paper was, *Interim Report of Beach Erosion Board*, U.S. Army, Office of the Chief of Engineers, Washington, D.C., Apr. 1933.
44. Notes of Dean Morrrough P. O'Brien on the early years of the BEB, p. 4.
45. R. J. COLONY, "Report to the Board on Sand Movement and Beach Erosion on the Source of the Sand on Long Island and New Jersey Beaches," New York, N.Y., Dec. 1930.
46. *Annual Report for the Year 1927-1928*, National Research Council, Division of Geology and Geography, App. C, p. 6.
47. Public Law 520, 71st Congress, entitled, "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved July 3, 1930, Section 2.
48. Ibid.
49. Ibid.
50. MORROUGH P. O'BRIEN, "A Critical Review of the E. I. Brown Analysis of Inlets on Sandy Coasts," Hydraulic Engineering Laboratory, University of California, Berkeley, 1971, p. 1.
51. ELLIOTT J. DENT, "The Preservation of Sandy Beaches in the Vicinity of New York City," *Transactions, American Society of Civil Engineers*, Vol. 80, 1916, pp. 1821-1822.
52. General Orders No. 8, Army Service Forces, Office of the Chief of Engineers, Washington, D.C., May 7, 1946. The effective date of the order was May 10, 1946. However, because the official notice was not distributed until May 21, 1946, the Shore Protection Board held its last meeting on May 13, 1946 (jointly with the BEB).
53. *Annual Report for the Year 1930-1931*. National Research Council, Division of Geology and Geography, App. D, p. 1.

54. "The History and Program, Constitution and By-Laws, American Shore and Beach Preservation Association," Jan. 1939, p. 6.
55. J. Spencer Smith, president of the ASBPA, made some illuminating comments on this point during hearings on H.R. 7590 held Feb. 7, 1934, before the House of Representatives Committee on Rivers and Harbors. H.R. 7590 was an attempt to have Federal funds made available for the construction of shore protection structures, and Smith argued strongly in favor of the bill. He stated that originally he had considered beach problems to be a State matter and had been against Federal participation. In time, though, he changed his mind and explained his reasoning in this way:

". . . and here is what it comes down to, gentlemen; You have got a changed economic condition in this country. In the early days of our beaches the local communities received a revenue. People could only reach them through the railroad trains. They came here, they resided there, and they made their contribution. The communities where there were beaches were relatively few, but in the last few years that picture has changed completely until today you have visiting these beaches people from all States in the Union. No longer do people now reside in those communities; no longer do they pay rent or own property because of the very condition that has arisen, due to the automobile, due to changed conditions, changes in people's ways of living, . . ." (Hearings before the Committee on Rivers and Harbors, House of Representatives, 73d Congress, 2d session, Feb. 7, 1934, p. 20.)
56. MAJ. GEN. WALTER K. WILSON, Jr., and RICHARD O. EATON, "A History of the Beach Erosion Board," *Shore and Beach*, Vol. 28, No. 1, Apr. 1960, p. 6.
57. *Annual Report, Chief of Engineers, U.S. Army*, 1934, p. 1528.
58. This point is discussed by Dean Saville in the article, "Panel Discussion on Federal Laws," *Shore and Beach*, Apr. 1946. See specifically p. 22.
59. Information obtained from personnel records of Jay V. Hall, Jr.
60. Information obtained from personnel records of Ralph G. Davis.
61. Information obtained from personnel records of Ethyl L. Sweet.
62. Information obtained from conversation with Maj. Gen. Glen E. Edgerton on Dec. 18, 1972.
63. *Interim Report of Beach Erosion Board*, U.S. Army, Office of the Chief of Engineers, Washington, D.C., Apr. 1933, pp. 1-6.
64. COL. EARL I. BROWN, "Activities of the United States Beach Erosion Board," *Shore and Beach*, Apr. 1935, p. 44.

65. See Minutes of the First Meeting of the Shore Protection Board dated Dec. 22, 1930.
66. From correspondence from Capt. Frank Bowman, Recorder for the BEB, to Chief of Engineers, Mar. 6, 1937.
67. "Beach Erosion Board New Wave Tank," *Shore and Beach*, July 1937, pp. 86–87.
68. Notes of Dean M. P. O'Brien on the early years of the BEB, p. 8. See also, **MORROUGH P. O'BRIEN**, "Estuary Tidal Prisms Related to Entrance Areas," *Civil Engineering*, Vol. 1, No. 8, May 1931, pp. 738–739.
69. Notes of Dean M. P. O'Brien, op. cit., p. 8. See also, **MORROUGH P. O'BRIEN**, "A Report on Sand Movement and Beach Erosion Along the Pacific Coast of the United States," Mar. 1931, p. 38.
70. *Interim Report of Beach Erosion Board*, U.S. Army, Office of the Chief of Engineers, Washington, D.C., Apr. 1933, par. 5/10.
71. See, for example, the semimonthly progress report on the New Jersey field research dated Aug. 1-15, 1930.
72. Minutes of the 26th Meeting of the BEB held Nov. 1, 1935.
73. *Annual Report for the Year 1931-1932*, National Research Council, Division of Geology and Geography, App. I, p. 1.
74. Minutes of the Second Meeting of the BEB held Mar. 18 and 19, 1931.
75. Ibid.
76. Ibid.
77. House of Representatives Document No. 204, 72d Congress, 1st session, "Fort Fisher, N.C." Jan. 5, 1932. (The actual report is dated Dec. 29, 1931.)
78. LT. COL. C. H. CUNNINGHAM, "Shore Damage and Shore Protection on the Connecticut Shoreline," *Annual Report of the Connecticut Society of Civil Engineers, Incorporated*, 1939, p. 79.
79. Minutes of the Fifth Meeting of the BEB held Oct. 22, 1931.
80. LT. COL. C. H. CUNNINGHAM, op. cit., p. 79.
81. This information obtained in discussion with George M. Watts, Chief of the Engineering Division, CERC.

82. Report of the BEB contained in House Document No. 206, "Cold Spring Inlet (Cape May Harbor), N.J.," 83d Congress, 1st session, 1953, p. 10.
83. Public Law 409, 74th Congress, entitled, "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved Aug. 30, 1935, Section 5.
84. Circular Letter from the Office of the Chief of Engineers, Washington, D.C., dated Oct. 29, 1935; R. & H. No. 62, 1935, E. D. 6608.
85. From correspondence file of the BEB re: Study at Old Orchard Beach, Maine.
86. Ibid.
87. Index of Studies made by the Beach Erosion and Shore Protection Boards from Sept. 18, 1930 to Mar. 1, 1938 over the area from Maine to and Including Va., p. 4 of the summary for Old Orchard Beach, Maine. NOTE: This index is not 100 percent complete.
88. "Beach Erosion Board Report on Old Orchard Beach, Maine," dated Sept. 20, 1935, p. 11.
89. Letter dated Feb. 25, 1974, from Col. John H. Mason, U.S. Army Engineer Division, New England, Waltham, Mass.
90. CAPT. R. S. PATTON, "The Purposes of the American Shore and Beach Preservation Association," op. cit., p. 132.
91. CAPT. R. S. PATTON, "Coast Erosion Problems," *Shore and Beach*, Apr. 1935, p. 38.
92. Report on Coastal Protection," by the National Resources Board," *Shore and Beach*, Jan. 1935, p. 32.
93. Ibid, p. 32.
94. NATIONAL RESOURCES COMMITTEE, *Drainage Basin Problems and Programs*, 1937 revision, p. 110.
95. Ibid.
96. National Industrial Recovery Act of June 16, 1933, Title II, Section 202, Clause (b), as contained in *Public Laws*, 73d Congress, 1st session, Vol. 48, Pt. 1, p. 201.
97. F. E. SCHMITT, "Ten Years of Shore Protection," *Shore and Beach*, Apr. 1940, p. 47.

98. This Feb. 4, 1936 letter from Secretary of War George H. Dern to the Honorable Royal S. Copeland is in the BEB collection located at the Federal Records Center, Suitland, Md.
99. COL. EARL I. BROWN, "The Economics of Beach Erosion," *Shore and Beach*, Apr. 1936, p. 44.
100. Ibid.
101. *Hearings Before the Committee on Rivers and Harbors*, House of Representatives, 73d Congress, 2d session, on H.R. 7590, held Feb. 7, 1934, p. 1.
102. Ibid, p. 38.
103. "United States Beach Improvement and Protection Act," *Shore and Beach*, Vol. 4, July 1936, p. 71.
104. Because of the importance of the interpretation of this point, it is discussed in a number of places throughout the literature pertaining to the BEB and its activities. See, for example, article by Lt. Col. C. H. Cunningham, "Shore Damage and Shore Protection on the Connecticut Shoreline," op. cit., p. 79.
105. Minutes of the 58th Meeting of the BEB held Mar. 18, 1940.
106. House of Representatives Document No. 820, 76th Congress, 3d session, "Beach Erosion Study, St. Simon Island, Ga.," prepared by BEB, report dated March 1940.
107. Public Law 834, 74th Congress, entitled, "An Act for the Improvement and Protection of the Beaches along the Shores of the United States," approved June 26, 1936.
108. THORNDIKE SAVILLE, "Coastal Erosion Problems and Planning," op. cit., p. 38.
109. General Kingman was appointed by War Department Orders dated Nov. 28, 1941.
110. Paper entitled, "Report on Wartime Activities," Author and date unknown, revised 1956, p. 1.
111. The dates for Dr. Keulegan were provided by him in correspondence; those for Prof. Krumbein were obtained in a personal interview on Dec. 7, 1972.
112. Information obtained largely from conversations with Prof. Krumbein and Dr. Mason, together with reference to an article by Clara S. Edmunds, "Beach Intelligence: A Report of the War-Time Activities of the Beach Erosion Board," *Shore and Beach*, Apr. 1946, p. 11.

113. CLARA S. EDMUNDS, op. cit., p. 11; also, W. C. ISEMINGER, "Brief History of Activities and Present Responsibilities of the Beach Erosion Board in the Field of Coast and Landing Beach Intelligence," file memorandum dated July 26, 1955.
114. Information from personal conversations with Prof. Krumbein and Clara S. Edmunds.
115. CLARA S. EDMUNDS, op. cit., p. 11.
116. Information from conversations with Dr. Garbis Keulegan and D. G. "Jimmy" Dumm.
117. Joseph M. Caldwell, "Memorandum for Record," dated June 16, 1964, p. 2.
118. Information obtained from conversations with Dr. Garbis Keulegan and Mr. Joseph M. Caldwell.
119. Information obtained from conversations with Dr. Martin A. Mason and Dr. Garbis Keulegan.
120. Information obtained from conversations with Prof. William Krumbein, Dr. Martin Mason, Dr. John Rodgers, and Dr. A. Lincoln Dryden, and confirmed by Dr. Robert Garrels in later correspondence.
121. Paper entitled, "Report on Wartime Activities," Author and date unknown, revised, 1956, pp. 3-4.
122. "Two Beach Erosion Board Civilian Experts Receive High War Department Service Awards," *Shore and Beach*, Apr. 1945, p. 22.
123. MARTIN A. MASON, "Federal Activities in Beach Erosion," *Shore and Beach*, Oct. 1946, p. 52.
124. Minutes of the joint meeting of the Shore Protection and Beach Erosion Boards held Dec. 5, 1945.
125. Public Law 166, 79th Congress, 1st session, approved July 31, 1945.
126. Internal memorandum transmitting draft of material for new edition of Orders and Regulations. Memorandum dated Sept. 26, 1945. Draft pages not numbered.
127. General Orders No. 8, U.S. Army, Office of the Chief of Engineers, Washington, D.C., May 7, 1946.
128. "Status of H.R. 2033," discussion by President J. Spencer Smith and others, *Shore and Beach*, Apr. 1946, p. 29.

129. Ibid p. 30.
130. Ibid, Dean Saville, speaking, p. 32.
131. "New Federal Aid Law is Enacted," *Shore and Beach*, Oct. 1946, p. 43.
132. Public Law 727, 79th Congress, 2d session, approved Aug. 13, 1946.
133. It is not entirely clear why the breakdown between public and private benefits was so strongly stressed in shore protection projects. There were some within the Corps who questioned the policy. In a memorandum dated Sept. 22, 1949, Col. F. F. Frech, at that time a BEB member, stated, "It seems to me that this subject (private vs. public benefits) is over-emphasized. In the case of river and harbor and flood control projects, there is no curse on private benefits. In fact, there are doubtless many projects on the books where the direct benefits accrue entirely to private interests." (p. 4). Col. Frech notwithstanding, however, the policy continued.
134. Minutes of the joint meeting of the Shore Protection and Beach Erosion Boards, Oct. 30, 1944.
135. See "Memorandum for Members of the Beach Erosion Board" dated Aug. 26, 1947 and signed by Col. C. L. Hall.
136. Information obtained from dates on photos of construction.
137. From conversations with Thorndike Saville, Jr., Robert Jachowski, and Joseph M. Caldwell.
138. See memorandum to Gen. Glen Edgerton from Dr. Martin A. Mason dated Sept. 15, 1948.
139. See "Memorandum for Board Members," dated Aug. 28, 1947 and signed by Lt. Col. W. B. Stelzenmuller.
140. "History," two-page paper in BEB files, p. 2. (Author and date unknown.)
141. WILSON and EATON, op. cit., p. 8.
142. Information from conversation with Maj. Gen. Glen E. Edgerton on Dec. 18, 1972.
143. Information from conversations with Maj. Gen. Edgerton and Dr. Martin A. Mason.
144. Exact figures on staff strength have been difficult to obtain. However, organization charts of the BEB staff have been helpful in this regard. See App. E for selected organization charts.

145. Dates of construction were confirmed by Mary Nell Wrenn and Ralph L. Rector.
146. From conversations with Louis Spencer and Adrian Wrenn, and from information contained in U.S. Army, Corps of Engineers, Beach Erosion Board, TM-9, "Proof Test of Water Transparency Method of Depth Determination," by JAY V. HALL, Jr., July 1948.
147. From interview with Clyde Shepherd on Dec. 8, 1972.
148. From discussion with Adrian Wrenn on Dec. 20, 1972.
149. From conversations with Adrian Wrenn and Clyde Shepherd.
150. From interview with Clyde Shepherd on Dec. 8, 1972.
151. From interview with Adrian Wrenn on Dec. 20, 1972.
152. Richard Eaton, then of the U.S. Army Engineer Division, South Pacific, in San Francisco, was strongly in favor of the BEB's beginning a contract program with the Nation's various educational institutions. He expressed his thoughts on the matter in a memorandum dated Aug. 29, 1947, to Col. C. L. Hall, who was then Senior Member of the seven-man BEB, and Resident Member of the Board's staff. Board members and staff were also anxious to establish such a program, but realized that it could not be done until adequate funding became available.
153. *Annual Report of the Chief of Engineers*, 1949, p. 2655.
154. BRIG. GEN. DABNEY O. ELLIOTT, retired, U.S. Army, and former President, BEB, "The Beach Erosion Board," *Proceedings of First Conference on Coastal Engineering*, Long Beach, Calif., Oct. 1950, (published 1951), p. 131.
155. The names of these institutions were secured from the Research Progress Reports which appeared in issues of the *Bulletin of the Beach Erosion Board*.
156. THORNDIKE SAVILLE, Jr., JOSEPH M. CALDWELL, and H. B. SIMMONS, "Preliminary Report: Laboratory Study of the Effect of an Uncontrolled Inlet on the Adjacent Beaches," TM-94, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., May 1957.
157. These first research topics were discussed at the 72d Meeting of the BEB and are in the minutes of that meeting, dated Feb. 10, 1947.
158. Minutes of the 85th Meeting of the BEB, held in Philadelphia, Pa., Dec. 5 and 6, 1949.

159. Minutes of the 71st Meeting of the BEB held at the Board's office in Washington, D.C., Dec. 11, 1946.
160. W. C. ISEMINGER, "Brief History of Activities and Present Responsibilities of the Beach Erosion Board in the Field of Coast and Landing Beach Intelligence," file memorandum dated July 26, 1955, p. 4.
161. Letter from Col. Charles G. Holle, ENGWR-842.01, to all Division Engineers; District Engineers; President, Mississippi River Commission; Resident Member, BERH; Resident Member, BEB; and Supervisor, New York Harbor, dated July 15, 1946.
162. "History," two-page paper in the BEB files, p. 2. (Author and date unknown.)
163. "Overseas Work," memorandum in the files of the BEB dated Jan. 30, 1969. (Author unknown.)
164. *Bulletin of the Beach Erosion Board*, Vol. 1, No. 1, Apr. 1947, p. iii.
165. See *Bulletin of the Beach Erosion Board*, Vol. 3, No. 1, Jan. 1949 and Vol. 5, No. 1, Jan. 1951. Information regarding where the actual translation was done was received from Richard Eaton.
166. Lorenz Straub was appointed by way of Special Orders No. 14 issued by the Department of the Army, Office of the Chief of Engineers, dated Apr. 7, 1950.
167. Information was obtained from BEB organization charts and from conversations with Richard Eaton.
168. J. W. JOHNSON, "Foreword," *Proceedings from the 12th Coastal Engineering Conference*, Vol. I, Washington, D.C., Sept. 1970, p. iv.
169. Information obtained from correspondence with J. W. Johnson and from a conversation with Thorndike Saville, Jr.
170. EARL E. GESLER, RICHARD O. EATON, and JAY V. HALL, Jr., *The 18th International Navigation Congress*, Section II, Ocean Navigation, Question 1—New designs for breakwaters with vertical sides and of structures with sloping faces: (a) for port protection; (b) for coastal protection. Rome, Italy, 1953.
171. JOSEPH M. CALDWELL, "Research Activities of the Beach Erosion Board," *Proceedings of the Second Conference on Coastal Engineering*, Houston, Tex., Nov. 1951, p. 190.
172. Minutes of the 79th Meeting of the BEB dated Oct. 22, 1948. Information also obtained from correspondence with Martin A. Mason and Rudolph P. Savage.

173. "Preface," *Shore Protection Planning and Design*, TR-4, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., June 1954.
174. Ibid.
175. "Introduction," *Shore Protection Planning and Design*, TR-4, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., June 1954, p. vi.
176. Tables D1 and D2 in App. D were from R. L. WIEGEL, "Tables of the Functions d/L and d/L_o ," Institute of Engineering Research Series 3, No. 265, University of California, Berkeley, 1948, 58 1s.
177. *Annual Report of the Chief of Engineers, U.S. Army, Civil Works Activities*, Vol. 1, 1956, p. 54.
178. Information obtained from conversations with Rudolph P. Savage. See also Revised BEB TR-4, Aug. 1957.
179. Information obtained from conversations with George Simmons. See also "Summary of Capabilities," MP 3-64, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, updated 1968, p. 6.
180. Information obtained from George Simmons and Thorndike Saville, Jr.
181. THORNDIKE SAVILLE, Jr., "Coastal Engineering Research Benefits," Coastal Engineering Research Center paper dated Nov. 26, 1965, p. 2.
182. Information from conversations with Joseph M. Caldwell and Thorndike Saville, Jr.
183. Public Law 71, 84th Congress, 1st session, approved June 15, 1955.
184. "Comprehensive Investigations on Hurricanes and Associated Problems (P. L. 71, 84th Congress, 1st Session)," Internal Office Memorandum dated Nov. 25, 1955, p. 12.
185. Assistance with this information was obtained from Joseph M. Caldwell.
186. Information from conversations with Dean M. P. O'Brien and from article by Jay V. Hall, Jr., "Artificially Nourished and Constructed Beaches," *Proceedings of the Third Conference on Coastal Engineering*, Cambridge, Mass., Oct. 1952, p. 119.
187. Information from conversation with Rudolph P. Savage.
188. House of Representatives Document No. 552, 75th Congress, 3d session, "Beach Erosion at Santa Barbara, California," prepared by BEB, report dated Jan. 15, 1938, pp. 2-3. See also, R. L. WIEGEL, "Sand Bypassing at Santa Barbara, California," *Journal of the Waterways and Harbors Division*, ASCE, Vol. 85, June 1959, pp.1-30.

189. ELLIOTT J. DENT, "The Preservation of Sandy Beaches in the Vicinity of New York City," *Transactions, American Society of Civil Engineers*, Vol. 80, 1916, p. 1804.
190. House of Representatives Document No. 450, 75th Congress, 2d session, "Study of an Artificial Bathing Beach at Orchard Beach, Pelham Bay, N.Y.," prepared by the BEB, Oct. 7, 1937, pp. 7-8.
191. HENRY S. SHARP, "Artificial Beach Construction in the Vicinity of New York," *The Scientific Monthly*, July 1927, p. 34. See also JAY V. HALL, Jr., "Artificially Nourished and Constructed Beaches," *op. cit.*, p. 23.
192. Richard Eaton has pointed out that between 1930 and 1950, beach nourishment was also used to help restore eroded beaches along sections of the southern California coast. During this period, however, the positive effect of this action on the downdrift beaches was largely a byproduct of projects undertaken for other purposes.
Eaton participated in many of these operations and thus brought this experience with him when he rejoined the BEB staff in Jan. 1951.
193. Conversations with George M. Watts were most helpful in regard to the subjects of beach nourishment and sand bypassing.
194. JAY V. HALL, Jr., "Artificially Nourished and Constructed Beaches," *op. cit.*, p. 119.
195. Information from George M. Watts.
196. Information obtained from the files of the BEB, with additional helpful comments from George M. Watts and Ralph L. Rector.
197. Public Law 826, 84th Congress, 2d session, approved July 28, 1956.
198. Ralph L. Rector provided information concerning Federal cost sharing in shore protection projects.
199. Information obtained from the files of the BEB. See also Minutes of the 84th Meeting of the BEB, Sept. 12 and 13, 1949.
200. Information obtained from the files of the BEB.
201. Information obtained from the files of the BEB.
202. Information obtained from the files of the BEB; from conversations with members of the CERC (formerly BEB) staff; and from correspondence with Dr. Martin A. Mason.
203. Information obtained from BEB File No. 321, "Fort Belvoir, 1957."

204. See, for example, Senate Report No. 1079, 85th Congress, 1st session, "Amending the Act of August 7, 1946, as Amended, to Provide for the Exchange of Lands of the United States as a Site for the New Sibley Memorial Hospital," Aug. 21, 1957.
205. Date of completion was provided by Ralph L. Rector and confirmed by Robert A. Jachowski.
206. Public Law 645, 86th Congress, approved July 14, 1960.
207. Public Law 520, 71st Congress, approved July 3, 1930.
208. From conversations with Joseph M. Caldwell. See also **RICHARD C. VETTER**, "Growth and Support of Oceanography in the United States from 1958 to 1963," National Academy of Sciences, National Research Council, Committee on Oceanography, Washington, D.C., July 1964.
209. See *Annual Report of the Chief of Engineers, U.S. Army, Civil Works Activities*, Vol. 2, 1961, p. 2068; Vol. 2, 1962, p. 2105; and Vol. 2, 1963, p. 1844.
210. **R. P. SAVAGE**, "Memorandum for Record. Subject: The Third International Course in Hydraulic Engineering," Nov. 1, 1960, p. 1.
211. Correspondence between R. C. H. Russell of the Hydraulics Research Station at Wallingford, Berkshire, England, and Joseph M. Caldwell and Thorndike Saville, Jr., of the BEB staff from June to Nov. 1960.
212. BEB Administrative Memorandum 12-61 dated Apr. 6, 1961, and signed by Col. H. E. Sprague.
213. Information received from John R. Vogler.
214. **U.S. ARMY ENGINEER DIVISION, NORTH ATLANTIC**, "Report on Operation Five-High March 1962 Storm," Civil Works Branch, Construction-Operations Division, New York, Aug. 1963, p. 3-2.
215. **ARTHUR N. STRAHLER**, *Physical Geography*, 3d Edition, p. 105.
216. **U.S. ARMY ENGINEER DIVISION, NORTH ATLANTIC**, "Report on Operation Five-High March 1962 Storm," Civil Works Branch, Construction-Operations Division, New York, Aug. 1963. p. 2-2.
217. **JOSEPH M. CALDWELL**, "Shore Erosion by Storm Waves," MP 1-59, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., Apr. 1959.

218. Information obtained from the files of the BEB and from a conversation with Thorndike Saville, Jr.
219. U.S. ARMY ENGINEER DIVISION, NORTH ATLANTIC, "Report on Operation Five-High March 1962 Storm," Civil Works Branch, Construction-Operations Division, New York, Aug. 1963, p. 6-5. George M. Watts and Joseph M. Caldwell also provided useful information on this matter.
220. Ibid, p. 2-6.
221. Information obtained from conversations with George M. Watts and Joseph M. Caldwell, and confirmed by Richard O. Eaton.
222. Information obtained from conversations with George M. Watts, Ralph L. Rector, and David B. Duane.
223. Public Law 874, 87th Congress, approved Oct. 23, 1962, Section 103.

INTERVIEWS

The research work for the preparation of the "History of the Beach Erosion Board" was greatly aided by way of personal interviews with people who had either played a role, directly or indirectly, in the agency's development through the years, or were closely associated with the field of coastal engineering. Most of the interviews were conducted in person. In instances where this was not possible, people were contacted by telephone and correspondence. Below is a list of the names of all those who so participated:

Col. Carl H. Bronn	Garbis H. Keulegan
Joseph M. Caldwell	William C. Krumbein
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Robert L. Harris	Clyde Shepherd
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Robert Hudson	Joseph B. Tiffany
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BIBLIOGRAPHY

- ALLEN, R. H., "A Glossary of Coastal Engineering Terms," MP 2-72, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Washington, D.C., Apr. 1972.
- ALLEN, R. H., and SPOONER, E. L., "Annotated Bibliography of BEB and CERC Publications," MP 1-68, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Washington, D.C., July 1968.
- AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, "Report of Meeting," Washington, D.C., MacCrellich and Quigley Co., Trenton, N.J., Dec. 1926.
- AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, "Report of Meeting," Washington, D.C., MacCrellich and Quigley Co., Trenton, N.J., May 1927.
- AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, "A Story of Cooperation, A Message to Coastal Communities," Office of the Secretary, Newark, N.J., 1940.
- BEACH EROSION BOARD, "Fort Fisher, N. C.," H. Doc. 204, 72d Cong., 1st sess., War Department, U.S. Army, Corps of Engineers, Dec. 1931.
- BEACH EROSION BOARD, "Interim Report of Beach Erosion Board," Office of the Chief of Engineers, U.S. Army, Corps of Engineers, Washington, D.C., Apr. 1933.
- BEACH EROSION BOARD, "Beach Erosion Report on Old Orchard Beach, Maine," U.S. Army, Corps of Engineers, Washington, D.C., Sept. 1935.
- BEACH EROSION BOARD, "Wave Tank Experiments on Sand Movement," U.S. Army, Office Chief of Engineers, Washington, D.C., Experiments Nos. 1 to 4, Vol. 1, Dec. 1936.
- BEACH EROSION BOARD, "Study of an Artificial Bathing Beach at Orchard Beach, Pelham Bay, N.Y.," H. Doc. 450, 75th Cong., 2d sess., U.S. Army, Corps of Engineers, Washington, D.C., Nov. 1937.
- BEACH EROSION BOARD, "Beach Erosion at Santa Barbara, Calif.," H. Doc. 552, 75th Cong., 3d sess., U.S. Army, Corps of Engineers, Washington, D.C., Jan. 1938.
- BEACH EROSION BOARD, "Beach Erosion Study, St. Simon Island, Ga.," H. Doc. 820, 76th Cong., 3d sess., U.S. Army, Corps of Engineers, Washington, D.C., Mar. 1940.
- BEACH EROSION BOARD, "Cold Spring Inlet (Cape May Harbor), N. J.," H. Doc. 206, 83d Cong., 1st sess., U.S. Army, Corps of Engineers, Washington, D.C., 1953.

- BEACH EROSION BOARD**, *The Bulletin of the Beach Erosion Board*, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., Vol. I, No. 1, Apr. 1947 through Vol. 17, July 1963.
- BLACKMAN, B.**, "Report on Jetties," report to Shore Protection Board, Aug. 1938.
- BOWMAN, I.**, "Address by the Chairman of the National Research Council," *Shore and Beach*, Vol. 2, Jan. 1934.
- BROWN, E. I., Col.**, "Inlets on Sandy Coasts," *Proceedings, American Society of Civil Engineers*, Vol. 54, 1928, pp. 505-553.
- BROWN, E. I., Col.**, "The Economics of Beach Protection," *Shore and Beach*, Apr. 1936, pp. 42-45.
- CALDWELL, J. M.**, "Research Activities of the Beach Erosion Board," *Proceedings, Second Conference on Coastal Engineering*, Houston, Tex., Nov. 1951, pp. 187-194.
- CALDWELL, J. M.**, "The Design of Wave Channels," *Proceedings of the First Conference on Ships and Waves*, Hoboken, N.J., Oct. 1954.
- CALDWELL, J. M.**, "Status of Research in Shore Line Protection," *The Bulletin of the Beach Erosion Board*, Vol. 11, No. 1, July 1957, pp. 17-27.
- CALDWELL, J. M.**, "Shore Erosion by Storm Waves," MP 1-59, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., Apr. 1959.
- CALDWELL, J. M.**, "Failure Record of Coastal Engineering Projects," Office Memorandum, 10 Oct. 1968.
- CASSIDY, W. F., Maj. Gen.**, "The Trend Toward Dual Purpose Inlet Control," paper presented before the American Shore and Beach Preservation Association, Ocean City, Md., June 1961.
- COASTAL ENGINEERING RESEARCH CENTER**, "Land Against the Sea," MP 4-64, U.S. Army, Corps of Engineers, Washington, D.C., May 1964.
- COASTAL ENGINEERING RESEARCH CENTER**, "Establishment of Coastal Engineering Research Center," *CERC Bulletin*, Vol. 1, U.S. Army, Corps of Engineers, Washington, D.C., 1964, pp. 1-3.
- COASTAL ENGINEERING RESEARCH CENTER**, "Summary of Capabilities," MP 3-68, U.S. Army, Corps of Engineers, Washington, D.C., updated Nov. 1971.

- COLBERT, L. O., Rear Adm., "The Coast and Geodetic Survey—150 Years of Service," *Shore and Beach*, Apr. 1957, pp. 8–10.
- COLL, B. D., KEITH, J. E., and ROSENTHAL, H. H., *United States Army in World War II, The Technical Services, The Corps of Engineers: Troops and Equipment*, Office of Chief of Military History, Department of the Army, Washington, D.C., 1958.
- COLONY, R. J., "Report on Source of the Sands Comprising the Beaches of Long Island and New Jersey," Board on Sand Movement and Beach Erosion, Corps of Engineers; date of receipt at BSMBE, Dec. 1930.
- COMMITTEE ON WAR EFFORT, "Utilization of Geology and Geologists in War Time," Geological Society of America, Feb. 1942.
- CULLUM, G. W., Maj. Gen., *Gen. Cullum's Biographical Register of the Officers and Graduates of the United States Military Academy*, Vol. VI-A, Supplement 1910-1920.
- CULLUM, G. W., Maj. Gen., *Gen. Cullum's Biographical Register of the Officers and Graduates of the United States Military Academy*, Vol. IX, Supplement 1940-1950.
- CUNNINGHAM, J. T., *The New Jersey Shore*, Rutgers University Press, New Brunswick, N.J., 1958.
- CUNNINGHAM, C. H., Lt. Col., "Shore Damage and Shore Protection on the Connecticut Shoreline," *Annual Report of the Connecticut Society of Civil Engineers, Inc.*, 1939, pp. 52–82.
- DARLING, J. M., "Seasonal Changes in Beaches of the North Atlantic Coast of the United States," *Proceedings of Ninth Conference on Coastal Engineering*, Lisbon, Portugal, June 1964, pp. 236–248.
- DENT, E. J., "The Preservation of Sandy Beaches in the Vicinity of New York City," *Transactions, American Society of Civil Engineers*, Vol. 80, 1916, pp. 1786–1828.
- DENT, E. J., "Sand Movement and Beach Erosion," *Civil Engineering*, Vol. 1, No. 9, June 1931, pp. 821–826.
- DENT, E. J., Col., "The Next Step in Shore Protection," *Shore and Beach*, July 1938, pp. 76–81.
- DORST, J. A., "Ft. Humphreys and Historical Belvoir," *The Military Engineer*, Vol. 15, No. 82, July-Aug. 1923, pp. 332–337.
- DRYDEN, A. L., "Surface Features of Coral Reefs," TM-4, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., May 1944.

- DUNHAM, J. W., "Proposed Santa Monica Causeway Project," *Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers*, Vol. 94, Nov. 1968, pp. 425-436.
- EDMUNDS, C. S., "Beach Intelligence—A Report of the War-Time Activities of the Beach Erosion Board," *Shore and Beach*, Apr. 1946, pp. 11-15.
- ELLIOTT, D. O., Brig. Gen., "The Beach Erosion Board," *Proceedings of First Conference on Coastal Engineering*, Long Beach, Calif., Oct. 1950, pp. 126-131.
- ENGINEERING NEWS-RECORD, "New Jersey Engineers Study Shore Erosion and Protection," Vol. 95, No. 15, Oct. 1925, pp. 598-600.
- ESCOFFIER, F. F., "The Harrison County Artificial Beach," *Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers*, Vol. 82, Sept. 1956, pp. 1060-1-1060-11.
- FREEMAN, J. R., *Hydraulic Laboratory Practice*, comprising a translation, revised to 1929, of *Die Wasserbaulaboratorien Europas*, American Society of Mechanical Engineers, New York, 1929.
- GAILLARD, D. D., Capt., "Wave Action in Relation to Engineering Structures," Professional Paper No. 31, U.S. Army, Corps of Engineers, U.S. Government Printing Office, Washington, D.C., 1904.
- GANNON, P. J., "Outline History of the American Shore and Beach Preservation Association," *Shore and Beach*, Vol. 38, Oct. 1970, pp. 5, 6, and 40.
- GELINEAU, V., "Save the Golden Band of Ocean Beaches!," *Engineering News-Record*, Vol. 110, No. 24, June 1933, pp. 765-771.
- GESLER, E. E., Col., "National Aspects of Beach Erosion," *Shore and Beach*, Oct. 1950.
- GESLER, E. E., Col., "The Future of Coastal Engineering," *Shore and Beach*, Apr. 1955.
- GRAHAM, J., Maj. Gen., "One-Third Century of Progress," *Shore and Beach*, Vol. 33, Oct. 1965, pp. 5, 6, and 37.
- HAFERKORN, H. E., *Sand Movement, Beaches, and Kindred Subjects—A Bibliography*, The Engineer School, U.S. Army, Fort Humphreys (now Fort Belvoir), Va., 1930.
- HALL, J. V., Jr., "Proof Test of Water Transparency Method of Depth Determination," TM-9, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., July 1948.

- HALL, J. V., Jr., and HERRON, W. J., Jr., "Test of Nourishment of the Shore by Offshore Deposition of Sand, Long Branch, N.J.," TM-17, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., June 1950.
- HALL, J. V., Jr., "Erosion Engineers Measure the Waves," *Shore and Beach*, Vol. 18, Oct. 1950.
- HALL, J. V., Jr., "Artificially Nourished and Constructed Beaches," *Proceedings of Third Conference on Coastal Engineering*, Cambridge, Mass., Oct. 1952, pp. 119-136 (also TM-29, Beach Erosion Board, Dec. 1952).
- HAUPT, L. M., "Changes Along the New Jersey Coast," *Annual Report of the State Geologist (N.J.) for the year 1905*, Geological Survey of New Jersey, MacCrellich and Quigley Co., Trenton, N.J., pp. 25-95.
- HARPER'S NEW MONTHLY MAGAZINE, "Montauk Point, Long Island," Vol. 43, Sept. 1871, pp. 481-493.
- HICKS, S. D., "On the Classification and Trends of Long Period Sea Level Series," *Shore and Beach*, Apr. 1972, pp. 20-23.
- HONOUR, W. W., and KOSSAN, R. L., *Washmic 1971*, Rany Company, McLean, Va., 1971.
- HORTON, D. F., "Federal, State, and Corps of Engineers Responsibilities for Shore Protection," Studies and Reports Branch, Beach Erosion Board, paper presented at Engineer School at Fort Belvoir, Va., Mar. 1948.
- ISEMINGER, W. C., "Brief History of Activities and Present Responsibilities of the Beach Erosion Board in the Field of Coast and Landing Beach Intelligence," Office Memorandum, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., 26 July 1955.
- ITSCHNER, E. C., Lt. Gen., "Partners in Erosion Control," *Shore and Beach*, Dec. 1959, pp. 4-8.
- JOHNSON, D. W., *Shore Processes and Shoreline Development*, Wiley and Sons, New York, 1919.
- JOHNSON, D. W., "The Problem of Coast Protection," *The Geographical Review*, Vol. 17, 1927, pp. 135-137.
- JOHNSON, D. W., "Studies of Mean Sea-Level," Report of the Committee on Shoreline Investigations, Bulletin No. 70, National Research Council, Washington, D.C., July 1929.

- JOHNSON, D. W., and SMITH, W. S., "Recent Storm Effects on the Northern New Jersey Shoreline, and their Supposed Relation to Coastal Subsidence," *Annual Administrative Report of the State Geologist for the Year 1913*, Bulletin 12, Geological Survey of New Jersey, pp. 27-44.
- JOHNSON, J. W., "Lessons in Coastal Engineering Gained from California Projects," *Symposium on Coastal Engineering*, Stellenbosch, South Africa, June 1969.
- JOHNSON, J. W., "Foreword," *Proceedings, 12th Coastal Engineering Conference*, Vol. 1, Sept. 1970, pp. iv-vi.
- KEULEGAN, G. H., "Depths of Offshore Bars," TM-8, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., July 1945. *
- KRUMBEIN, W. C., "Shore Processes and Beach Characteristics," TM-3, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., May 1944.
- LANE, A. C., and CHENEY, W. F., Jr., "Sea-Level Change Near New York," *Science*, Vol. 71, Mar. 1930, p. 319.
- LAWTON, C. H., "Santa Barbara Beach," *Shore and Beach*, Apr. 1936.
- LOCKETT, J. B., "History of the Corps of Engineers Committee on Tidal Hydraulics," (January 1949 to June 1971), Committee on Tidal Hydraulics Technical Bulletin No. 18, U.S. Army, Corps of Engineers, June 1972.
- MARMER, H. A., "Is the Atlantic Coast Sinking? The Evidence from the Tide," *Geographical Review*, Vol. 38, No. 4, Oct. 1948, pp. 652-657.
- MARMER, H. A., "Sea Level Changes Along the Coasts of the United States in Recent Years," *Transactions American Geophysical Union*, Vol. 30, No. 2, Apr. 1949, pp. 201-204.
- MASON, M. A., "Federal Activities in Beach Erosion," *Shore and Beach*, Oct. 1946, pp. 52-55.
- MASON, M. A., "The Importance of Shore Protection Studies," *The Bulletin of the Beach Erosion Board*, Vol. 1, No. 2, July 1947, pp. 13-16.
- MASON, M. A., "Basic Knowledge of Shore Phenomena," *The Bulletin of the Beach Erosion Board*, Vol. 1, No. 3, Oct. 1947, pp. 10-14.
- MASON, M. A., "Method of Solution of Shore Protection," *The Bulletin of the Beach Erosion Board*, Vol. 2, No. 1, Jan. 1948, pp. 8-12.

- MASON, M. A., and KEULEGAN, G., "A Wave Method for Determining Depths Over Bottom Discontinuities," TM-5, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., May 1944.
- MATTHEWS, E. R., *Coast Erosion and Protection*, Griffin and Company, Limited, London, 1913.
- McINTYRE, J. B., "The Beach Erosion Board, U.S. Corps of Engineers, U.S. Army," Masters Thesis, The American University, Washington, D.C., 1955.
- MEADE, R. H., and EMERY, K. O., "Sea Level as Affected by River Runoff, Eastern United States," *Science*, Vol. 173, July 1971, pp. 425-428.
- NATIONAL RESEARCH COUNCIL, Annual Reports, Years 1922-1923 through 1931-1932, Division of Geology and Geography, Washington, D.C.
- NATIONAL RESOURCES COMMITTEE, *Drainage Basin Problems and Programs, 1937*, Revision, U.S. Government Printing Office, Washington, D.C., 1938.
- NOBLE, C. C., Maj. Gen., "200 Years of Army Engineers," *The Louisiana Engineer*, Feb. 1972, pp. 8-12.
- O'BRIEN, M. P., "A Report on Land Movement and Beach Erosion Along the Pacific Coast of the United States," report to the Beach Erosion Board, Mar. 1931.
- O'BRIEN, M. P. "Estuary Tidal Prisms Related to Entrance Areas," *Civil Engineering*, Vol. 1, No. 8, May 1931, pp. 738-739.
- O'BRIEN, M. P., "Preface," *Proceedings of First Conference on Coastal Engineering*, Oct. 1950.
- O'BRIEN, M. P., "A Critical Review of the E. I. Brown Analysis of Inlets on Sandy Coasts," Hydraulic Engineering Laboratory, University of California, Berkeley, Calif., 1971.
- O'BRIEN, M. P., "Some Comments on Coastal Engineering," *Proceedings, 13th Coastal Engineering Conference*, Vol. 1, July 1972, pp. 3-8.
- PATTON, R. S., "Problems Involved in Coast Erosion," *The Military Engineer*, Vol. 16, No. 90, 1924, pp. 458-463.
- PATTON, R. S., "The Purposes of Our Association," Shore and Beach Preservation Association, Washington, D.C., Dec. 1926.
- PATTON, R. S., "Moriches Inlet: A Problem in Beach Evolution," *Geographical Review*, Vol. 21, 1931, pp. 627-632.

- PATTON, R. S., "Coast Erosion Problems," *Shore and Beach*, Apr. 1935, pp. 38-41.
- PENFIELD, W. C., "The Oldest Periodic Beach Nourishment Project," *Shore and Beach*, Vol. 28, Apr. 1960, pp. 9-15.
- PILLSBURY, G. B., Brig. Gen., "Tidal Hydraulics," Professional Paper No. 34, War Department, U.S. Army, Corps of Engineers, U.S. Government Printing Office, Washington, D.C., 1940.
- RANKIN, J. K., "Development of the New Jersey Shore," *Proceedings, Third Conference on Coastal Engineering*, Cambridge, Mass., Oct. 1952.
- RAYNER, A. C., "Coastal Engineering Research," *Army Research and Development Newsmagazine*, Oct. 1967, pp. 22-23.
- RHODES, R. F., "Investigation of Steel Sheet Piling," Beach Erosion Board, U.S. Army Engineer District, Savannah, Ga., July 1936.
- PRESIDENT'S SCIENCE ADVISORY COMMITTEE, "Effective Use of the Sea," Report of the Panel on Oceanography, U.S. Government Printing Office, Washington, D.C., June 1966.
- ROUSE, H., and INCE, S., "History of Hydraulics," Iowa Institute of Hydraulic Research, State University of Iowa, 1957.
- ROYAL COMMISSION ON COAST EROSION, "First Report of the Royal Commission Appointed to Inquire into and to Report on Certain Questions Affecting Coast Erosion and the Reclamation of Tidal Lands in the United Kingdom," Vol. I, presented to both Houses of Parliament by Command of His Majesty, Wyman and Sons, Limited, London, 1907.
- ROYAL COMMISSION ON COAST EROSION AND AFFORESTATION, "Third (and Final) Report of the Royal Commission Appointed to Inquire into and to Report on Certain Questions Affecting Coast Erosion, The Reclamation of Tidal Lands, and Afforestation in the United Kingdom," Vol. III, presented to both Houses of Parliament by Command of His Majesty, Wyman and Sons, Limited, London, 1911.
- RUSSELL, R. J., "Instability of Sea Level," *American Scientist*, 1957, pp. 414-430.
- SAVAGE, R. P., "Sand Bypassing at Port Hueneme, California," TM-92, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., Mar. 1957.
- SAVAGE, R. P., "Experimental Dune Building on the Outer Banks of North Carolina," *Shore and Beach*, Vol. 30, Oct. 1962, pp. 23-27.

- SAVILLE, T., "National Planning for Coastal Protection," *Shore and Beach*, July 1941, pp. 70-71.
- SAVILLE, T., "Future Federal Policy in Coastal Erosion?," *Shore and Beach*, Vol. 10, Oct. 1942, pp. 35-40.
- SAVILLE, T., Jr., "Coastal Engineering Research Benefits," Internal Memorandum, 26 Nov. 1965.
- SCHLEY, J. L., Maj. Gen., "Scope of Duties of the Beach Erosion and Shore Protection Boards," *Shore and Beach*, July 1938, pp. 70-73.
- SCHMITT, F. E., "Ten Years of Shore Protection," *Shore and Beach*, Apr. 1940, pp. 46-49.
- SCHWARTZ, M. L., "The Brunn Theory of Sea-Level Rise as a Cause of Shore Erosion," *The Journal of Geology*, Vol. 75, No. 1, Jan. 1967, pp. 76-92.
- SHARP, H. S., "Artificial Beach Construction in the Vicinity of New York," *The Scientific Monthly*, Vol. 25, July 1927, pp. 34-39.
- SHORE AND BEACH, "The Beach Erosion Board Study at Santa Barbara, California," Vol. 6, Apr. 1938, pp. 27-34.
- SHORE AND BEACH, "National Responsibility in Coastal Protection," Vol. 11, Apr. 1943, pp. 3-4.
- SHORE AND BEACH, "Federal Assistance Bills Hearing," Vol. 13, Apr. 1945.
- SHORE AND BEACH, "Two Beach Erosion Board Civilian Experts Receive High War Department Service Awards," Apr. 1945.
- SHORE AND BEACH, "New Federal Aid Law is Enacted," Vol. 14, Oct. 1946.
- SIMMONS, G. W., "Research Facilities and Special Equipment of the Beach Erosion Board," *The Annual Bulletin of the Beach Erosion Board*, Vol. 13, July 1959, pp. 16-30.
- SOMMERS, M., "The Army's Pet Prophets," *Saturday Evening Post*, Mar. 1945, pp. 18, 19, and 97.
- SOUICIE, G., "Where Beaches Have Been Going: Into the Ocean," *Smithsonian*, June 1973, pp. 55-60.

- STATE OF NEW JERSEY, BOARD OF COMMERCE AND NAVIGATION, "Report on the Erosion and Protection of the New Jersey Beaches," Engineering Advisory Board on Coast Erosion, Trenton, N.J., 1922.
- STATE OF NEW JERSEY, BOARD OF COMMERCE AND NAVIGATION, "Report on the Erosion and Protection of the New Jersey Beaches," Engineering Advisory Board on Coast Erosion, Trenton, N.J., 1924.
- STATE OF NEW YORK, JOINT LEGISLATIVE COMMITTEE STUDYING THE PROBLEM OF CHECKING EROSION ALONG THE ATLANTIC SHORELINE OF THE STATE, "Report to the Legislature of the State of New York," Feb. 1945.
- STEWART, J. Q., "The Great Atlantic Coast Tides of 5-8 March 1962," *Weatherwise*, Vol. 15, No. 2, June 1962, pp. 116-120.
- SULLIVAN, C. J., *Army Posts and Towns, The Baedeker of the Army*, Free Press Interstate, Burlington, Vt., 1935.
- THOMPSON, S. G., "Studies, Surveys and Experiments of the Beach Erosion Board," *Shore and Beach*, Vol. 3, Oct. 1935, pp. 114-118.
- TIFFANY, J. B., "History of the Waterways Experiment Station," U.S. Army Engineer, Waterways Experiment Station, Vicksburg, Miss., June 1968.
- TROWER, W. P., Col., "Progress Report on the Beach Erosion Board," *Shore and Beach*, Apr. 1955; pp. 18-20.
- U.S. ARMY, *The Army Almanac*, U.S. Government Printing Office, Washington, D.C., 1950.
- U.S. ARMY, CORPS OF ENGINEERS, "Annual Report of the Chief of Engineers," U.S. Government Printing Office, Washington, D.C., 1930 through 1953.
- U.S. ARMY, CORPS OF ENGINEERS, "Annual Report of the Chief of Engineers, Civil Works Activities," U.S. Government Printing Office, Washington, D.C., 1954 through 1964.
- U.S. ARMY, CORPS OF ENGINEERS, "Geneses of the Corps of Engineers," as presented by the Corps of Engineers Museum, Fort Belvoir, Va., undated, circa 1965.
- U.S. ARMY, CORPS OF ENGINEERS, BEACH EROSION BOARD, "Manual of Procedure in Beach Erosion Studies," Paper No. 2, Dec. 1938, U.S. Government Printing Office, Washington, D.C., 1939.

- U.S. ARMY, CORPS OF ENGINEERS, BEACH EROSION BOARD, *Shore Protection Planning and Design*, TR-4, 1st ed., June 1954; Revision and Addenda, Aug. 1957; 2d ed., May 1961; 3d ed., June 1966, U.S. Government Printing Office, Washington, D.C.
- U.S. ARMY, CORPS OF ENGINEERS, OFFICE OF THE CHIEF OF ENGINEERS, *Shore Protection Program*, Washington, D.C., revisions July 1970 and June 1971.
- U.S. ARMY ENGINEER DIVISION, NORTH ATLANTIC, "Report on Operation Five-High March 1962 Storm," Civil Works Branch, Construction-Operations Division, New York, Aug. 1963.
- U.S. CONGRESS, *Public Law of the United States of America passed by the 73d Congress*, 1933-1934, Vol. 48, Part I, U.S. Government Printing Office, Washington, D.C.
- U.S. CONGRESS, "An Act Authorizing, the Construction, Repair, and Preservation of Certain Public Works on Rivers and Harbors, and for other Purposes," Hearings Before the United States Senate Committee on Commerce, Parts 1-4, 71st Cong., 2d sess., on H.R. 11781, May 1930, U.S. Government Printing Office, Washington, D.C.
- U.S. CONGRESS, "Shore and Beach Preservation," Hearings before the Committee on Rivers and Harbors, 73d Cong., 2d sess., on H.R. 7590, Feb. 1934, U.S. Government Printing Office, Washington, D.C.
- U.S. CONGRESS, "Beach Erosion," Hearings before the Subcommittee of the Committee on Rivers and Harbors, 79th Cong., 1st sess., on H.R. 2032 and H.R. 2033, Apr. 1945, U.S. Government Printing Office, Washington, D.C.
- U.S. CONGRESS, "Beach Erosion Studies," H. Rept. 654 (to accompany H.R. 2032) from the Committee on Rivers and Harbors, 79th Cong., 1st sess., June 1945.
- U.S. CONGRESS, "Beach Erosion," H. Rept. 1919 (to accompany H.R. 2033) from the Committee on Rivers and Harbors, 79th Cong., 2d sess., Apr. 1946.
- U.S. CONGRESS, "Beach Erosion," S. Rept. 1752 (to accompany H.R. 2033) from the Committee on Commerce, 79th Cong., 2d sess., July 1946.
- U.S. CONGRESS, "Authorizing an Examination and Survey of the New England, New York, Long Island, and New Jersey Coastal and Tidal Areas," S. Rept. 388 (to accompany S. 414) from the Committee on Public Works, *Senate Miscellaneous Reports on Public Bills*, 84th Cong., 1st sess., 1955.
- U.S. CONGRESS, "Beach Erosion—Extension of Federal Aid to Private as Well as Public Property," Hearings before the Subcommittee on Rivers and Harbors of the Committee on Public Works, on H.R. 4470 and other related bills, 84th Cong., 2d sess., Feb. 1956.

- U.S. CONGRESS, "River and Harbor, Beach Erosion Control, and Flood Control Projects," S. Rept. 1524 (to accompany H.R. 7634) from the Committee on Public Works, 86th Cong., 2d sess., June 1960.
- U.S. CONGRESS, "Marine Sciences and Research Act," S. Rept. 1526 (to accompany S. 2692) from the Committee on Interstate and Foreign Commerce, *Senate Miscellaneous Reports on Public Bills*, 86th Cong., 2d sess., June 1960.
- U.S. CONGRESS, "River and Harbor, Beach Erosion Control, and Flood Control Projects," S. Rept. 2258 (to accompany S. 3773) from Committee on Public Works, 87th Cong., 2d sess., Oct. 1962.
- U.S. CONGRESS, "Making Certain Changes in the Functions of the Beach Erosion Board and the Board of Engineers for Rivers and Harbors," S. Rept. 271 (to accompany S. 1523) from the Committee on Public Works, 88th Cong., 1st sess., June 1963.
- U.S. CONGRESS, "Making Certain Changes in the Functions of the Beach Erosion Board and the Board of Engineers for Rivers and Harbors," H. Rept. 848 (to accompany S. 1523), from the Committee on Public Works, 88th Cong., 1st sess., Oct. 1963.
- UNITED STATES STATUTES AT LARGE, 1955, Vol. 69, U.S. Government Printing Office, Washington, D.C., 1955.
- VOGLER, J. R., "Foreign Coastal Engineering and Related Research," *The Annual Bulletin of the Beach Erosion Board*, Vol. 15, July 1961, pp. 6-7.
- WATTS, G. M., "Behavior of Beach Fill at Virginia Beach, Virginia," TM-113, U.S. Army, Corps of Engineers, Beach Erosion Board, Washington, D.C., June 1959.
- WEAVER, T. D., Brig. Gen., "A Year of Progress—A Report by the Beach Erosion Board," *Shore and Beach*, Oct. 1956, pp. 11-13.
- WICKER, C. F., "History of New Jersey Coastline," *Proceedings, First Conference on Coastal Engineering*, Long Beach, Calif., Oct. 1950, pp. 299-319.
- WEIGEL, R. L., "Sand Bypassing at Santa Barbara, California," *Journal of the Waterways and Harbors Division*, American Society of Civil Engineers, Vol. 85, June 1959, pp. 1-30.
- WILSON, W. K., Jr., Maj. Gen., "A Progress Report on Beach Erosion Board Activities," *Shore and Beach*, Vol. 28, Oct. 1960, pp. 5-7.
- WILSON, W. K., Jr., Maj. Gen., and EATON, R. O., "A History of the Beach Erosion Board," *Shore and Beach*, Vol. 28, No. 1, Apr. 1960, pp. 4-9, and 39.

OTHER WRITTEN SOURCE MATERIAL

Beach Erosion Board files in storage, Federal Records Center, Suitland, Md.

Beach Erosion Board files which are now part of the National Archives, Washington, D.C.
(includes material on Board on Sand Movement and Beach Erosion).

Minutes of the Meetings, Beach Erosion Board, total of 122 meetings held between Dec. 22, 1930 and Sept. 20, 1963.

Minutes of the Meetings, Board on Sand Movement and Beach Erosion, total of 13 meetings held between Feb. 1, 1929 and June 17, 1930.

Minutes of the Meetings, Shore Protection Board, total of 36 meetings held between Dec. 22, 1930 and May 13, 1946.

M. P. O'Brien Collection, 1926-1973, University of California, Berkeley, Water Resources Center Archives.

M. P. O'Brien Papers (uncataloged reports and other documents pertaining to the Beach Erosion Board, arranged by State), 1922-1963, University of California, Berkeley, Water Resources Center Archives.

Personnel Records (201 Files) for: J. V. Hall, Jr., E. L. Sweet, and R. G. Davis.

Semimonthly Progress Reports of field engineers at New Jersey field research station to the Board on Sand Movement and Beach Erosion, U.S. Army, Corps of Engineers, May 31, 1929 to Aug. 1-15, 1930.

APPENDIX A

FEDERAL LEGISLATION DIRECTLY RELATED TO THE U. S. ARMY, CORPS OF ENGINEERS, BEACH EROSION BOARD, AND OTHER PERTINENT DOCUMENTS

Special Orders No. 6, Office, Chief of Engineers, dated January 23, 1929.

Public Law 520, 71st Congress (H.R. 11781), approved July 3, 1930.

Special Orders No. 72, Office, Chief of Engineers, dated September 18, 1930.

Public Law 409, 74th Congress (H.R. 6732), approved August 30, 1935.

Public Law 834, 74th Congress (S. 3505), approved June 26, 1936.

Special Orders No. 73, Office, Chief of Engineers, dated July 27, 1938.

Public Law 166, 79th Congress (H.R. 2032), approved July 31, 1945.

General Orders No. 8, Office, Chief of Engineers, dated May 7, 1946.

Public Law 525, 79th Congress (H.R. 6407), approved July 24, 1946.

Public Law 727, 79th Congress (H.R. 2033), approved August 13, 1946.

Special Orders No. 14, Office, Chief of Engineers, dated April 7, 1950.

Public Law 71, 84th Congress (S. 414), approved June 15, 1955.

Public Law 826, 84th Congress (H.R. 11861), approved July 28, 1956.

Public Law 645, 86th Congress (H.R. 7634), approved July 14, 1960.

Public Law 874, 87th Congress (H.R. 13273), approved October 23, 1962.

Public Law 172, 88th Congress (S. 1523), approved November 7, 1963.

(S. O. 6.)

WAR DEPARTMENT

Office of the Chief of Engineers

Washington, January 23, 1929.

Special Orders,))

No. 6.) Extract.

Par. 1.

By authority of the Secretary of War, a board of officers of the Corps of Engineers, to consist of:

Colonel William J. Barden,
Colonel George B. Pillsbury,
Lieutenant Colonel Elliott J. Dent,
Major Brehon B. Somervell,

is hereby appointed to investigate and report on the subjects of sand movement and beach erosion at such localities as may be designated by the Chief of Engineers.

The Board is authorized to employ such expert civilian assistance as it deems necessary for the investigations assigned to it.

The Board will hold its first meeting in Washington, D.C., upon the call of the Senior Member. It will assemble thereafter at such times and places as the Senior Member may designate, and is authorized to visit such points as it deems necessary for the proper performance of its duties.

Upon the completion of the duties assigned them, the members of the board will return to their proper station. The travel directed is necessary in the military service.

* * * * *

By order of the Chief of Engineers:

John H. Carruth,
Major, Corps of Engineers,
Chief, Personnel Section.

(SEAL)

Public Law No. 520, 71st Congress (H.R. 11781), approved July 3, 1930. "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes."

....

Section 2.

The Chief of Engineers of the United States Army, under the direction of the Secretary of War, is authorized and directed to cause investigations and studies to be made in cooperation with the appropriate agencies of various States on the Atlantic, Pacific, and Gulf coasts and on the Great Lakes, and the Territories, with a view to devising effective means of preventing erosion of the shores of coastal and lake waters by waves and currents; and any expenses incident and necessary thereto may be paid from funds appropriated for examinations, Surveys and Contingencies for Rivers and Harbors: *Provided*, That the War Department may release to the appropriate State agencies information obtained by these investigations and studies prior to the formal transmission of reports to Congress: *Provided further*, That no money shall be expended under authority of this section in any State which does not provide for cooperation with the agents of the United States and contribute to the project such funds and/or services as the Secretary of War may deem appropriate and require; that there shall be organized under the Chief of Engineers, United States Army, by detail from time to time from the Corps of Engineers and from the engineers of State agencies charged with beach erosion and shore protection, a board of seven members, of whom four shall be officers of the Corps of Engineers and three shall be selected with regard to their special fitness by the Chief of Engineers from among the State agencies cooperating with the War Department. The board will furnish such technical assistance as may be directed by the Chief of Engineers in the conduct of such studies as may be undertaken and will review the reports of the investigations made. In the consideration of such studies as may be referred to the board by the Chief of Engineers, the board shall, when it considers it necessary and with the sanction of the Chief of Engineers, make, as a board or through its members, personal examinations of localities under investigation: *Provided further*, That the salary of the civilian members shall be paid by their respective States, but the traveling and other necessary expenses connected with their duties on the board shall be paid in accordance with the law and regulations governing the payment of such expenses to civilian employees of the Engineer Department.

Special Orders No. 72, Office, Chief of Engineers, dated September 18, 1930.

(S. O. 72, P. 1-3.)

WAR DEPARTMENT
Office of the Chief of Engineers

Washington, September 18, 1930.

Special Orders,)
No. 72.) Extract.

Par. 1.

Paragraph 1 of Special Orders 6, Office, Chief of Engineers, January 23, 1929, as amended by paragraph 1 and 2, Special Orders 11, Office, Chief of Engineers, February 13, 1929, and by paragraph 2, Special Orders 24, Office, Chief of Engineers, April 19, 1929, and by paragraph 4, Special Orders 41, Office, Chief of Engineers, June 26, 1930, is hereby revoked.

Par. 2.

By authority of the Secretary of War, a board of officers of the Corps of Engineers, to be known as the Shore Protection Board, to consist of:

Colonel William J. Barden,
601 Army Bldg., 39 Whitehall St., New York, N.Y.

Colonel Earl I. Brown,
1109 Gimbel Bldg., 35 South 9th St.,
Philadelphia, Pa.

Lieutenant Colonel Elliott J. Dent,
Fort Humphreys, Va.

Major Gordon R. Young,
U.S. Engineer Office, Foot of Front St.,
Norfolk, Va.

is hereby appointed to investigate and report on the subject of shore protection of Federal property or problems relating thereto at such localities as may be designated by the Chief of Engineers.

The Board is authorized to employ such expert civilian assistance as it deems necessary for the investigations assigned to it.

The board will assemble at such times and places as may be designated by the Senior Member, and is authorized to visit such points as it deems necessary for the proper performance of its duties.

Upon completion of the duties assigned them, the members of the board will return to their proper stations. The travel directed is necessary in the public service.

Par. 3.

By authority of the Secretary of War, the District Engineer in charge of any River and Harbor District, Engineer Department at Large, is appointed an additional member of the board of officers constituted by paragraph 2, Special Orders 72, Office, Chief of Engineers, September 18, 1930, when the board is considering the subject of shore protection of Federal property or problems relating thereto affecting any locality within the limits of his district.

Par. 4.

Under the provisions of an item in Section 2 of the River and Harbor Act approved July 3, 1930, directing the organization under the Chief of Engineers, United States Army, of a board of seven (7) members, including officers of the Corps of Engineers and engineers of State agencies charged with beach erosion and shore protection, the following are appointed, to be known as the Beach Erosion Board:

Colonel William J. Barden, Corps of Engineers,
601 Army Bldg., 39 Whitehall St., New York, N.Y.

Colonel Earl I. Brown, Corps of Engineers,
1109 Gimbel Bldg., 25 South 9th St.,
Philadelphia, Pa.

Lieutenant Colonel Elliott J. Dent, Corps
of Engineers, Fort Humphreys, Va.

Major Gordon R. Young, Corps of Engineers,
U.S. Engineer Office, Foot of Front St.,
Norfolk, Va.

General Richard King Hale, Associate
Commissioner, Department of Public Works,
State of Massachusetts, State House,
Boston, Mass.

Mr. Victor J. Gelineau, Chief Engineer,
New Jersey State Board of Commerce and
Navigation, No. 1 Exchange Place,
Jersey City, N.J.

Mr. Thorndike Saville, Chief Engineer,
Department of Conservation and Development
of the State of North Carolina,
Box 352, Chapel Hill, N.C.

The board will assemble at such times and places as may be designated by the Senior Member, and is authorized to visit such points as it deems necessary for the proper performance of its duties. Upon completion of the duties assigned them, the members of the board will return to their proper stations.

The travel directed is necessary in the public service.

* * * * *

By order of the Chief of Engineers:

R. G. Barrows,
Major, Corps of Engineers,
Chief, Personnel Section.

Public Law No. 409, 74th Congress (H.R. 6732), approved August 30, 1935. "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes."

Sec. 5. Every report submitted to Congress in pursuance of any provision of law for preliminary examination and survey looking to the improvement of the entrance at the mouth of any river or at any inlet, in addition to other information which the Congress has directed shall be given, shall contain information concerning the configuration of the shore line and the probable effect thereon that may be expected to result from the improvement having particular reference to erosion and/or accretion for a distance of not less than ten miles on either side of the said entrance.

Public Law No. 834, 74th Congress (S. 3505), approved June 26, 1936. "An Act For the improvement and protection of the beaches along the shores of the United States."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is hereby declared to be the policy of the United States to assist in the construction where Federal interests are involved, but not the maintenance, of works for the improvement and protection of the beaches along the shores of the United States, and to prevent erosion due to the action of waves, tides, and currents, with the purpose of preventing damage to property along the shores of the United States, and promoting and encouraging the healthful recreation of the people. As used in this Act, the word "beaches" includes all those situated on the coasts of the Atlantic and Pacific Oceans, the Gulf of Mexico, and the shores of the Great Lakes, and all estuaries and bays directly connected therewith.

Sec. 2. (a) It shall be the duty of the Secretary of War, through the Beach Erosion Board, organized under the provisions of section 2 of the Rivers and Harbors Act, approved July 3, 1930, to make investigations with a view to determining the most suitable methods of beach protection and restoration of beaches in different localities; to advise the States, counties, municipalities, or individuals of the appropriate locations for recreational facilities; and to publish from time to time such useful data and information concerning the protection of beaches as the Board may deem to be of value to the people of the United States: *Provided*, That not more than 75 per centum of the cost of any specific investigation shall be borne by the United States.

(b) All provisions of existing law relating to examinations and surveys and to works of improvement of rivers and harbors shall apply, insofar as practicable, to examinations and surveys and to works of improvement relating to shore protection; except that all projects having to do with shore protection shall be referred for consideration and recommendation to the Beach Erosion Board instead of to the Board of Engineers for Rivers and Harbors.

Sec. 3. The Beach Erosion Board, in making its report on any work or project relating to shore protection shall, in addition to any other matters upon which it may be required to report, state its opinion, as to (a) the advisability of adopting the project, (b) what Federal interest, if any, is involved in the proposed improvement, and (c) what share of the expense, if any, should be borne by the United States.

Sec. 4. Any expenses incident and necessary in the undertaking of the investigations and studies authorized herein may be paid from funds hitherto or hereafter appropriated for examinations, surveys, and contingencies for rivers and harbors.

Approved, June 26, 1936.

Special Orders No. 73, Office, Chief of Engineers, dated July 27, 1938.

(S. O. 73, Par. 1.)

WAR DEPARTMENT

Office of the Chief of Engineers

Washington, July 27, 1938.

Special Orders)

No. 73)

Par. 1.

By authority of the Secretary of War, Mr. Morrrough P. O'Brien, Chairman, Department of Mechanical Engineering, University of California, Berkeley, California, is hereby appointed a member of the Beach Erosion Board, vice Mr. Victor J. Gelineau, deceased, effective July 2, 1938, for a term expiring December 31, 1942.

* * * * *

By order of the Chief of Engineers:

S. C. Godfrey,
Colonel, Corps of Engineers,
Acting Chief, Military Division.

Public Law No. 166, 79th Congress (H.R. 2032), approved July 31, 1945. "An Act Authorizing general shore-line investigations at Federal expense, and to repeal an Act for the improvement and protection of the beaches along the shores of the United States, approved June 26, 1936."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in addition to participating in cooperative investigations and studies with agencies to the various States as authorized in section 2 of the River and Harbor Act, approved July 3, 1930, it shall be the duty of the Chief of Engineers, through the Beach Erosion Board, to make general investigations with a view to preventing erosion of the shores of the United States by waves and currents and determining the most suitable methods for the protection, restoration, and development of beaches; and to publish from time to time such useful data and information concerning the erosion and protection of beaches and shore lines as the Board may deem to be of value to the people of the United States. The cost of the general investigations herein authorized shall be borne wholly by the United States. As used in this Act, the word "shores" includes the shore lines of the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, Lake Champlain, and estuaries and bays directly connected therewith.

Sec. 2. All provisions of existing law relating to examinations and surveys and to works of improvement of rivers and harbors shall apply, insofar as practicable, to examinations and surveys and to works of improvement relating to shore protection; except that all projects having to do with shore protection shall be referred for consideration and recommendation to the Beach Erosion Board instead of to the Board of Engineers for Rivers and Harbors.

Sec. 3. The Beach Erosion Board, in making its report on any cooperative investigation and studies under the provisions of section 2 of the River and Harbor Act, approved July 3, 1930, relating to shore protection work shall, in addition to any other matters upon which it may be required to report, state its opinion as to (a) the advisability of adopting the project; (b) what public interest, if any, is involved in the proposed improvement; and (c) what share of the expense, if any, should be borne by the United States.

Sec. 4. Any expenses incident and necessary in the undertaking of the general investigations authorized herein may be paid from funds hitherto or hereafter appropriated for examinations, surveys, and contingencies for rivers and harbors.

Sec. 5. The Act of June 26, 1936 (Public, Numbered 834, Seventy-fourth Congress), is hereby repealed.

Approved July 31, 1945.

General Orders No. 8, Office of Chief, Engineers, dated May 7, 1946.

(G. O. 8)

ARMY SERVICE FORCES
OFFICE OF THE CHIEF OF ENGINEERS

GENERAL ORDERS)
No. 8)

Washington 25, D.C.
7 May 1946

Subject: Abolishment of Shore Protection Board

1. By authority of the Secretary of War and effective 10 May 1946, the Shore Protection Board constituted by paragraph 2 of Special Order No. 72, Office of the Chief of Engineers, 18 September 1930, is abolished.

2. The duties and functions of the Shore Protection Board will hereafter become the responsibility of the Beach Erosion Board.

BY ORDER OF THE CHIEF OF ENGINEERS:

CHAS. G. HOLLE
Colonel, Corps of Engineers
Executive Officer

(SEAL)

Public Law 525, 79th Congress, (H.R. 6407), approved July 24, 1946. "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes."

....

Sec. 4. The Secretary of War may assign two retired engineer officers of the Army, with their consent, to active duty; one as resident or senior member of the Board of Engineers for Rivers and Harbors organized pursuant to the provisions of section 3 of the River and Harbor Act of June 13, 1902, as amended, and one as resident or senior member of the Beach Erosion Board organized pursuant to the provisions of section 2 of the River and Harbor Act of July 3, 1930: *Provided*, That such assignment shall not be made for a period extending beyond four years from the date of retirement.

Public Law 727, 79th Congress, (H.R. 2033), approved August 13, 1946. "An Act Authorizing Federal participation in the cost of protecting the shores of publicly-owned property."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That with the purpose of preventing damage to public property and promoting and encouraging the healthful recreation of the people, it is hereby declared to be the policy of the United States to assist in the construction, but not the maintenance, of works for the improvement and protection against erosion by waves and currents of the shores of the United States that are owned by States, municipalities, or other political subdivisions: Provided, That the Federal contribution toward the construction of protective works shall not in any case exceed one-third of the total cost: Provided further, That where a political subdivision has heretofore erected a sea wall to prevent erosion, by waves and currents, to a public highway considered by the Chief of Engineers sufficiently important to justify protection, Federal contribution toward the repair of such wall and the protection thereof by the building of an artificial beach is authorized at not to exceed one-third of the original cost of such wall, and that investigations and studies hereinafter provided for are hereby authorized for such localities: Provided further, That the plan of protection shall have been specifically adopted and authorized by Congress after investigation and study by the Beach Erosion Board under the provisions of section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented.

Sec. 2. When the Chief of Engineers shall find that any such project has been constructed in accordance with the authorized plans and specifications he shall cause to be paid to the State, municipality, or political subdivision the amount authorized by Congress.

Sec. 3. The Chief of Engineers may, in his discretion, from time to time, make payments on such construction as the work progresses, but these payments, including previous payments, if any, shall not be more than the United States pro rata part of the value of the labor and materials which have been actually put into such construction in conformity to said plans and specifications: *Provided, That the construction of improvement and protective works may be undertaken by the Chief of Engineers upon the request of, and contribution of required funds by, the interested State, municipality or other political subdivision.*

Sec. 4. As used in this Act, the word "shores" includes all the shore lines of the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and lakes, estuaries and bays directly connected therewith.

Approved August 13, 1946.

Special Orders No. 14, Office, Chief of Engineers, dated April 7, 1950.

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS

SPECIAL ORDERS)
NUMBER 14)

Washington 25, D.C.
7 April 1950

1. The following verbal orders of the Chief of Engineers are hereby confirmed and made of record:

By authority of the Secretary of the Army, DR. LORENZ G. STRAUB, Engineering Consultant, Division of Waterways, Department of Conservation, State of Minnesota, is hereby appointed a member of the Beach Erosion Board, Corps of Engineers, U.S. Army, for a term of four (4) years effective 1 April 1950 and expiring 31 March 1954, vice GENERAL RICHARD K. HALE, resigned.

BY ORDER OF THE CHIEF OF ENGINEERS:

J. E. KERKERIEG
Lt. Col., Corps of Engineers
Chief, Military Personnel Branch
Personnel Division

Public Law 71, 84th Congress, (S. 414), approved June 15, 1955. "An Act To authorize an examination and survey of the coastal and tidal areas of the eastern and southern United States; with particular reference to areas where severe damages have occurred from hurricane winds and tides."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954, and September 11, 1954, in the New England, New York, and New Jersey coastal and tidal areas, and the hurricane of October 15, 1954, in the coastal and tidal areas extending south to South Carolina, and in view of the damages caused by other hurricanes in the past, the Secretary of the Army, in cooperation with the Secretary of Commerce and other Federal agencies concerned with hurricanes, is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred.

Sec. 2. Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required.

Sec. 3. There are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act.

Approved June 15, 1955.

Public Law 826, 84th Congress, (H.R. 11861), approved July 28, 1956. "An Act To amend the Act entitled 'An Act authorizing Federal participation in the cost of protecting the shores of publicly-owned property', approved August 13, 1946."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act entitled "An Act authorizing Federal participation in the cost of protecting the shores of publicly owned property", approved August 13, 1946, is hereby amended to read as follows: "That (a) with the purpose of preventing damage to the shores of the United States, its Territories and possessions and promoting and encouraging the healthful recreation of the people, it is hereby declared to be the policy of the United States, subject to the following provisions of this Act to assist in the construction, but not the maintenance, of works for the restoration and protection against erosion, by waves and currents, of the shores of the United States, its Territories and possessions.

"(b) The Federal contribution in the case of any project referred to in subsection (a) shall not exceed one-third of the cost of the project, and the remainder shall be paid by the State, municipality, or other political subdivision in which the project is located.

"(c) When in the opinion of the Chief of Engineers the most suitable and economical remedial measures would be provided by periodic beach nourishment, the term 'construction' may be construed for the purposes of this Act to include the deposit of sand fill at suitable intervals of time to furnish sand supply to project shores for a length of time specified by the Chief of Engineers.

"(d) Shores other than public will be eligible for Federal assistance if there is benefit such as that arising from public use or from the protection of nearby public property or if the benefits to those shores are incidental to the project, and the Federal contribution to the project shall be adjusted in accordance with the degree of such benefits.

"(e) No Federal contribution shall be made with respect to a project under this Act unless the plan therefor shall have been specifically adopted and authorized by Congress after investigation and study by the Beach Erosion Board under the provisions of section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented.

"Sec. 2. When the Chief of Engineers shall find that any such project has been constructed in accordance with the authorized plans and specifications he shall cause to be paid to the State, municipality, or other political subdivision involved the amount authorized by Congress.

*"Sec. 3. The Chief of Engineers may, in his discretion, from time to time, make payments on such construction as the work progresses, but these payments, including previous payments, if any, shall not be more than the United States pro rata part of the value of the labor and materials which have been actually put into such construction in conformity to said plans and specifications: *Provided*, That the construction of restoration and protective works under this Act may be undertaken by the Chief of Engineers upon the request of, and contribution of required funds by, the interested State, municipality, or other political subdivision.*

"Sec. 4. As used in this Act, the word 'shores' includes all the shorelines of the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and lakes, estuaries, and bays directly connected therewith."

Approved July 28, 1956.

Public Law 645, 86th Congress, (H.R. 7634), approved July 14, 1960. "An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes."

....

Sec. 102. That the Secretary of the Army is hereby authorized to reimburse local interests for such work done by them, on the beach erosion projects authorized in section 101, subsequent to the initiation of the cooperative studies which form the basis for the projects: *Provided*, That the work which may have been done on these projects is approved by the Chief of Engineers as being in accordance with the projects hereby adopted: *Provided further*, That such reimbursement shall be subject to appropriations applicable thereto or funds available therefor and shall not take precedence over other pending projects of higher priority for improvements.

Sec. 103. That the last paragraph of section 2 of the River and Harbor Act of July 3, 1930 (46 Stat. 933 at 945) pertaining to cooperative shore erosion studies and to the Beach Erosion Board, is hereby amended to read as follows:

"The Chief of Engineers of the United States Army, under the direction of the Secretary of the Army, is authorized and directed to cause investigations and studies to be made in cooperation with the appropriate agencies of the various States on the Atlantic, Pacific, and gulf coasts and on the Great Lakes, and of the States of Alaska and Hawaii, the Commonwealth of Puerto Rico, and the possessions of the United States, with a view to devising effective means of preventing erosion of the shores of coastal and lake waters by waves and currents; and any expenses incident and necessary thereto may be paid from funds appropriated for General Investigations, Civil Functions, Department of the Army: *Provided*, That the Department of the Army may release to the appropriate cooperating agencies information obtained by these investigations and studies prior to the formal transmission of reports to Congress: *Provided further*, That no money shall be expended under authority of this section in any State which does not provide for cooperation with the agents of the United States and contribute to the project such funds or services as the Secretary of the Army may deem appropriate and require; that there shall be organized under the Chief of Engineers, United States Army, a Board of seven members, of whom four shall be officers of the Corps of Engineers and three shall be civilian engineers selected by the Chief of Engineers with regard to their special fitness in the field of beach erosion and shore protection. The Board will furnish such technical assistance as may be directed by the Chief of Engineers in the conduct of such studies as may be undertaken and will review the reports of the investigations made. In the consideration of such studies as may be referred to the Board by the Chief of Engineers, the Board shall, when it considers it necessary and with the sanction of the Chief of Engineers, make, as a board or through its members, personal examination of localities under investigation: *Provided further*, That the civilian members of the Board may be paid at rates not to exceed \$100 a day for each day of attendance at Board meetings, not to exceed thirty days per annum, in addition to the traveling and other necessary expenses connected with their duties on the Board in accordance with the provisions of section 5 of the Administrative Expenses Act of 1946, as amended (5 U.S.C. 73b-2)."

Public Law 874, 87th Congress, (H.R. 13273), approved October 23, 1962. "An Act Authorizing the construction, repair, and preservation of certain works on rivers and harbors for navigation, flood control, and for other purposes."

....

Sec. 102. That the Secretary of the Army is hereby authorized to reimburse local interests for such work done by them on the beach erosion projects authorized in section 101, and in other sections of this Act, subsequent to the initiation of the cooperative studies which form the basis for the projects: *Provided*, That the work which may have been done on these projects is approved by the Chief of Engineers as being in accordance with the projects herein adopted: *Provided further*, That such reimbursement shall be subject to appropriations applicable thereto or funds available therefor and shall not take precedence over other pending projects of higher priority for improvements.

Sec. 103. (a) The Act approved August 13, 1946, as amended by the Act approved July 28, 1956 (33 U.S.C. 426e-h), pertaining to shore protection, is hereby further amended as follows:

(1) the word "one-third" in section 1 (b) is deleted and the word "one-half" is substituted therefor;

(2) the following is added after the word "located" in section 1 (b): ", except that the costs allocated to the restoration and protection of Federal property shall be borne fully by the Federal Government, and, further, that Federal participation in the cost of a project for restoration and protection of State, county, and other publicly owned shore parks and conservation areas may be, in the discretion of the Chief of Engineers, not more than 70 per centum of the total cost exclusive of land costs, when such areas: Include a zone which excludes permanent human habitation; include but are not limited to recreational beaches; satisfy adequate criteria for conservation and development of the natural resources of the environment; extend landward a sufficient distance to include, where appropriate, protective dunes, bluffs, or other natural features which serve to protect the uplands from damage; and provide essentially full park facilities for appropriate public use, all of which shall meet with the approval of the Chief of Engineers";

(3) the following is added after the word "supplemented" in section 1 (e): ", or, in the case of a small project under section 3 of this Act, unless the plan therefor has been approved by the Chief of Engineers"; and

(4) sections 2 and 3 are amended to read as follows:

"Sec. 2. The Secretary of the Army is hereby authorized to reimburse local interests for work done by them, after initiation of the survey studies which form the basis for the project, on authorized projects which individually do not exceed \$1,000,000 in total cost: *Provided*, That the work which may have been done on the projects is approved by the Chief of Engineers as being in accordance with the authorized projects: *Provided further*, That such reimbursement shall be subject to appropriations applicable thereto or funds available therefor and shall not take precedence over other pending projects of higher priority for improvements.

"Sec. 3. The Secretary of the Army is hereby authorized to undertake construction of small shore and beach restoration and protection projects not specifically authorized by Congress, which otherwise comply with section 1 of this Act, when he finds that such work is advisable, and he is further authorized to allot from any appropriations hereafter made for civil works, not to exceed \$3,000,000 for any one fiscal year for the Federal share of the costs of construction of such projects: *Provided*, That not more than \$400,000 shall be allotted for this purpose for any single project and the total amount allotted shall be sufficient to complete the Federal participation in the project under this section including periodic nourishment as provided for under section 1 (c) of this Act: *Provided further*, That the provisions of local cooperation specified in section 1 of this Act shall apply: *And provided further*, That the work shall be complete in itself and shall not commit the United States to any additional improvement to insure its successful operation, except for participation in periodic beach nourishment in accordance with section 1 (c) of this Act, and as may result from the normal procedure applying to projects authorized after submission of survey reports."

(b) All provisions of existing law relating to surveys of rivers and harbors shall apply to surveys relating to shore protection and section 2 of the River and Harbor Act approved July 3, 1930, as amended (33 U.S.C. 426), is modified to the extent inconsistent herewith.

(c) The cost-sharing provisions of this Act shall apply in determining the amounts of Federal participation in or payments toward the costs of authorized projects which have not been substantially completed prior to the date of approval of this Act, and the Chief of Engineers, through the Beach Erosion Board, is authorized and directed to recompute the amounts of Federal contribution toward the costs of such projects accordingly.

....

Sec. 110. The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following named localities and subject to all applicable provisions of section 110 of the River and Harbor Act of 1950:

Falmouth Harbor, Maine.
Channel between Point Shirley and Deer Island, Massachusetts.
Little Egg Inlet, New Jersey.
Brigantine Inlet, New Jersey.
Corsons Inlet, New Jersey.
Kings Bay Deepwater Channel, Georgia.
Auglaize River at Wapakoneta, Ohio.

Surveys of the coastal areas of the United States and its possessions, including the shores of the Great Lakes, in the interest of beach erosion control, hurricane protection and related purposes: *Provided*, That surveys of particular areas shall be authorized by appropriate resolutions of either the Committee on Public Works of the United States Senate or the Committee on Public Works of the House of Representatives.

Public Law 172, 88th Congress, (S. 1523), approved November 7, 1963. "An Act To make certain changes in the functions of the Beach Erosion Board and the Board of Engineers for Rivers and Harbors, and for other purposes."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Board established by section 2 of the River and Harbor Act approved July 3, 1930, as amended (33 U.S.C. 426), referred to as the Beach Erosion Board, is hereby abolished. There shall be established under the Chief of Engineers, United States Army, a Coastal Engineering Research Center which, except as hereinafter provided in section 3 hereof, shall be vested with all the functions of the Beach Erosion Board, including the authority to make general investigations as provided in section 1 of the Act approved July 31, 1945 (59 Stat. 508), and such additional functions as the Chief of Engineers may assign.

Sec. 2. The functions of the Coastal Engineering Research Center established by section 1 of this Act, shall be conducted with the guidance and advice of a Board on Coastal Engineering Research, constituted by the Chief of Engineers in the same manner as the present Beach Erosion Board.

Sec. 3. All functions of the Beach Erosion Board pertaining to review of reports of investigations made concerning erosion of the shores of coastal and lake waters, and the protection of such shores, are hereby transferred to the Board established by section 3 of the River and Harbor Act approved June 13, 1902, as amended (33 U.S.C. 541), referred to as the Board of Engineers for Rivers and Harbors.

Approved November 7, 1963.

APPENDIX B

MEMBERSHIP OF THE CORPS OF ENGINEERS BEACH EROSION BOARD

Although the Beach Erosion Board was to have four military members at any one time, there was no established tenure of office. During the BEB's 33-year life, length of term ranged from just a few weeks to 7 years. Until 1940, military membership on the Board was quite stable, involving just some 10 or 11 officers. After the war, however, most of those military men who had been concerned with beach problems during the agency's formative years had retired from active duty. Thus, in the postwar years it was decided that military membership on the BEB should be geared primarily to officers who were engineers in the U.S. Army, Corps of Engineers' Division and District offices located in the coastal regions of the country. From 1945 on, the average length of military membership on the BEB was about 2 years.

List I is a tabulation of all military officers of the U.S. Army, Corps of Engineers who served as members of the BEB. Although each officer's name is listed only once, there were several who were members of the Board more than one time. An effort was made to list each officer's name chronologically, in the order of first term of membership on the Board.

List II is comprised of the names of the officers who held the position of either Senior Member or President of the Beach Erosion Board. Dates of office are included.

There were also to be three civilian members on the Beach Erosion Board. List III includes the names of the men who served in this capacity and the dates they held office. The tenure of office for these members again was not formally established. The original members seem to have been given indefinite terms, while later appointees were generally given renewable 4-year terms.

LIST I

Military officers of the U.S. Army, Corps of Engineers who served as members of the Beach Erosion Board.

- | | |
|--------------------------------|---------------------------------------|
| 1. Col. William J. Barden | 31. Col. William J. Ely |
| 2. Col. Earl I. Brown | 32. Col. Herbert D. Vogel |
| 3. Col. Elliott J. Dent | 33. Lt. Col. William B. Stelzenmuller |
| 4. Maj. Gordon R. Young | 34. Maj. Gen. Glen E. Edgerton |
| 5. Maj. Brehon B. Somervell | 35. Col. Dabney O. Elliott |
| 6. Maj. Robert W. Crawford | 36. Col. Walter D. Luplow |
| 7. Maj. Charles H. Cunningham | 37. Col. Richard W. Pearson |
| 8. Col. Edmund L. Daley | 38. Col. Wendell P. Trower |
| 9. Capt. Frank O. Bowman | 39. Col. Donald S. Burns |
| 10. Maj. Albert C. Lieber, Jr. | 40. Col. John R. Hardin |
| 11. Col. Edwin H. Marks | 41. Col. John S. Seybold |
| 12. Col. Francis B. Wilby | 42. Col. William C. Ready |
| 13. Col. Jarvis J. Bain | 43. Col. Herman W. Schull, Jr. |
| 14. Lt. Col. John F. Conklin | 44. Maj. Peter Somers |
| 15. Col. Earl North | 45. Col. John U. Allen |
| 16. Lt. Col. J.S. Bragdon | 46. Col. William F. Cassidy |
| 17. Lt. Col. H.B. Vaughan, Jr. | 47. Col. Everett A. Hansen |
| 18. Lt. Col. John W. Stewart | 48. Brig. Gen. Theron D. Weaver |
| 19. Capt. William C. Hall | 49. Brig. Gen. Henry J. Hoeffler |
| 20. Brig. Gen. John J. Kingman | 50. Maj. Gen. Charles G. Holle |
| 21. Col. Roger G. Powell | 51. Maj. Gen. Frank M. Albrecht |
| 22. Col. Albert H. Burton | 52. Maj. Gen. Walter K. Wilson, Jr. |
| 23. Col. Peter A. Feringa | 53. Brig. Gen. Robert G. MacDonnell |
| 24. Col. Clarence Renshaw | 54. Brig. Gen. Thomas H. Lipscomb |
| 25. Col. Earl E. Gesler | 55. Maj. Gen. Keith R. Barney |
| 26. Col. Xenophon H. Price | 56. Brig. Gen. Howard A. Morris |
| 27. Col. Charles L. Hall | 57. Brig. Gen. Arthur H. Frye, Jr. |
| 28. Col. Albert B. Jones | 58. Brig. Gen. Seymour A. Potter, Jr. |
| 29. Col. Leland H. Hewitt | 59. Brig. Gen. Peter C. Hyzer |
| 30. Col. Frederic F. Frech | 60. Brig. Gen. John C. Dalrymple |

Other officers of the U.S. Army, Corps of Engineers, who served the Beach Erosion Board in some official capacity but at no time were voting members:

- | | |
|------------------------------|--------------------------|
| 1. Capt. Charles I. McGinnis | 3. Col. H.E. Sprague |
| 2. Col. Allen A. Futral | 4. Lt. Col. M.E. Stevens |

LIST II

Military officers of the U.S. Army, Corps of Engineers who held the position of either Senior Member or President of the Beach Erosion Board. Dates of office are included.

Col. William J. Barden	September 1930 to October 1934
Col. Earl I. Brown	October 1934 to May 1938
Col. Edmund K. Daley	May 1938 to October 1938
Col. Francis B. Wilby	October 1938 to October 1939
Col. Jarvis J. Bain	October 1939 to December 1940
Col. Elliott J. Dent	December 1940 to October 1941
Brig. Gen. John J. Kingman	December 1941 to October 1945
Col. Xenophon H. Price	October 1945 to February 1946
Col. Charles Lacey Hall	February 1946 to July 1948
Maj. Gen. Glen E. Edgerton	July 1948 to April 1949
Col. Dabney O. Elliott	June 1949 to September 1950
Col. Earl I. Gesler	October 1950 to March 1953
Col. Leland H. Hewitt, Acting President	March 1953 to June 1953
Col. Leland H. Hewitt	June 1953 to April 1954
Col. Wendell P. Trower	April 1954 to June 1955
Col. Clarence Renshaw, Acting President	July 1955 to August 1955
Brig. Gen. Theron D. Weaver	August 1955 to December 1956
Maj. Gen. Charles G. Holle	January 1957 to October 1958
Maj. Gen. W.K. Wilson, Jr.	November 1958 to September 1960
Maj. Gen. Keith R. Barney	September 1960 to March 1962
Maj. Gen. William F. Cassidy	March 1962 to February 1963
Maj. Gen. Robert G. MacDonnell	February 1963 to November 1963

LIST III

Civilian engineers who served as members of the U.S. Army, Corps of Engineers, Beach Erosion Board. Dates of office are included.

Victor Gelineau	September 1930 to February 1938
Richard K. Hale	September 1930 to April 1950
Thorndike Saville	September 1930 to November 1963
Morrough P. O'Brien	July 1938 to November 1963
Lorenz G. Straub	April 1950 to October 1963

APPENDIX C

OFFICIAL PUBLICATIONS OF THE BEB AND BEB COOPERATIVE BEACH EROSION STUDIES

Interim Report of the Beach Erosion Board, April 15, 1933, U.S. Army, Corps of Engineers, Washington, D.C.

Manual of Procedure in Beach Erosion Studies, Paper No. 2 of the Beach Erosion Board, Office of the Chief of Engineers, Washington, D.C., December 1, 1938.

TECHNICAL MEMORANDUMS

TM	TITLE, AUTHOR, AND DATE
1	"A Model Study of the Effect of Submerged Breakwaters on Wave Action," by 1st Lt. William C. Hall, May 1940.
2	"Abrasion of Beach Sand," by Martin A. Mason, February 1942.
3	"Shore Processes and Beach Characteristics," by W. C. Krumbein, May 1944.
4	"Surface Features of Coral Reefs," by Lincoln Dryden, May 1944.
5	"A Wave Method for Determining Depths Over Bottom Discontinuities," by Martin A. Mason and Garbis H. Keulegan, May 1944.
6	"An Ocean Wave Measuring Instrument," by Joseph M. Caldwell, October 1948.
7	"Shore Currents and Sand Movement on a Model Beach," by W. C. Krumbein, September 1944.
8	"Depths of Offshore Bars," by G. H. Keulegan, July 1945.
9	"Proof Test of Water Transparency Method of Depth Determination," by J. V. Hall, Jr., July 1948.
10	"Experimental Steel Sheet Pile Groins, Palm Beach, Florida," by C. W. Ross, 1948.
11	"Reflection of Solitary Waves," by Joseph M. Caldwell, November 1949.
12	"Durability of Steel Sheet Piling in Shore Structures," by A. C. Rayner and C. W. Ross, February 1952.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
13	"Longshore Current Observations in Southern California," by F. P. Shepard, January 1950.
14	"Report on Beach Study in the Vicinity of Mugu Lagoon, California," by D. L. Inman, March 1950.
15	"Longshore Bars and Longshore Troughs," by Francis P. Shepard, January 1950.
16	"Accretion of Beach Sand Behind a Detached Breakwater," by John W. Handin and John C. Ludwick, May 1950.
17	"Test of Nourishment of the Shore by Offshore Deposition on Sand," by J. V. Hall, Jr. and W. J. Herron, Jr., June 1950.
18	"The Rayleigh Disk as a Wave Direction Indicator," by J. V. Hall, Jr., July 1950.
19	"Submarine Topography and Sedimentation in the Vicinity of Mugu Submarine Canyon, California," by D. L. Inman, July 1950.
20	"Beach Cycles in Southern California," by Francis P. Shepard, July 1950.
21	"The Interpretation of Crossed Orthogonals in Wave Refraction Phenomena," by Willard J. Pierson, Jr., January 1951.
22	"The Source, Transportation, and Deposition of Beach Sediment in Southern California," by John W. Handin, March 1951.
23	"The Use and Accuracy of the Emery Settling Tube for Sand Analysis," by D. M. Poole, W. S. Butcher, and R. L. Fisher, July 1951.
24	"The Accuracy of Present Wave Forecasting Methods with Reference to Problems in Beach Erosion on the New Jersey and Long Island Coasts," by W. J. Pierson, Jr., April 1951.
25	"The Slope of Lake Surfaces Under Variable Wind Stresses," by B. Haurwitz, November 1951.
26	"Sand Movement on the Shallow Inter-Canyon Shelf at La Jolla, California," by F. P. Shepard and D. L. Inman, November 1951.
27	"Wind Set-up and Waves in Shallow Water," by Thorndike Saville, Jr., June 1952.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
28	"Source of Beach Sand at Santa Barbara, California, as Indicated by Mineral Grain Studies," by Parker D. Trask, October 1952.
29	"Artificially Nourished and Constructed Beaches," by Jay V. Hall, Jr., December 1952.
30	"Annotated Bibliography on Tsunamis," by Marcial P. Cueller, February 1953.
31	"Laboratory Study of Wave Energy Losses by Bottom Friction and Percolation," by Rudolph P. Savage, February 1953.
32	"Accuracy of Hydrographic Surveying in and Near the Surf Zone," by Thorndike Saville, Jr. and Joseph M. Caldwell, March 1953.
33	"Laboratory Investigations of the Vertical Rise of Solitary Waves on Impermeable Slopes," by Jay V. Hall, Jr. and George M. Watts, March 1953.
34	"Development and Field Tests of a Sampler for Suspended Sediment in Wave Action," by George M. Watts, March 1953.
35	"Analysis of Moving Fetches for Wave Forecasting," by Kenneth Kaplan, March 1953.
36	"Wave and Lake Level Statistics for Lake Michigan," by Thorndike Saville, Jr., March 1953.
37	"Wave and Lake Level Statistics for Lake Erie," by Thorndike Saville, Jr., March 1953.
38	"Wave and Lake Level Statistics for Lake Ontario," by Thorndike Saville, Jr., March 1953.
39	"Areal and Seasonal Variations in Beach and Nearshore Sediments at La Jolla, California," by Douglas L. Inman, March 1953.
40	"The Mechanics of Deep Water, Shallow Water, and Breaking Waves," by Jack R. Morison and R. C. Crooke, March 1953.
41	"Laboratory Study of Equilibrium Profiles of Beaches," by R. L. Reçtor, August 1954.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
42	"A Study of Sand Movement at South Lake Worth Inlet, Florida," by George M. Watts, October 1953.
43	"On Ocean Wave Spectra and a New Method of Forecasting Wind-Generated Sea," by Gerhard Neumann, December 1953.
44	"Coast Erosion and the Development of Beach Profiles," by Per Bruun, June 1954.
45	"Modification of Wave Height Due to Bottom Friction, Percolation and Refraction," by Charles L. Bretschneider and R. O. Reid, October 1954.
46	"Field Investigations of Wave Energy Loss in Shallow Water Ocean Waves," by Charles L. Bretschneider, September 1954.
47	"Stability of Oscillatory Laminar Flow Along a Wall," by Huon Li, July 1954.
48	"Sand Movement by Waves," by Theodore Scott, August 1954.
49	"Bore Hole Studies of the Naturally Impounded Fill at Santa Barbara, California," by Parker D. Trask and Theodore Scott, August 1954.
50	"Statistical Significance of Beach Sampling Methods," by W. C. Krumbein, August 1954.
51	"Generation of Wind Waves Over a Shallow Bottom," by Charles L. Bretschneider, October 1954.
52	"Laboratory Study of Effect of Tidal Action on Wave-Formed Beach Profiles," by George M. Watts and Robert F. Dearduff, December 1954.
53	"Laboratory Study of Effect of Varying Wave Periods on Beach Profiles," by George M. Watts, September 1954.
54	"Laboratory and Field Tests of Sounding Leads," by George M. Watts, November 1954.
55	"North Atlantic Coast Wave Statistics Hindcast by Bretschneider-Revised Sverdrup-Munk Method," by Thorndike Saville, Jr., November 1954.
56	"An Electronic Wave Spectrum Analyzer and Its Use in Engineering Problems," by Willard J. Pierson, Jr., October 1954.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
57	"North Atlantic Coast Wave Statistics Hindcast by the Wave Spectrum Method," by G. Neumann and R. W. James, February 1955.
58	"A Magnetic Tape Wave Recorder and Energy Spectrum Analyzer for the Analysis of Ocean Wave Records," by Sheldon S. Chang, July 1955.
59	"Laboratory Study of Shock Pressures of Breaking Waves," by C. W. Ross, February 1955.
60	"Generalized Laboratory Study of Tsunami Run-up," by Kenneth Kaplan, January 1955.
61	"Laboratory Study of Wind Tides in Shallow Water," by Osvald J. Sibul, August 1955.
62	"Restudy of Test—Shore Nourishment by Offshore Deposition of Sand, Long Branch, New Jersey," by Robert L. Harris, November 1954.
63	"A Study of Sediment Sorting by Waves Shoaling on a Plane Beach," by Arthur T. Ippen and Peter S. Eagleson, September 1955.
64	"Laboratory Data on Wave Run-up and Overtopping on Shore Structures," by Thorndike Saville, Jr., October 1955.
65	"Sand Variation at Point Reyes Beach, California," by Parker D. Trask and Charles A. Johnson, October 1955.
66	"Factors Affecting the Economic Life of Timber in Coastal Structures," by Robert A. Jachowski, December 1955.
67	"A Model Study of the Run-up of Wind-Generated Waves on Levees with Slopes of 1:3 and 1:6," by Osvald J. Sibul and Ernest G. Tickner, December 1955.
68	"Wave Action and Sand Movement near Anaheim Bay, California," by Joseph M. Caldwell, February 1956.
69	"Wave Forces on Piles: A Diffraction Theory," by R. C. MacCamy and R. A. Fuchs, December 1954.
70	"The Effect of Fetch Width on Wave Generation," by Thorndike Saville, Jr., December 1954.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
71	"Re-Analysis of Existing Wave Force Data on Model Piles," by R. C. Crooke, April 1955.
72	"Laboratory Study of the Generation of Wind Waves in Shallow Water," by Osvald J. Sibul, March 1955.
73	"Graphical Approach to the Forecasting of Waves in Moving Fetches," by Basil W. Wilson, April 1955.
74	"Water Surface Roughness and Wind Shear Stress in a Laboratory Wave Channel," by Osvald J. Sibul, May 1955.
75	"Mechanics of Bottom Sediment Movement Due to Wave Action," by Madhav Manohar, June 1955.
76	"Movement of Sand Around Southern California Promontories," by Parker D. Trask, June 1955.
77	"Behavior of Beach Fill at Ocean City, New Jersey," by George M. Watts, February 1956.
78	"Hurricanes Affecting the Coast of Texas from Galveston to Rio Grande," by W. Armstrong Price, March 1956.
79	"Orbital Velocity Associated with Wave Action Near the Breaker Zone," by Douglas L. Inman and Noriyuki Nasu, March 1956.
80	"Model Study of Overtopping of Wind-Generated Waves on Levees with Slopes of 1:3 and 1:6," by Osvald J. Sibul and Ernest G. Tickner, April 1956.
81	"A Laboratory Study of Short-Crested Wind Waves," by G. C. Ralls, Jr. and R. L. Wiegel, June 1956.
82	"Changes in Sand Level on the Beach and Shelf at La Jolla, California," by D. L. Inman and G. S. Rusnak, July 1956.
83	"Approximate Response of Water Level on a Sloping Shelf to a Wind Fetch Which Moves Towards Shore," by R. O. Reid, June 1956.
84	"Wave Forecasting Relationships for the Gulf of Mexico," by Charles L. Bretschneider, December 1956.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
85	"Wave Statistics for the Gulf of Mexico off Brownsville, Texas," by Charles L. Bretschneider and Roy D. Gaul, September 1956.
86	"Wave Statistics for the Gulf of Mexico off Caplen, Texas," by Charles L. Bretschneider and Roy D. Gaul, September 1956.
87	"Wave Statistics for the Gulf of Mexico off Burrwood, Louisiana," by Charles L. Bretschneider and Roy D. Gaul, October 1956.
88	"Wave Statistics for the Gulf of Mexico off Apalachicola, Florida," by Charles L. Bretschneider and Roy D. Gaul, October 1956.
89	"Wave Statistics for the Gulf of Mexico off Tampa Bay, Florida," by Charles L. Bretschneider and Roy D. Gaul, October 1956.
90	"Relative Efficiency of Beach Sampling Methods," by W. C. Krumbein and H. A. Slack, September 1956.
91	"Changes in Configuration of Point Reyes Beach, California 1955-1956," by Parker D. Trask, November 1956.
92	"Sand Bypassing at Port Hueneme, California," by Rudolph P. Savage, March 1957.
93	"Modification of the Quadratic Bottom-Stress Law for Turbulent Channel Flow in the Presence of Surface Wind-Stress," by R. O. Reid, February 1957.
94	"Preliminary Report: Laboratory Study of the Effect of an Uncontrolled Inlet on the Adjacent Beaches," by Thorndike Saville, Jr., Joseph M. Caldwell, and Henry B. Simmons, May 1957.
95	"Effect of Bottom Roughness on Wind Tide in Shallow Water," by E. G. Tickner, May 1957.
96	"Factors Affecting Durability of Concrete in Coastal Structures," by Bryant Mather, June 1957.
97	"Turbulent Flow Near an Oscillating Wall," by George Kalkanis, July 1957.
98	"Hurricane Wave Statistics for the Gulf of Mexico," by Basil W. Wilson, June 1957.
99	"Model Tests on a Triple-Bulkhead Type of Floating Breakwater," by Culbertson W. Ross, September 1957.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
100	"Wave-Generated Ripples in Nearshore Sands," by Douglas L. Inman, October 1957.
101	"Dune Formation and Stabilization by Vegetation and Plantings," by John H. Davis, October 1957.
102	"A Method for Specification of Sand for Beach Fills," by W. C. Krumbein, October 1957.
103	"Model Study of Wave Refraction," by R. L. Wiegell and A. L. Arnold, December 1957.
104	"The Mechanics of the Motion of Discrete Spherical Bottom Sediment Particles Due to Shoaling Waves," by P. S. Eagleson, R. G. Dean, and L. A. Peralta, February 1958.
105	"Movement of Bottom Sediment in Coastal Waters by Currents and Waves; Measurements with the Aid of Radioactive Tracers in the Netherlands," by J. J. Arlman, P. Santema, and J. N. Svasek, March 1958.
106	"Laboratory Study of Breaking Wave Forces on Piles," by M. A. Hall, August 1958.
107	"Behavior of Beach Fill and Borrow Area at Harrison County, Mississippi," by George M. Watts, August 1958.
108	"Surf Statistics for the Coasts of the United States," by J. R. Helle, November 1958.
109	"Laboratory Data on Wave Runup on Roughened and Permeable Slopes," by Rudolph P. Savage, March 1959.
110	"Beaches Near San Francisco, California, 1956-1957," by Parker D. Trask, April 1959.
111	"Large-Scale Tests of Wave Forces on Piling (Preliminary Report)," by C. W. Ross, May 1959.
112	"The Propagation of Tidal Waves into Channels of Gradually Varying Cross-Section (Effect of a Frictional Resistance Over the Bed)," by Paul Perroud, May 1959.
113	"Behavior of Beach Fill at Virginia Beach, Virginia," by George M. Watts, June 1959.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
114	"Laboratory Study of Effect of Groins on the Rate of Littoral Transport: Equipment Development and Initial Tests," by R. P. Savage, June 1959.
115	"Suspended Sediment Sampling in Laboratory Wave Action," by John C. Fairchild, June 1959.
116	"On the Theory of the Highest Waves," by J. E. Chappellear, July 1959.
117	"The Damping of Oscillatory Waves by Laminar Boundary Layers," by Peter S. Eagleson, August 1959.
118	"Wave Variability and Wave Spectra for Wind-Generated Gravity Waves," by Charles L. Bretschneider, August 1959.
119	"Sand Movement by Wind Action (On the Characteristics of Sand Traps)," by K. Horikawa and H. W. Shen, August 1960.
120	"The Prediction of Hurricane Storm-Tides in New York Bay," by Basil W. Wilson, August 1960.
120-A	"Discussion of Technical Memorandum No. 120: 'The Prediction of Hurricane Storm-Tides in New York Bay' (and Closure by Author)," by D. L. Harris and B. W. Wilson, April 1961.
121	"Development and Tests of a Radioactive Sediment Density Probe," by Joseph M. Caldwell, September 1960.
122	"Effects of Reefs and Bottom Slopes on Wind Set-up in Shallow Water," by E. G. Tickner, November 1960.
123	"Transient Wind Tides in Shallow Water," by E. G. Tickner, January 1961.
124	"Experimental Study on the Solitary Wave Reflection Along a Straight Sloped Wall at Oblique Angle of Incidence," by T. C. Chen, March 1961.
125	"On the Description of Short-Crested Waves," by J. E. Chappellear, March 1961.
126	"Equilibrium Characteristics of Sand Beaches in the Offshore Zone," by P. S. Eagleson, B. Glenne, and J. A. Dracup, July 1961.
127	"Behavior of Beach Fill and Borrow Area at Prospect Beach, West Haven, Connecticut," by William H. Vesper, August 1961.

TECHNICAL MEMORANDUMS—Continued

TM	TITLE, AUTHOR, AND DATE
128	"Geomorphology of the South Shore of Long Island, New York," by Norman E. Taney, September 1961.
129	"Littoral Materials of the South Shore of Long Island, New York," by Norman E. Taney, November 1961.
130	"The Analysis of Observational Data from Natural Beaches," by W. C. Krumbein, November 1961.
131	"Littoral Studies Near San Francisco Using Tracer Techniques," by Adel M. Kamel, November 1962.
132	"Waves in Inland Reservoirs (Summary Report on Civil Works Investigation Projects CW-164 and CW-165)," prepared by representatives of the Missouri Division and Fort Peck District, the Southwestern Division and Tulsa District, the Beach Erosion Board, and Office, Chief of Engineers, November 1962.
133	"Higher Approximation to Nonlinear Water Waves and the Limiting Heights of Cnoidal, Solitary, and Stokes' Waves," by E. V. Laitone, February 1963.
134	"Beach Profile as Affected by Vertical Walls," by Abdel-Latif Kadib, June 1963.
135	"The Relationship Between Watershed Geology and Beach Radioactivity," by John R. Byerly, August 1963.

TECHNICAL REPORTS

TR	TITLE, AUTHOR, AND DATE
1	"A Study of Progressive Oscillatory Waves in Water," by Martin A. Mason, May 1941.
2	"A Summary of the Theory of Oscillatory Waves," by Morrough P. O'Brien and Martin A. Mason, November 1941.
3	"An Experimental Study of Submarine Sand Bars," by Garbis H. Keulegan, August 1948.
4	"Shore Protection Planning and Design," by Beach Erosion Board Staff, June 1954; revised August 1957; 2d edition issued May 1961. (A 3d edition was issued June 1966 by the BEB's successor agency, the Coastal Engineering Research Center (CERC). TR-4 was replaced by the CERC publication, "Shore Protection Manual," in 1973.

MISCELLANEOUS PAPERS

MP	TITLE, AUTHOR, AND DATE
1-59	"Shore Erosion by Storm Waves," by Joseph M. Caldwell, April 1959.
2-59	"Behavior of Sand-Asphalt Groins at Ocean City, Maryland," by Robert A. Jachowski, May 1959.
3-59	"Hurricane Surge Predictions for Chesapeake Bay," by Charles L. Bretschneider, September 1959.
4-59	"Hurricane Surge Predictions for Delaware Bay and River," by Charles L. Bretschneider, November 1959.
1-62	"A General Reconnaissance of Coastal Dunes of California," by R. P. Zeller, June 1962.

THE BULLETIN OF THE BEACH EROSION BOARD*

The Bulletin of the Beach Erosion Board, Vol. 1, No. 1, April 1947—Vol. 17, July 1963. (Includes: Special Issue No. 1, "Oscillatory Waves—Diagrams and Tables of Relationships Commonly Used in Investigations of Surface Waves," dated 1 July 1948. The major part of this work was performed by Robert L. Wiegel, Department of Engineering, University of California, Berkeley and Special Issue No. 2, "Shore Protection Planning and Design (Preliminary Edition)," dated March 1953. This work was performed by the Engineering Division of the BEB.)

*The *Bulletin* changed from a quarterly to an annual publication in July 1956.

BEB COOPERATIVE BEACH EROSION STUDIES

(Information from *The Annual Bulletin of the Beach Erosion Board*, Vol. 17, 1963.)

Location	BEB Report Completed	Published in House Doc.	Congress
Alabama:			
Perdido Pass (Alabama Pt.)	18 June 54	274	84
California:			
Santa Barbara			
Initial	15 Jan. 38	552	75
Supplemental	18 Feb. 42		
Final	22 May 47	761	80
Ballona Creek and 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 June 51	277	83
Carpinteria to Pt. Mugu	4 Oct. 51	29	83
Oceanside, Ocean Beach, Imperial Beach and Coronado, San Diego County	26 July 55	399	84
Santa Cruz County	13 Sept. 56	179	85
Humboldt Bay (Buhne Pt.)	29 Mar. 57	282	85
Newport Bay to San Mateo Creek, Orange County	3 Dec. 59	398	86
San Diego County	30 June 60	456	86
Ventura	28 Dec. 61	458	87
San Gabriel River to Newport Bay, Orange County	20 Apr. 62	602	87
Connecticut:			
Compo Beach, Westport	18 Apr. 35	239	74
Hawk's Nest Beach, Old Lyme	21 June 39		
Ash Creek to Saugatuck River	29 Apr. 49	454	81
Hammonasset River to East River	29 Apr. 49	474	81
New Haven Harbor to Housatonic River	29 June 51	203	83
Connecticut River to Hammonasset River	28 Dec. 51	514	82
Pawcatuck River to Thames River	31 Mar. 52	31	83
Niantic Bay to Connecticut River	11 July 52	84	83
Housatonic River to Ash Creek	12 Mar. 53	248	83
East River to New Haven Harbor	15 Nov. 55	395	84
Saugatuck River to Byram River	14 Nov. 56	174	85
Thames River to Niantic Bay	17 June 57	334	85

BEB COOPERATIVE BEACH EROSION STUDIES—Continued

Location	BEB Report Completed	Published in	
		House Doc.	Congress
Delaware:			
Kitts Hummock to Fenwick Island	11 Feb. 57	216	85
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 and Longboat Keys	12 Feb. 47	760	80
Jupiter Island	13 Feb. 47	765	80
Palm Beach*	13 Feb. 47	772	80
Pinellas County	22 Apr. 53	380	83
Palm Beach County (Lake Worth Inlet to South Lake Worth Inlet)	12 July 57	342	85
Key West	10 Mar. 58	413	85
Amelia Island	16 Aug. 60	200	87
Palm Beach County	23 Aug. 60	164	87
Virginia and Biscayne Keys	6 Apr. 62	561	87
Broward County and Hillsboro Inlet	23 Apr. 63		
Georgia:			
St. Simon Island	18 Mar. 40	820	76
Hawaii:			
Waikiki Beach	5 Aug. 52	227	83
Waimea and Hanapepe Bay, Kauai	17 Jan. 56	432	84
Haleiwa Beach, Oahu	28 Feb. 63		
Waikiki Beach, Oahu (revised)	1 Nov. 63	104	89
Illinois:			
State of Illinois	8 June 50	28	83
Louisiana:			
Grand Isle	28 July 36	92	75
Grand Isle	28 June 54	132	84
Belle Pass to Raccoon Point	13 June 61	338	87
Maine:			
Old Orchard Beach	20 Sept. 35		
Saco	2 Mar. 56	32	85
Hills Beach, Biddeford	27 Nov. 61	590	87

*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 Sept. 1940. Final report on experimental groins was published in 1948 as Technical Memorandum No. 10 of the Beach Erosion Board.

BEB COOPERATIVE BEACH EROSION STUDIES—Continued

Location	BEB Report Completed	Published in	
		House Doc.	Congress
Massachusetts:			
South Shore of Cape Cod (Pt. Gammon to Chatham)	26 Aug. 41		
Salisbury Beach	26 Aug. 41		
Winthrop Beach	12 Sept. 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
Chatham	22 Oct. 56	167	85
Pemberton Pt. to Cape Cod Canal	13 Jan. 59	272	86
Wessagussett Beach, Weymouth	6 July 59	334	86
Cape Cod Canal to Provincetown	5 Feb. 60	404	86
Clark Point, New Bedford	14 Aug. 61	584	87
Rockport	21 Nov. 61	515	87
Salisbury Beach	5 Dec. 61	517	87
Falmouth	28 Feb. 63		
Michigan:			
Berrien County (St. Joseph)	17 June 57	336	85
Mississippi:			
Hancock County	3 Apr. 42		
Harrison County			
Initial	15 Mar. 44		
Supplement	16 Feb. 48	682	80
New Hampshire:			
Hampton Beach	15 July 32		
Hampton Beach	14 Sept. 53	325	83
Atlantic Ocean shore (entire)	30 June 61	416	87
New Jersey:			
Manasquan Inlet and Adjacent Beaches	15 May 36	71	75
Atlantic City	11 July 49	538	81
Ocean City	15 Apr. 52	184	83
Sandy Hook to Barnegat Inlet	24 Mar. 54	361	84
Review Report—Sandy Hook to Barnegat Inlet	6 May 57	332	85
Barnegat Inlet to Delaware Bay			
Entrance to Cape May Canal	22 Sept. 58	208	86
Delaware Bay Shore—Cape May Canal to Maurice River	10 June 60	196	87
Raritan and Sandy Hook Bays	2 Nov. 61	464	87
Atlantic City	25 Mar. 63		

BEB COOPERATIVE BEACH EROSION STUDIES—Continued

Location	BEB Report Completed	Published in	
		House Doc.	Congress
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 June 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 June 54	134	84
Hamlin Beach State Park	20 Sept. 54	138	84
Braddock Bay State Park	15 Apr. 55		
Fire Island Inlet to Jones Inlet	10 Feb. 56	411	84
Fire Island Inlet to Montauk Pt. (combined with hurricane study)	30 June 59	425	86
Fire Island Inlet (review)	15 Oct. 63	115	89
North Carolina:			
Fort Fisher	10 Nov. 31	204	72
Wrightsville Beach	2 Jan. 34	218	73
Kitty Hawk, Nags Head and Oregon Inlet	1 Mar. 35	155	74
State of North Carolina	22 May 47	763	80
Carolina Beach and Vicinity	10 Mar. 61	418	87
Fort Macon-Atlantic Beach	30 Apr. 62	555	87
Ocracoke Island	15 Oct. 63	109	89
Ohio:			
Erie County—Vicinity of Huron	26 Aug. 41	220	79
Michigan Line to Marblehead	30 Oct. 44	177	79
Cities of Cleveland and Lakewood	22 Mar. 48	502	81
Chagrin River to Fairport	22 Nov. 49	596	81
Vermilion to Sheffield Lake Village	24 July 50	229	83
Fairport to Ashtabula	1 Aug. 51	351	82
Ashtabula to Pennsylvania State Line	1 Aug. 51	350	82
Sandusky to Vermilion	7 July 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 June 53	324	83
Michigan Line to Marblehead (review)	14 June 60	63	87
Sheffield Lake Community Park	13 June 61	414	87
Pennsylvania:			
Presque Isle Peninsula, Erie			
Interim	3 Apr. 42		
Final	23 Apr. 52	231	83
Review	21 Jan. 60	397	86

BEB COOPERATIVE BEACH EROSION STUDIES—Continued

Location	BEB Report Completed	Published in	
		House Doc.	Congress
Puerto Rico:			
Punta Las Marias, San Juan	5 Aug. 47	769	80
San Juan	3 May 62	575	87
Rhode Island:			
South Shore (Towns of Narragansett, South Kingstown, Charlestown and Westerly)	4 Dec. 48	490	81
South Kingstown and Westerly	27 Jan. 58	30	86
South Carolina:			
Folly Beach	31 Jan. 35	156	74
Pawleys Island, Edisto Beach and Hunting Island	24 July 51		
Hunting Island Beach	9 May 63		
Texas:			
Galveston (Gulf Shore)	10 May 34	400	73
Galveston Bay, Harris County	31 July 34	74	74
Galveston (Gulf Shore)	5 Feb. 53	218	83
Galveston (Bay Shore)	19 June 53	346	83
Bolivar Peninsula (Gulf Shore and Rollover Fish Pass)	8 June 59	286	86
Virginia:			
Willoughby Spit, Norfolk	20 Nov. 37	482	75
Colonial Beach, Potomac River	24 Jan. 49	333	81
Virginia Beach	25 June 52	186	83
Virginia Beach (review)	13 June 61	382	87
Wisconsin:			
Milwaukee County	21 May 45	526	79
Racine County	5 Mar. 52	88	83
Kenosha	16 Sept. 54	273	84
Manitowoc County	15 Apr. 55	348	84

APPENDIX D

BEB MEMBERS AND STAFF PARTICIPATION IN OVERSEAS CONSULTING AND INTERNATIONAL MEETINGS

Soon after the end of World War II, the program of the BEB began to encompass work outside the United States. BEB members and staff increasingly provided consultation services on coastal problems abroad, often in connection with Federal aid and defense activities. These efforts were representative of the trend toward the internationalism of coastal engineering commented upon within the text.

The following is a list of the countries, territories, and other locations which BEB members or staff visited between 1945 and 1963. Also included are the international meetings at which the BEB was represented, together with staff visits to national hydraulic laboratories abroad.

Year	Location	Type of Work or Meeting	BEB Members or Staff Participating
1945	Puerto Rico	Consultation	Jay V. Hall, Jr. Harold A. Ward
1946	Bermuda	Consultation	W. Clark Iseminger
1951	Toronto, Canada	American Shore and Beach Preservation Association	Col. Earl E. Gesler
1953	Rome, Italy	Permanent International Association of Navigation Congresses	Col. Earl E. Gesler
1954	Liberia	Consultation	Col. Wendell Trower M.P. O'Brien Richard O. Eaton Jay V. Hall, Jr.
1954	Gambia	Consultation	Richard O. Eaton
1954	Azores Islands	Consultation	Jay V. Hall, Jr.
1954	Grenoble, France	Fifth Coastal Engineering Conference	Joseph M. Caldwell Thorndike Saville

**BEB MEMBERS AND STAFF PARTICIPATION IN OVERSEAS
CONSULTING AND INTERNATIONAL MEETINGS—Continued**

Year	Location	Type of Work or Meeting	BEB Members or Staff Participating
1956	Puerto Rico	Consultation	Col. Everett A. Hansen Richard O. Eaton
1956	Ecuador	Consultation	Richard O. Eaton
1956	France	Consultation	W. Clark Iseminger
1957	England	Permanent International Association of Navigation Congresses	Thorndike Saville, Jr. Maj. Gen. Charles G. Holle
1957	Portugal	International Association for Hydraulic Research	Thorndike Saville, Jr.
1957	Newfoundland	Consultation	Jay V. Hall, Jr.
1958	Puerto Rico	Consultation	Albert C. Rayner
1959	Somalia	Consultation	Richard O. Eaton Jay V. Hall, Jr.
1959	Spain	Consultation and Wave Gage Installation	Cyrus M. Hare
1960	Newfoundland	Consultation	Richard O. Eaton
1960	Azores Islands	Consultation	Jay V. Hall, Jr.
1960	Spain	Consultation	Cyrus M. Hare
1960	Netherlands	Seventh Coastal Engineering Conference	Charles L. Bretschneider Rudolph P. Savage
1961	Ceylon	Consultation	Richard O. Eaton

**BEB MEMBERS AND STAFF PARTICIPATION IN OVERSEAS
CONSULTING AND INTERNATIONAL MEETINGS—Continued**

Year	Location	Type of Work or Meeting	BEB Members or Staff Participating
1962	Guatemala	Consultation	Richard O. Eaton Jay V. Hall, Jr.
1962	Mexico City, Mexico	Eighth Coastal Engineering Conference	Richard O. Eaton Thorndike Saville, Jr. Rudolph P. Savage Norman E. Taney
1963	India	Consultation	George M. Watts
1963	Samoa	Consultation	Albert C. Rayner
1963	Azores Islands	Consultation	Jay V. Hall, Jr.
1963	Somalia	Consultation	Jay V. Hall, Jr.
1963	Marshall Islands	Consultation	George M. Watts
1963	England	International Association for Hydraulic Research	Joseph M. Caldwell George M. Watts
1963	France	Tour of National Hydraulic Laboratory	Joseph M. Caldwell
1963	Italy	Tour of National Hydraulic Laboratory	Joseph M. Caldwell

APPENDIX E

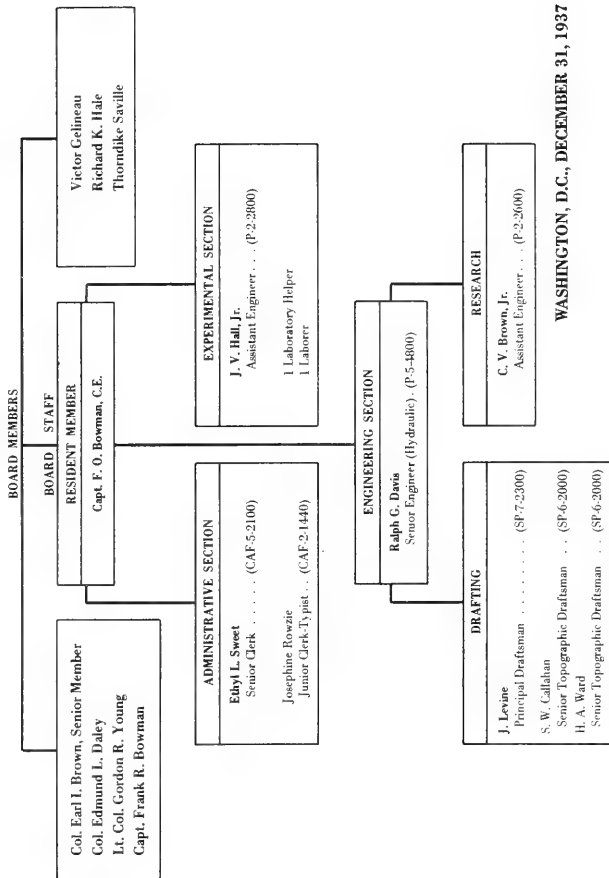
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OF THE

MEMBERSHIP AND STAFF OF THE

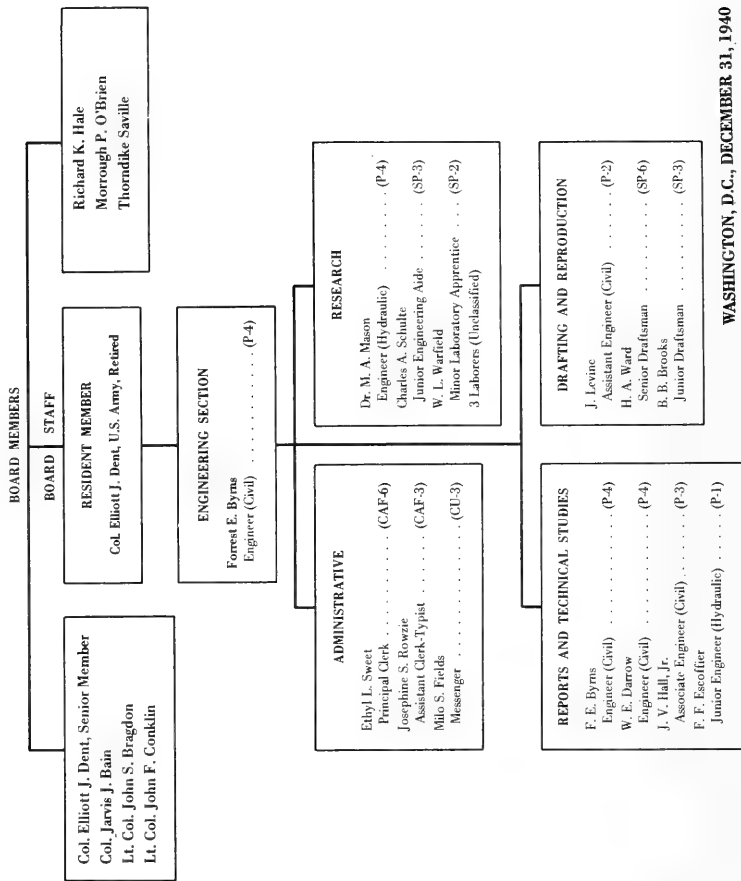
U. S. ARMY, CORPS OF ENGINEERS, BEACH EROSION BOARD

**OFFICE OF THE BEACH EROSION BOARD
ORGANIZATION CHART**



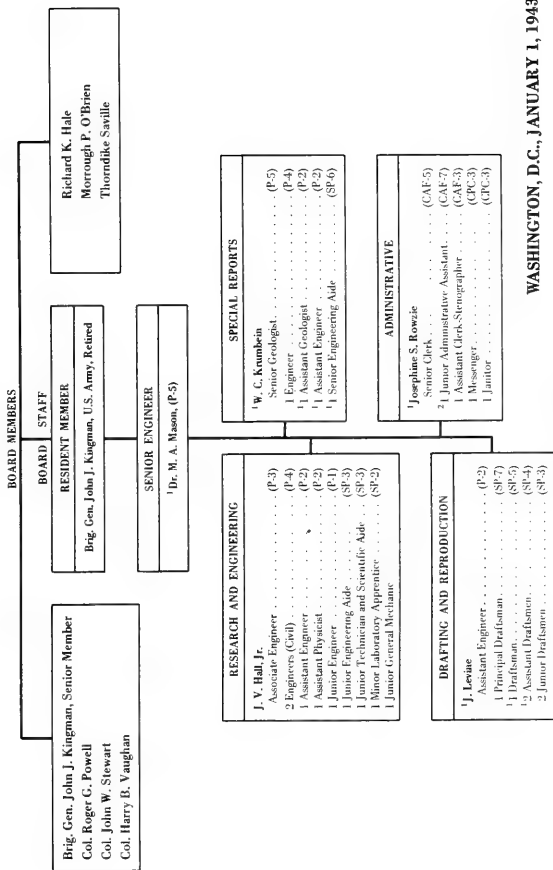
WASHINGTON, D.C., DECEMBER 31, 1937

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
BEACH EROSION BOARD
ORGANIZATION CHART



WASHINGTON, D.C., DECEMBER 31, 1940

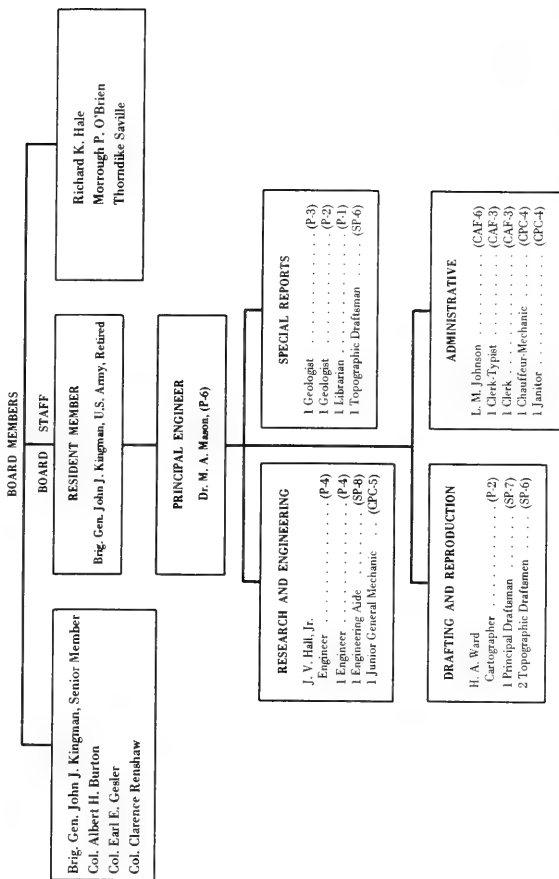
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WASHINGTON, D.C., JANUARY 1, 1943

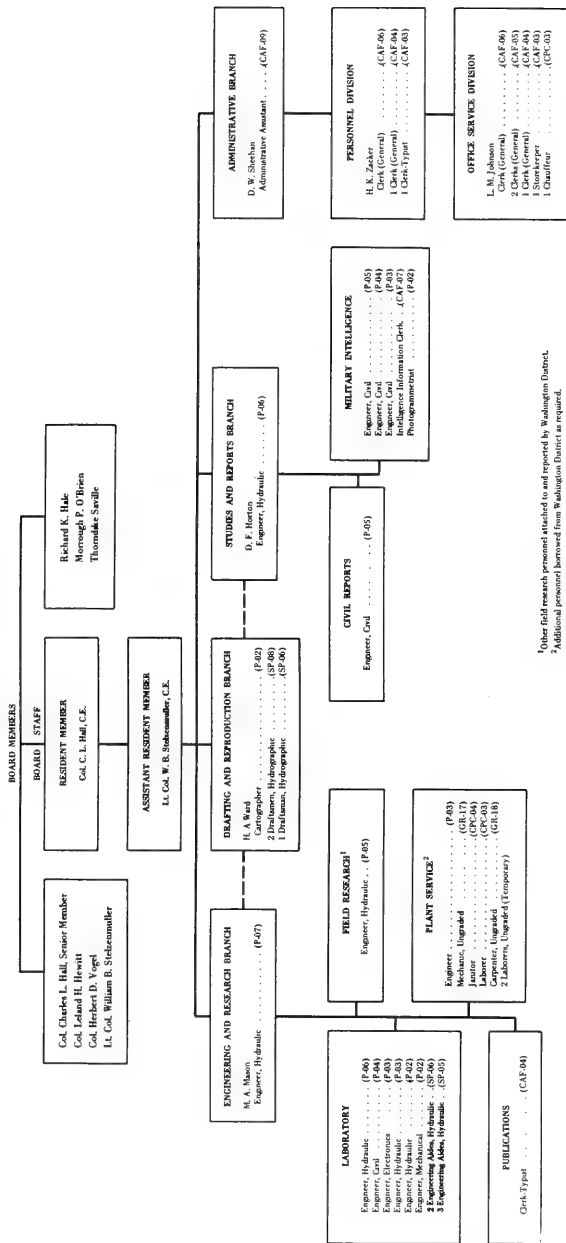
¹On Army Map Service payroll.
²On detail to OCE.

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OFFICE OF THE CHIEF OF ENGINEERS
BEACH EROSION BOARD
ORGANIZATION CHART



WASHINGTON, D.C., JULY 1, 1945

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
BEACH EROSION BOARD
ORGANIZATION CHART



Other field research personnel attached to and reported by Washington District.
 *Additional personnel borrowed from Washington District as required.

WASHINGTON, D. C., 1 JULY 1948

DEPARTMENT OF THE ARMY
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BEACH EROSION BOARD
ORGANIZATION CHART

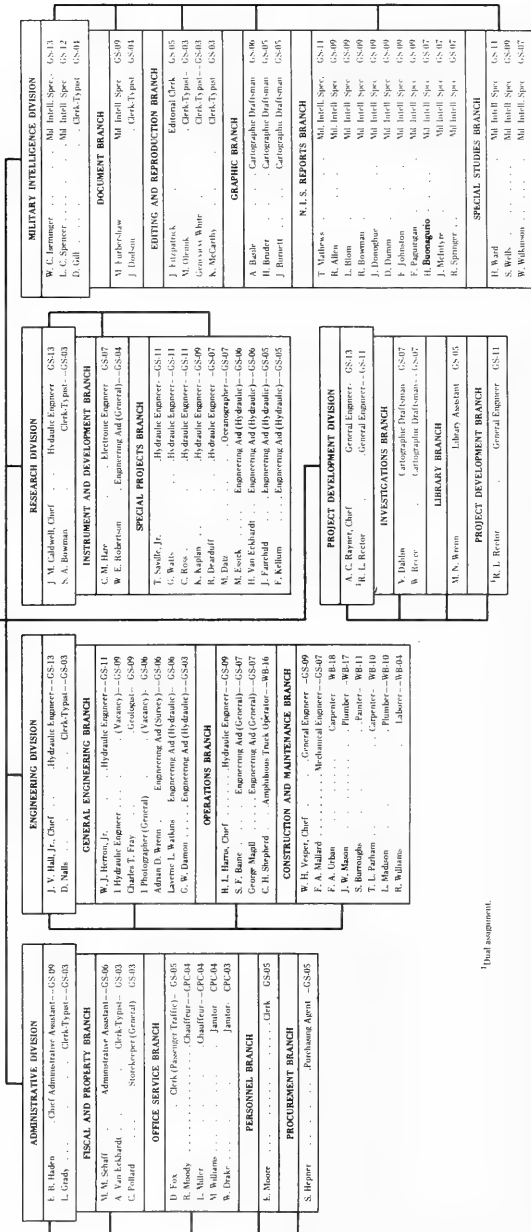
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J. V. Parker . . . O. & M. Examiner—GS-07
B. Boppreting . . . Clerk (Stenographer)—GS-05

Col. Leonard H. Hewitt, Acting President
Col. Wendell P. Trorer
Col. Herman W. Schull, Jr.
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Morrough P. O'Brien
Thorndike Saville
Lorenz G. Straub



¹Detail assignment.

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BEACH FRISON BUILDING

EN-MBR

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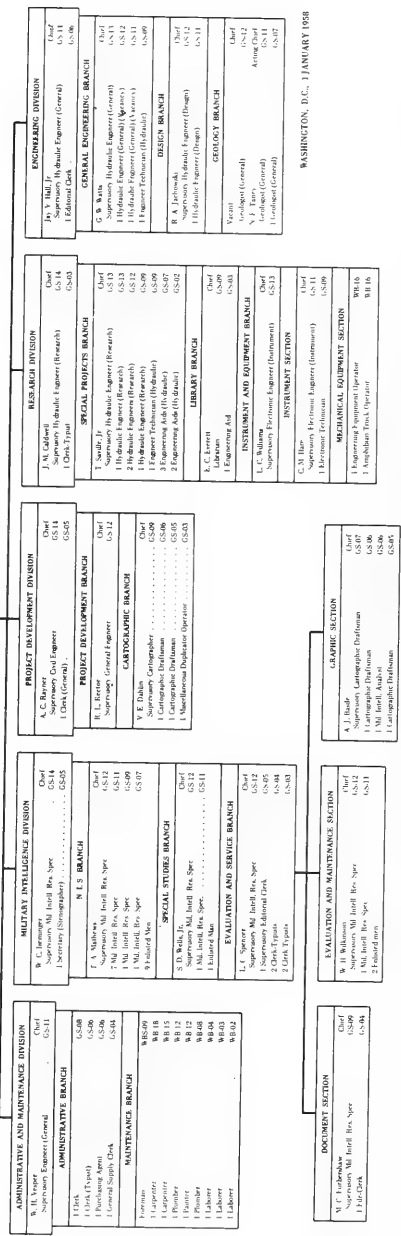
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Dr. Thorvald Savitz Commanding General Long Island Harbor Park, Commuters	Dr. L. C. Strub Director, St. Anthony Falls Hydrographic Laboratory Minneapolis, Minnesota
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R. D. Pittard Supervisory Hydraulic Engineer (Research)	Executive
D. T. Slatton, Secretary	Chief Technical Assistant
	GS-15
	GS-15
	WB-04



WASHINGTON, D. C., 1 JANUARY 1958

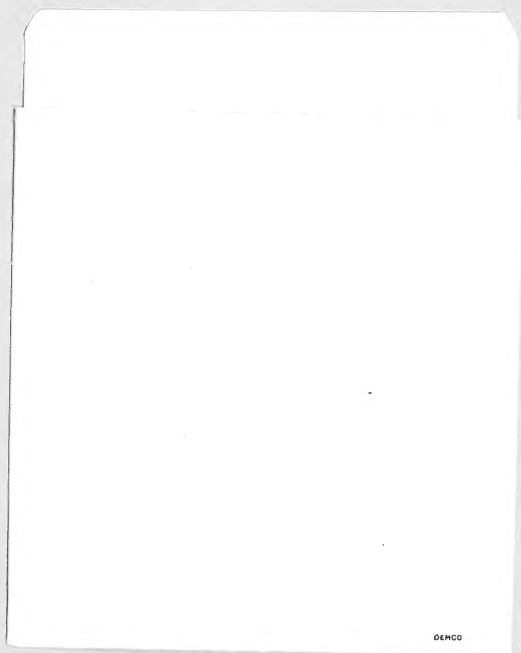
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<p>TC203 .U581mr no. 77-9 627</p> <p>Quinn, Mary-Louise The history of the Beach Erosion Board, U.S. Army, Corps of Engineers, 1930-63. - Fort Belvoir, Va. : U.S. Coastal Engineering Research Center, 1977. 181 p. : ill. (Miscellaneous report - U.S. Coastal Engineering Research Center ; no. 77-9) (Contract - U.S. Coastal Engineering Research Center ; DACW72-74-C-0011) Bibliography : p. 112.</p> <p>This report provides an accurate record of the 33-year history of the Beach Erosion Board (BEB), predecessor of the Coastal Engineering Research Center (CERC). The report discusses the events which led to the creation of the BEB, and the significant effects these events had upon the BEB's course of direction.</p> <p>1. U.S. Beach Erosion Board - History. 2. Shore protection - History - U.S. I. Title. II. Series: U.S. Coastal Engineering Research Center. Miscellaneous report no. 77-9. III. Series: U.S. Coastal Engineering Research Center. Contract DACW72-74-C-0011.</p>	<p>TC203 .U581mr no. 77-9 627</p> <p>Quinn, Mary-Louise The history of the Beach Erosion Board, U.S. Army, Corps of Engineers, 1930-63. - Fort Belvoir, Va. : U.S. Coastal Engineering Research Center, 1977. 181 p. : ill. (Miscellaneous report - U.S. Coastal Engineering Research Center ; no. 77-9) (Contract - U.S. Coastal Engineering Research Center ; DACW72-74-C-0011) Bibliography : p. 112.</p> <p>This report provides an accurate record of the 33-year history of the Beach Erosion Board (BEB), predecessor of the Coastal Engineering Research Center (CERC). The report discusses the events which led to the creation of the BEB, and the significant effects these events had upon the BEB's course of direction.</p> <p>1. U.S. Beach Erosion Board - History. 2. Shore protection - History - U.S. I. Title. II. Series: U.S. Coastal Engineering Research Center. Miscellaneous report no. 77-9. III. Series: U.S. Coastal Engineering Research Center. Contract DACW72-74-C-0011.</p>
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