HUNTING ISLAND BEACH, SOUTH CAROLINA

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED FEBRUARY 25, 1964, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A COOPERATIVE BEACH EROSION CONTROL STUDY OF HUNTING ISLAND BEACH, SOUTH CAROLINA, AUTHORIZED BY THE RIVER AND HARBOR ACT APPROVED JULY 3, 1930, AS AMENDED AND SUPPLEMENTED

JULY 20, 1964.—Referred to the Committee on Public Works and ordered to be printed with four illustrations

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U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1964

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

June 26, 1964

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 25 February 1964, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on a cooperative beach erosion control study of Hunting Island Beach, South Carolina, authorized by the River and Harbor Act approved 3 July 1930, as amended and supplemented.

The views of the South Carolina State Highway Department, the State of South Carolina, and the Department of the Interior are set forth in the inclosed communications, together with the reply of the Acting Chief of Engineers to the Secretary of the Interior.

The Bureau of the Budget advises that there is no objection to the submission of the proposed report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

STEPHEN AILES
Secretary of the Army

1 Incl
Report

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

June 9, 1964

Honorable Stephen Ailes
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. Joseph A. Califano's letter of March 27, 1964, submitted the proposed report of the Chief of Engineers on a beach erosion study of Hunting Island, South Carolina, made by the Corps of Engineers in cooperation with the State of South Carolina, under provisions of Section 2 of the River and Harbor Act of July 3, 1930, as amended and supplemented.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed report to the Congress. However, no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Carl H. Schwartz, Jr.
Chief, Resources and
Civil Works Division

COMMENTS OF THE STATE HIGHWAY DEPARTMENT, SOUTH CAROLINA

SOUTH CAROLINA

STATE HIGHWAY DEPARTMENT

COLUMBIA

September 19, 1963

Major General Jackson Graham
United States Army
Office of the Chief of Engineers
Washington 25, D. C.

Dear Sir:

Your letter of August 20 transmitted one copy of the proposed report of the Chief of Engineers, together with the reports of the Beach Erosion Board, and of the District and Division Engineers, on a cooperative beach erosion control study of Hunting Island Beach, South Carolina.

The report has been reviewed and the Department has no recommendations to make.

Yours very truly,

S. N. Pearman,
Chief Highway Commissioner.

COMMENTS OF THE STATE OF SOUTH CAROLINA

STATE DEVELOPMENT BOARD
COLUMBIA, SOUTH CAROLINA 29202

WALTER W. HARPER
DIRECTOR

TELEPHONE POPLAR 5-2912

February 10, 1964

Re Your
ENGCW-PD

Colonel Robert C. Marshall
Headquarters, Dept. of the Army
Office of the Chief of Engineers
Washington 25, D. C.

Dear Colonel Marshall:

In reference to the U. S. Army Engineers report on beach erosion at Hunting Island Beach, South Carolina and remedial steps, this agency would look with favor upon the end results. We are concerned with the promotion of travel in South Carolina and we feel that our beaches are major attractions. Therefore, any action which affects the beaches in this light are matters of concern to us.

However, our agency is charged only with the responsibility of promoting our attractions and, therefore, our position in no way is to be construed to endorse the financing aspects of the project.

Yours very truly,

S. Ernie Wright
Assistant Director

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

November 27, 1963

Dear General Wilson:

In accordance with the request in your letter of August 20, 1963, we have reviewed reports on a cooperative beach erosion control study of Hunting Island Beach, South Carolina. Your report recommends measures for stablizing the shores of Hunting Island at an estimated first cost of $455,000.

The Fish and Wildlife Service advises that it has not previously reported on this project because the proposed work was not made known to the Service until the Survey Report was submitted to the Beach Erosion Board. This Department requests that the Service be given timely information on all future project studies so that it may properly fulfill its responsibilities in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.)

The Fish and Wildlife Service reports that the proposed project would have a significant effect on fish and wildlife resources only in the Johnson Creek area where valuable oyster leases are located. To provide an opportunity to protect the oyster resource, it is recommended that the selection of borrow areas be coordinated with the Service and the South Carolina Department of Wildlife Resources.

We appreciate the opportunity of presenting our comments.

Sincerely yours,

Kenneth Holum
Assistant Secretary of the Interior

Lt. General Walter E. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

35-620 O-64—2

LETTER TO THE SECRETARY OF THE INTERIOR

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO
ENGCW-PD

11 December 1963

The Honorable Stewart L. Udall

The Secretary of the Interior

Dear Mr. Secretary:

This is in reply to the recent letter from the Assistant Secretary of the Interior commenting on the proposed report of the Chief of Engineers on Hunting Island Beach, South Carolina.

If the project is authorized by Congress, you may be assured that selection of borrow areas in the Johnson Creek area will be coordinated with the Fish and Wildlife Service and the South Carolina Department of Wildlife Resources.

Sincerely yours,

(Signed)

R. G. MacDONNELL
Major General, USA
Acting Chief of Engineers

x

HUNTING ISLAND BEACH, SOUTH CAROLINA

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO
ENGCW-PD

25 February 1964

SUBJECT: Beach Erosion Control Report on Cooperative Study of Hunting Island Beach, South Carolina

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the Beach Erosion Board accompanied by the reports of the District and Division Engineers on a beach erosion study of the shores of Hunting Island, South Carolina. The study was made by the Corps of Engineers in cooperation with the State of South Carolina under the provisions of section 2 of the River and Harbor Act approved July 3, 1930, as amended.

2. After full consideration of the reports of the District and Division Engineers, the Beach Erosion Board recommends periodic nourishment for a period of 10 years of about 18,500 feet of beach on the northern part of Hunting Island with initial placement of a feeder beach amounting in volume to a 3-year advance nourishment supply and construction of one groin at the north end of the island, all substantially in accordance with the plan of the District Engineer. The estimated first cost of the improvement including advanced nourishment, is $455,000. Annual charges are estimated at $116,000, including $97,500 for periodic nourishment. Annual benefits are estimated at $187,000 and the benefit-cost ratio is 1.6. The Federal first cost is estimated at $319,000 with $68,000 annually for a period of 10 years for periodic nourishment. Remaining costs are to be borne by local interests including a cash contribution of 30 percent of the costs of initial work, a sum currently estimated at $136,000. Use of the recently prescribed interest rate of 3 percent in computing annual charges and benefits would result in no appreciable change in the benefit-cost ratio or the local cash contribution.

3. After due consideration of these reports, I concur generally in the views and recommendations of the Beach Erosion Board. Accordingly, I recommend improvement of the shores of Hunting Island, South Carolina, by construction of one groin and initial placement of sand on a feeder beach equal in volume to a 3-year advance nourishment supply with periodic nourishment thereafter for a period of 10 years,

in accordance with the plans of the Beach Erosion Board. The Federal first cost of groin construction and initial placement of the advance nourishment supply is estimated at $319,000, and the Federal cost of subsequent periodic nourishment is estimated to average $68,000 annually. Prior to construction, responsible local authorities would be required to:

a. Contribute 30 percent of the first cost of the project construction, a sum currently estimated at $136,000, and agree that during the 10-year period following initial construction they also will contribute prior to the periodic nourishment work 30 percent of the costs thereof, a sum estimated at $29,500 annually.

b. Furnish assurances satisfactory to the Secretary of the Army that, during the economic life of these works, they will:

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

(2) Hold and save the United States free from all claims for damages due to the construction and nourishment under the project;

(3) Control water pollution to the extent necessary to safeguard the health of bathers;

(4) Maintain for public use as a park and conservation area meeting the criteria for such areas as expressed in Public Law 87-874, the portion of the park upon which the Federal participation is based;

(5) Assure maintenance and periodic nourishment of the project as may be required to serve the intended purpose, subject to Federal participation as recommended herein.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

REPORT OF THE BEACH EROSION BOARD

CORPS OF ENGINEERS, U. S. ARMY
BEACH EROSION BOARD
WASHINGTON, D. C.

9 May 1963

SUBJECT: Beach Erosion Control Report on Cooperative Study of Hunting Island Beach, South Carolina.

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

1. This report is on a study of beach erosion made in cooperation with the State of South Carolina under authority of section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. The purpose of the investigation was to determine the best method of arresting erosion and of stabilizing the beach.

2. The study area comprises the Atlantic Ocean shore of Hunting Island with a length of 4.3 miles between Johnson Creek on the north and Fripp Inlet on the south. It is located in Beaufort County. In 1960 the permanent population of the county was about 44,000. Although the State owns the entire island, in the southerly portion building lots have been leased for private use.

3. The study area is a sandy barrier beach island on which the beach is backed by a series of dunes. Tides in the area are semi-diurnal with mean and spring ranges of 6.2 and 7.3 feet respectively. Waves approach the shore from the north and northeast during the fall and winter and from the southeast during the spring and summer. The directions of waves are such as to produce a southwestward predominance of littoral drift, but with reversals in direction. Along the northern part of the island, the draw of the tidal flow into St. Helena Sound appears to cause a predominant northward littoral drift. Although large quantities of sand appear to reach St. Helena Sound from shores to the north, little of the material reaches Hunting Island under present conditions in the cyclical pattern of changes in inlet shoals and channels. The deficiency in supply is on the order of 250,000 cubic yards of sand annually which results in severe erosion, especially of the northern portion of the island.

4. The District Engineer has developed plans for stabilizing the shore of Hunting Island, and has made economic analyses of proposed protective measures. He concludes that the most suitable plan for the stabilization of shores within the study area comprises artificial nourishment at an estimated average annual rate of about 250,000 cubic yards of suitable sand and a terminal groin at the north end of the island. He finds the plan justified by benefits from prevention of

loss of land and development features and recreational benefits, and that the area qualifies as a park and conservation area under criteria expressed in Public Law 87-874. The costs, benefits, and economic justification of the plan of protection based on the price level of 1962 are:

Estimated first costs	$455,000
Estimated annual charges	116,000
Estimated annual benefits	187,000
Benefit-cost ratio	1.6

Accordingly he recommends a Federal project therefor with Federal participation to the extent of 70 percent of initial costs and periodic nourishment costs for a period of 10 years, subject to certain conditions. The Division Engineer concurs.

5. Local interests were informed of the findings and recommendations of the District and Division Engineers and invited to present additional information for the consideration of the Beach Erosion Board. No communications were received as a result of the public notice.

VIEWS AND RECOMMENDATIONS OF THE BEACH EROSION BOARD

6. The Beach Erosion Board has carefully considered the report of the District and Division Engineers The Board notes that the existing beaches at Hunting Island appear adequate in width, but that stabilization is necessary to prevent damage to backshore improvements. The Board believes that periodic nourishment in conjunction with a terminal groin at the north end of the island is the most suitable and economical plan of protection. The plan therefore qualifies for Federal participation in the costs of periodic nourishment, as well as in the initial costs. Federal participation in periodic nourishment costs should be limited initially to a period of 10 years to permit re-evaluation of techniques and benefits.

7. The Board also concurs in the view of the reporting officers that the portion of the park for which the plan provides stabilization is a park and conservation area meeting the criteria for such areas set forth in Public Law 87-874. The State should be required to assure that the area will be kept as a park and conservation area, including the preservation of the natural dune protection, as a condition for Federal participation to the extent of 70 percent of the costs.

8. The Board desires to repeat the opinion stated in its 1951 report that the dunes constitute valuable protection and that they should be preserved. In leasing lots on the southern portion of the island for private development, the State should permit building only behind the dunes and should require that excavation of material from the dunes in

connection with building construction or cutting paths across the dunes be avoided.

9. The Board notes that the proposed nourishment program will require a large quantity of sand which will be placed by hydraulic dredge. The Board believes that, in order to obtain maximum benefits from the dredging, borrow areas should be selected to the extent practicable in such locations that navigation benefits may result in the form of improved channels or mooring areas and better access to the island by water.

10. In accordance with existing statutory requirements the Beach Erosion Board states its opinion that:

a. It is advisable for the United States to adopt a project authorizing Federal participation in the costs of stabilizing the shore of Hunting Island;

b. The public interest involved in the proposed measures is associated with prevention of damages to publicly owned property and recreational benefits to the public; and

c. The share of the expense which should be borne by the United States is 70 percent of the first costs and of periodic nourishment cost for an initial period of 10 years.

11. The Board recommends adoption of a project by the United States authorizing Federal participation in amount of 70 percent of the first costs and of periodic nourishment costs of the shore of Hunting Island, South Carolina. The plan comprises periodic nourishment of about 18,500 feet of beach on the northern part of the island with initial placement of a 3-year advance nourishment, and construction of one groin at the north end of the island. Federal participation in periodic nourishment would be limited initially to a period of 10 years. Federal participation is recommended subject to the conditions that responsible local authorities:

a. Contribute 30 percent of the first costs of the project, a sum currently estimated at $136,000;

b. Furnish assurances satisfactory to the Secretary of the Army that they will:

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

(2) Hold and save the United States free from claims for damages due to the construction and periodic nourishment under the project;

(3) Control water pollution to the extent necessary to safeguard the health of bathers;

(4) Maintain the portion of the park upon which the Federal participation is based as a park and conservation area meeting the criteria for such areas as expressed in Public Law 87-874 and its administration for public use during the period of Federal aid to nourishment.

12. The estimated cost of the initial work including advance nourishment, is $455,000, of which the Federal share would be $319,000. The estimated cost of periodic nourishment is $97,500 annually, of which the Federal share for a period of 10 years would be $68,000 a year.

FOR THE BOARD:

R. G. MacDONNELL
Major General, USA
President

At the time of approval of this report the members of the Beach Erosion Board were:

Major General R. G. MacDonnell, President
Dr. Thorndike Saville, State of New York
Dean Morrough P. O'Brien, State of California
Dr. Lorenz G. Straub, State of Minnesota
Brigadier General Arthur H. Frye, Jr., U. S. Army
Brigadier General John C. Dalrymple, U. S. Army
Brigadier General Peter C. Hyzer, U. S. Army

SYLLABUS

The District Engineer finds that the Hunting Island Beach area has sustained severe recession of the shoreline, with accompanying damages, and dissipation of available beach area in the past, and that such condition is likely to continue in the absence of suitable corrective measures. The annual net rate of loss of material in the area experiencing progressive erosion was found to average approximately 12 cubic yards per linear foot of shoreline. The District Engineer further concludes that the best protection against this condition, commensurate with costs, can be obtained through implementation of a plan of beach nourishment - which plan would afford protection against further recession of the mean-high-water shoreline and consequent damages, and generate additional recreational benefits to the public. The recommended plan of improvement consists of a 750,000-cubic yard advance nourishment feeder beach; a terminal groin approximately 800 feet in length; and replenishment of the feeder beach to provide nourishment requirements currently estimated at 250,000 cubic yards annually. The recommended Federal project, subject to certain conditions of local cooperation, has a first cost presently estimated at $455,000. The ratio of estimated annual benefits to estimated annual costs of improvement is 1.6.

35-620 O-64—3

U. S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
MUNICIPAL MARINA
CHARLESTON, SOUTH CAROLINA

26 March 1963

SUBJECT: Survey Report on Cooperative Beach Erosion Control Study at Hunting Island Beach, South Carolina

TO: Division Engineer
U. S. Army Engineer Division, South Atlantic
ATTN: SADEW
Atlanta, Georgia

AUTHORITY

1. This study was made by the Corps of Engineers, United States Army, in cooperation with the South Carolina State Highway Department, under authority of Section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. Formal application by the South Carolina State Highway Department, dated 16 July 1959, was approved by the Chief of Engineers on 8 September 1959.

PURPOSE AND SCOPE

2. The purpose of this report is to present the results of investigations to determine the engineering and economic feasibility of plans directed toward development of the best method of arresting erosion and stabilizing the beach at Hunting Island State Park, South Carolina.

PRIOR REPORTS

3. An interim report, dated 15 February 1949, was made on beach-erosion control and shore protection of Hunting Island and other South Carolina coastal areas. The interim report recommended further study of the effectiveness of experimental palmetto-log groins.

4. A Beach-Erosion Control Report, dated 11 February 1952, was made on a study of Hunting Island, Edisto Beach, and Pawleys Island, South Carolina. The study, made in cooperation with the State of South Carolina, was for the purpose of determining the best method of preventing further erosion and of stabilizing and

improving the beaches. The report recommended artificial nourishment alone as the most economical method of complete protection at Hunting Island. The cooperating agency did not desire an economic analysis.

DESCRIPTION

5. Hunting Island is located along the southeastern shore of South Carolina in Beaufort County, 16 miles east of the city of Beaufort, 9 miles southwest of Edisto Beach, and 35 miles northeast of Tybee Roads at the mouth of the Savannah River. Plate 1 shows the location of Hunting Island, which is also shown on United States Coast and Geodetic Chart No. 793 and United States Coast and Geodetic Survey Air Photo Compilation Sheet No. T-5187.

6. Hunting Island is a state park comprising about 1,850 acres of wooded land with an average elevation of about 12 feet above mean low water. The average width of the island is 3,800 feet; the frontage on the ocean is about 4.3 miles. The island is bounded on the north by Johnson Creek and St. Helena Sound and on the south by Fripp Inlet. It is separated from the mainland by a wide expanse of marsh and Harbor River. The shoreline at Hunting Island has a north-northeast, south-southwest alignment, with a continuous sandy beach.

7. Population. The 1960 population of Beaufort County, in which Hunting Island is located, was 44,187. Beaufort, the largest city in the county, had a population of 6,298. Other significant population centers within 85 miles of Hunting Island are Charleston, South Carolina, with an urbanized area population of 160,000; and Savannah, Georgia, with an urbanized area population of 170,000. Attendance records compiled by the State Park Director's office for Hunting Island, the only public ocean-front beach in Beaufort County, show an annual attendance in excess of 300,000 persons for the years 1960 and 1961, and an average annual attendance of 250,000 persons for the preceding five years. These are principally day-users residing in Beaufort County. In addition to summer visitors, many persons visit the island during other seasons for fishing and recreation. Permanent residents of Hunting Island number less than 20, including State Park personnel.

8. Ownership and accessibility of shore. There is no Federally-owned shore within the study area. Hunting Island, in its entirety, is owned by the State of South Carolina. In many instances building lots have been leased by the State to individuals for construction of private beach cottages. However, all portions of the ocean frontage are available for use by the public. The public has access to the beach from each of two

bathhouse areas, from various picnic and parking areas, and from points along a road which traverses the entire length of the ocean front. The study area is served by U. S. Highway No. 21 which is linked to Hunting Island by bridges over Harbor River and Johnson Creek constructed at a cost in excess of $1,000,000. U. S. Highway No. 21 terminates at Hunting Island.

9. Beach development. Improvements at Hunting Island consist of state-owned facilities, private dwellings constructed on building lots leased from the state, and public utilities. Development by the state consists of public bathhouses, picnic shelters, parking areas, warehousing, boathouse and dock, residences, service buildings, water system, an inoperative lighthouse, and five miles of roads - for a total estimated value of $325,000. There are 31 privately-owned beach cottages with a total estimated value of $217,000. The electrical and telephone facilities serving Hunting Island have replacement values estimated at $61,000 and $4,000, respectively.

10. Water pollution. Water pollution constitutes no hazard to the health of bathers in the Hunting Island Beach area.

STATEMENT OF THE PROBLEM AND IMPROVEMENTS DESIRED

11. The beach at the study area is eroding rapidly and existing improvements are being threatened and/or destroyed by encroachment of the ocean. The high-water line along the beach front has receded 100 to 500 feet since 1948. Improvements desired by local interests and proposed by the cooperating agency are those necessary to arrest erosion and stabilize the present mean-high-water shoreline.

12. A meeting of local interests was held at Hunting Island State Park on 5 January 1961. In addition to Corps of Engineers personnel, who conducted the meeting, the meeting was attended by the following interests: The Beaufort County Delegation, consisting of a state senator and two members of the State House of Representatives; the South Carolina State Highway Department; the South Carolina State Forestry Commission; and various lessees and representatives of lessees of Hunting Island State Park residential lots. In justification of the improvement, local interests cite the need for portection of property, and the recreational benefits to be derived by state park users numbering some 300,000 annually.

FACTORS PERTINENT TO THE PROBLEM

13. Geomorphology. The following paragraphs on the general geology of the beaches and the coastal plain of South Carolina

were extracted from a report by Dr. Stephen Taber, former head of the geology department of the University of South Carolina. The complete report of Dr. Taber is included as Appendix A.

14. The South Carolina Coastal Plain consists of sands, clays, marls, and limestones that thin out along the Fall Line and thicken toward the coast. After the older formations were deposited, they were arched upward along a northwest-southeast axis located close to the North Carolina-South Carolina line. This explains why Cretaceous formations extend down to the vicinity of the coast in Horry and Georgetown counties.

15. The surface material of the beaches is late Pleistocene (Pamlico) and recent in age. The underlying formation of beaches north of Winyah Bay is the Pee Dee of Cretaceous age, but southwestward the formations are progressively younger, consisting chiefly of the Cooper marl of Eocene age and the Hawthorn formations of Miocene age.

16. During the Pleistocene there were repeated changes in sea level due chiefly to the enlargement and shrinkage of the great ice caps and glaciers. During periods of low sea level the shoreline was farther out and the streams were able to deepen their channels below present sea level. During periods of high sea level erosion by waves and current removed some of the earlier deposits along the new shoreline, and sediments were deposited over the submerged portion of the Coastal Plain, thus forming the present terraces. The lowest and youngest of these terraces is the Pamlico, which has an elevation of about 25 feet along its inner margin.

17. The Pamlico formation extends less than ten miles inland near the North Carolina-South Carolina line, but in the southern part of the state it extends inland for over 30 miles. Also, as shown by well logs, it is thicker in the southern part of the state. This greater accumulation of Pleistocene and Recent Sediments in the coastal region southwest of the Santee-Pee Dee River systems is probably due to the tremendous load of material that has been brought to the ocean by these streams, and distributed along the coast toward the southwest by the prevailing longshore currents. The Santee, with numerous tributaries in the Piedmont and Mountain provinces, carried a greater volume of water than any other stream in the South Atlantic states. For a long distance north of the Santee and Pee Dee only small streams, originating in the Coastal Plain and therefore carrying little sediment, enter the ocean.

18. The Pamlico formation was deposited on the surface that was slightly irregular because of valley cutting during previous periods of low sea level and because of the formation of some beach ridges and lines of sand dunes by the earlier fluctuations in sea level. As the sea gradually encroached on the land, tree stumps, accumulations of plant material in swamps, and the remains of land mammals were buried under the deposits. The Pamlico formation consists mostly of fine sand with a little clay, the latter being more abundant near the base where some peat and peaty soils are also found. Shells are common, especially in the lower part.

19. The retreat of the sea following deposition of the Pamlico formation was gradual with the building up of many ridges and lines of dunes, the latter being much larger, on the average, than those now forming. It took time for vegetation to cover the areas abandoned by the sea, and therefore more sand was available for dune building between the advancing vegetation and the retreating high water line. Today, with the sea encroaching on forested areas at many places, there is less bare sand exposed.

20. Characteristics of littoral materials. A detailed presentation of the physical characteristics of the littoral materials along Hunting Island beach is contained in Appendix B. These data are summarized in the following paragraphs.

21. A limited number of sample analyses are available with which to determine the size characteristics of the littoral material. The earliest recorded data are for three samples collected from the foreshore (between the high and low water line) in November 1948 at stations 2+99S, 12+00N, and 18+00S. The median diameter for each of the three samples was 0.20 mm before removal of shell content, and 0.17 mm after removal. In March 1962 samples were taken from the backshore, foreshore, and offshore areas at stations 52+00N, 29+00S, and 127+00S. A total of six samples were analyzed from the backshore zone, six from the foreshore, and nine from the offshore zone. Offshore samples were taken at elevations -3, -6, -12, and -18 feet mean low water. During the same period two samples were collected from Johnson Creek, located behind Hunting Island, which is a possible source of material for beach nourishment.

22. Size data for samples collected in March 1962 are not considered to be completely representative of normal conditions, but reflect the effect of abnormal tides in the study area associated with the east coast storm of 6-9 March 1962. The samples were collected about three weeks subsequent to occurrence of the abnormal tides, which is considered insufficient lapse of time to

allow normal processes to restore the slopes and other conditions to those existing previously. A summary tabulation of grain size data is given in Table 1, following (see also Appendix B).

TABLE 1

AVERAGE GRAIN SIZE DATA

Location	Median Diam. mm	Sorting Coeff.	Skewness	Larger Than 0.70 mm	Smaller Than 0.125 mm
Backshore	0.16	1.15	-0.26	0.10%	4.8%
Foreshore	0.15	1.18	-0.17	0%	19.2%
Offshore	0.17	1.38	-0.37	2.9%	16.5%
Composite	0.16	1.22	-0.23	1.3%	13.9%

23. Sources of littoral materials. It appears that erosion of beaches to the north of the study area would constitute the principal natural source of supply of littoral material to nourish the beach; however, St. Helena Sound separates these beaches from the study area and interrupts the littoral transport, resulting in deposition of material on shoals in the inlet and on the outer bar and movement along the outer bar to downdrift shores. No significant littoral supply is presently reaching the study area to offset losses and prevent a general recession of the shoreline. Existing groins in the area show no significant build-up of material, and all groins have been flanked. In the past, erosion of the dunes behind the beach during storms probably supplied some material to feed the beach. However, with recession of the shoreline, no significant dunes remain.

24. Littoral forces.

a. Waves. Principal wave data available for the study area are those presented in the sea and swell charts prepared by the U. S. Navy Hydrographic office. Those charts were compiled from data obtained by ships operating offshore within the area between latitude 30° and 35°N and from the shore eastward to the 75° meridiam. The sea and swell data have been incorporated into diagrams which are shown on Plate 1. Sea and swell moving away from the shore would have no effect on the shore of the study area and therefore are not included in the diagrams. Observation of the diagrams indicates that waves of all magnitudes approach more frequently from the east and northeast which, because of the bearing of the shoreline, set up a predominant southwesterly drift.

Local observers state that daily wave heights range from about 0.5 foot to 4 feet, and that storm waves have ranged from 9 to 15 feet in height.

b. Winds. A wind diagram compiled from observations of the United States Weather Bureau at Charleston, South Carolina, for the 8-year period 1951-1958, is shown on Plate 1. The diagram indicates the velocity, the direction from which the wind blew, and the duration in hours for an average year. The coast line in the study area is exposed to onshore or alongshore winds from northeast through east and south to south-southwest. Winds from the northeast through east to southeast operate over practically unlimited fetches of the Atlantic Ocean. Fetches to the south and southwest are limited but still are extensive. The wind diagram indicates that the stronger winds have a northerly component. This is in agreement with the direction of wave approach as indicated by sea and swell data. No evidence of significant transport of sand by wind is indicated. The following table shows the average velocity and duration of winds from all directions for the 1951-1958 period. Shown also are the prevailing wind directions and duration of calms.

TABLE 2

ANNUAL AVERAGE WIND DATA 1951-1958, CHARLESTON, S. C.

	N	NE	E	SE	S	SW	W	NW	Calm	Prevailing Direction
MPH:	9.6	10.4	10.3	9.3	9.0	9.4	9.0	9.7		
HOURS:	1621	902	903	717	1597	1333	1136	520	35	North

c. The yearly average winds over the Atlantic Ocean off the South Carolina shore, compiled from records of the United States Hydrographic office, are shown in the offshore surface wind diagram on Plate 1. The diagram gives wind data for the area between latitude 30° and 35°N, and longtitude 75° and 80°W as reported by ships at sea. The diagram indicates that the predominant winds (higher velocity winds) are from the northeast quadrant and the prevailing winds (winds of greater duration) are from the southeast quadrant.

d. Storms. The most destructive storms of record along the South Carolina coast were the hurricanes of August 1893 and August 1940. The hurricane of 1893 entered the mainland near Beaufort, South Carolina, and was accompanied by an enormous wave which completely inundated the coastal islands in the vicinity,

including the study area. The maximum high tide at nearby Edisto Island was 14.2 feet above mean low water, or about 8 feet above normal high tide. No record is available regarding specific damage at the study area; however, total property damage in the coastal area was estimated at $10,000,000.

e. The hurricane of August 1940 entered the mainland with its center near Savannah, Georgia. The maximum wind velocity near the study area was estimated at between 80 and 100 miles per hour. The maximum high tide at Hunting Island was 14.5 feet above mean low water. The entire island was again inundated and the high-water shoreline receded on an average of about 85 feet.

f. The hurricane of September 1959 crossed the coast of South Carolina near Hunting Island. Maximum winds of 138 miles per hour were recorded in the vicinity of Beaufort, South Carolina. The lowest barometer reading was 28.08 inches just offshore from the study area. The storm surge tide occurred within the hour of predicted low tide, and the high water marks observed after the storm indicated that the average surge tide was 11.1 feet above mean low water. Shallow dunes along the beach were lost and recession of the high-water shoreline averaged about 25 feet. Damage to residences and improved property was estimated at about $20,000.

g. The storm of 6-9 March 1962, occasioned by unusually strong sustained north and northeast winds during a period of spring tides, produced tides at the study area of about 2 feet above normal, with extensive wave run-up, for a period of 5 days. Recession of the high-water shoreline varied from 10 to 40 feet. Caving banks from wave action resulted in the loss of two beach cottages and the partial destruction of a public bathhouse. Property damage was estimated at $25,000.

h. Although 28 hurricanes have struck the South Carolina coast in the past 61 years, affecting the study area in varying degree, it has been observed that the more frequent predominant northerly winds which produce waves that act upon the beach have a greater cumulative erosional effect.

i. Tides. The mean tidal range at the study area is 6.2 feet and the spring range is 7.3 feet. Considerably higher tides are associated with the occurrence of hurricanes and other storms. The maximum tide of record occurred in conjunction with the hurricane of August 1940. High-water marks surveyed near the beach subsequent to this storm stood at elevation 14.5 feet above mean low water.

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25. Shore history. Surveys by the United States Coast and Geodetic Survey since 1851 and by the Corps of Engineers, United States Army, in 1948, 1961, and 1962 were utilized in compiling the shore history of the study area.

a. Shoreline and offshore changes. Detailed data on mean-high-water shoreline changes from 1859 to 1962 for the 21,400-foot reach of the study area from station 73+00N to station 141+00S are given in Appendix C. Considerable variation in the average rate of shoreline recession over the period of record is evident. For the northern section of the beach, from station 0+00 to station 73+00N, the annual recession averaged 24.5 feet during the period 1859 to 1920. The annual recession for the section south of this reach, station 0+00 to station 141+00S, during the same period averaged 2.4 feet, while the annual average recession for the entire shoreline was 10.2 feet (a portion of the shoreline, between stations 40+00S and 90+00S, advanced as much as 400 feet during this period). Comparison of later surveys, in 1933 and 1948, for the same segments shows an annual average recession of 17.7 feet for the north section and 35.9 feet for the remaining section. The annual average for the entire shoreline for this period was 30 feet. For the entire period of record, 1859-1962, the annual recession for the reach from station 0+00 to station 73+00N averaged 22.7 feet, while the remainder of the shoreline receded at the average rate of 9.2 feet per year. The annual average recession for the entire shoreline during the period of record was 14.1 feet. Shoreline changes along Harbor Island, located across Johnson Creek from the north end of the study area, are considered pertinent to the problem and limited investigation was conducted thereon. Study of this area showed an average annual recession of 23 feet for the south half of the shoreline during the period 1933-1955, while the north half of the shoreline advanced at an average annual rate of 12 feet.

b. A comparison of the 1859 and 1962 surveys at the study area indicates a net loss of material in the offshore zones. Along the major portion of the coastline it is evident that the 6-foot depth contour has moved landward a distance roughly equivalent to the recession of the mean high water shoreline, especially in recent years during which the underwater slopes have not changed appreciably. However, visual observation, and the bearing of the 1961 and 1962 6-foot depth contours together with beach profiles reveal a tremendous gain of material off the southern end of Hunting Island adjacent to the approach to Fripp Inlet. Comparison of the 12- and 18-foot depth contours indicates a net loss of material except that, here too, a gain is indicated in the zone off the southern end of the study area.

Investigation of the area offshore of Harbor Island showed alternate loss and gain of depth since 1934, with the most recent (1958) data showing landward movement of the depth contours. Detailed data relative to offshore depth changes are shown in Appendix C.

c. Prior corrective action and existing structures. The South Carolina State Highway Department has taken the following described prior corrective action in efforts to control beach erosion at the study area. Experimental untreated palmetto pile and log groins were constructed at station 0+00 and station 6+00S in 1948. The north groin was 417 feet in length and the south groin was 355 feet. In 1949 and 1950 permanent type creosote treated pile and timber sheeting groins, 361 feet in length, were constructed at station 6+00N and station 12+00S. In 1951 additional permanent type groins were constructed at station 54+00N and station 60+00N. The experimental type groins at stations 0+00 and 6+00S proved impractical due to constant maintenance requirements and were subsequently replaced with permanent type groins. An experimental bulkhead of green oak material was constructed along a 600-foot section of the beach during 1957. The bulkhead consisted of a single wall with a double thickness of 3-inch sheeting supported by wales and piling spaced at 7-foot intervals. The length of sheeting and piling was 16 to 18 feet; minimum penetration below the strand was 10 feet. Fill material, to the grade of the finished wall, or about 6 feet above mean high water, was pumped from the beach during periods of low tide. The useful life of the structure was less than two years.

d. The overall performance of the groins has been highly unsatisfactory. Periodic observation of the groins in the past has shown some temporary arrest of progressive erosion in the effective areas; this, however, at the expense of increased erosion and recession of the shoreline south of the protected areas. The shoreline in the protected areas, following short periods of abatement, continued to recede and all groins have been flanked. The groins constructed at station 6+00N and station 54+00N were severely breached in recent years by wave action associated with storms. In 1961 the Highway Department removed the groins at stations 6+00N and 12+00S and utilized the salvaged materials to lengthen the shoreward ends of the groins at stations 0+00 and 6+00S in an effort to afford protection for a bathhouse and picnic area located near the shoreline between the latter stations. The extended groins were subsequently flanked, and the bathhouse and picnic area have sustained extensive damage, as the shoreline continues to recede.

e. Profiles. Detailed data on beach slopes, based on profiles run in 1948, 1961, and 1962, are given in Appendix C. The foreshore slope at 31 profiles averaged about 1 on 44 for both

the 1961 and 1962 surveys. The foreshore at 7 profiles run in 1948 for the limited reach of 4800 feet between stations 24+00N and 24+00S averaged 1 on 50. Underwater slopes seaward of mean low water to an average depth of -6.5 feet m.l.w. averaged 1 on 36 for the 1961 survey and 1 on 39 for the 1962 survey. The slight flattening of the underwater slopes indicated by the 1962 survey is likely due to the accelerated erosion occasioned by high water conditions associated with the storm of March 1962. Underwater slopes to an average depth of -6.5 feet m.l.w. for the 1948 limited survey averaged about 1 on 28.

f. Volumetric accretion and erosion. There are no complete littoral barriers located within the study area which would aid in establishing rates of movement of littoral materials. Computations of material losses and gains were made utilizing beach profile data from 1948 to 1962. Details of volumetric accretion and erosion are given in Appendix C.

g. The 1961 and 1962 survey data covering the 21,400 feet between station 73+00N and station 141+00S, the limits of the shoreline under study, together with the 1948 survey data covering the 4800 feet between stations 24+00N and 24+00S, were used in determining annual volumetric changes. The 1961-1962 data indicated that from the landward side of the backshore area to the 6.5-foot depth contour there has been an average loss of 16.8 cubic yards per lineal foot of shore between stations 73+00N and 112+00S, and an average gain of 10.5 cubic yards per lineal foot of shore between stations 112+00S and 141+00S - or a net average annual loss for the entire shoreline of 13 cubic yards per lineal foot.

h. Similar consideration of the 1948 and 1962 survey data indicated that, for the 4800-foot reach between stations 24+00N and 24+00S to which the 1948 survey was limited, there has been an annual average loss of 17.5 cubic yards per lineal foot of shoreline. Survey data covering a period of much shorter duration (March 1961 - March 1962) for this same reach indicated a 40 percent greater average loss of 24.4 cubic yards per lineal foot of shoreline.

ANALYSIS OF THE PROBLEM

26. Shore processes pertinent to the problem.

a. Littoral transport. The existing groins at the study area presently afford little indication of the direction or rate of littoral transport. All groins have been flanked and recent periodic observation of the groins shows no significant

difference in bottom configuration in the areas on either side of the groins. Some temporary arrest of progressive erosion resulted during a period immediately following installation of the groins, and was accompanied by increased erosion and recession of the shoreline southwest of the protected area, indicating a southwestward direction of littoral transport. Substantiating this indication of predominant southwestward littoral transport is the movement of offshore shoals and bars in that direction, as well as the presence and shape of southward trailing recurved spits in the vicinity of the island. The loss of more than 6500 feet of shoreline at the north end of the study area during the period of record (1859-1962) together with accretion and offshore deposition of material at the south end further substantiates this analysis of the drift movement. Moreover, the direction of predominant winds affecting the area and the direction of wave approach, presented elsewhere in the report, are such that would establish predominant southwesterly littoral transport. The wind, sea, and swell data also indicate that occasional reversal of drift can be expected along this portion of the coast; however, no quantitive data on reversal of drift are available. The magnitude of the present net southwesterly littoral drift along Hunting Island, other than that originating in the study area itself, is believed insignificant, as further explained in the following paragraph.

b. Supply and loss of littoral materials. The present rate of supply of material along the foreshore of the study area is obviously greatly influenced by the expansive estuary of St. Helena Sound which separates the study area from the northern beaches. It appears that the long-term shore processes at St. Helena Sound comprise southward littoral transport with large quantities of sand reaching the inlet from shores to the north, deposition of the material on shoals in the inlet and on the outer bar and movement along the outer bar to downdrift shores. The latter movement is usually cyclical and for large inlets the cycles may be of many years' duration. Indications are that very little new material is presently reaching the study area because of the present condition of the channels in the pattern of cyclical changes of those channels. Another important factor is the effect of tidal currents in causing dominant direction of drift to be toward an inlet along shores immediately adjacent to it on both sides. From losses at the south end of Harbor Island and the north end of Hunting Island, and the accretion of the northern portion of Harbor Island, it appears that tidal currents cause northward movement from a nodal zone in the vicinity of Johnson Creek.

c. The data on volumetric changes from 1948 to 1962 are considered to be representative of the deficiency of supply of material to the study area during a period of normal storm

incidence and other natural processes. The 1961-1962 survey data indicate an annual deficiency of 16.8 cubic yards per lineal foot of shore in the area of progressive erosion, and a surplus of 10.5 cubic yards per lineal foot of shore in the area of accretion - or a net deficiency for the entire shoreline of 13 cubic yards per lineal foot. It must be recognized, however, that this rate is based on observations of only one year's duration. Based on observations involving a longer period of time (1948-1962), the annual deficiency for a 4800-foot reach of shoreline typical of the area of progressive erosion was 28.5 percent less than that indicated for the same reach when only the one-year period 1961-1962 was considered. Therefore, adjustment of the deficiency indicated for the entire shoreline by the 1961-1962 surveys, the only available surveys covering the entire study area, in an effort to approximate average rates representative of long-term periods is believed realistic treatment. (See Appendix C.)

d. Considering all factors involved, including above-mentioned adjustments, it appears that on a long-term basis the annual deficiency of material, in the zone from the landward side of the backshore to the 6.5-foot depth contour, for the reach of shoreline evidencing progressive erosion will probably average about 12 cubic yards per lineal foot of shoreline. The shore recession, due to this deficiency in supply, has resulted in insufficient width of beach to protect onshore installations.

27. Methods of correcting problem conditions. The following subparagraphs set forth the various remedial measures considered in resolution of the problem of arresting erosion and stabilizing the beach at the study area.

a. Beach nourishment. The present high-water shoreline at the study area could be stabilized by artificial beach nourishment to the extent necessary to satisfy the deficiency rate for the eroding shore - this rate being an average of about 12 cubic yards per lineal foot of beach, per year. Under present conditions the dry beach area available for sunbathing and recreation at high tide is very limited, the strand in many instances being completely inundated. Such a stabilized beach would be beneficial in that it would provide both protection to existing improvements, and increased recreational capability. This plan could be implemented without impairment of littoral processes responsible for conditions that obtain at downdrift beaches.

b. Beach nourishment with groins. A properly designed groin system could be incorporated in a beach nourishment plan to reduce the rate of loss of material from the area, thus reducing periodic nourishment requirements. The landward horizontal section

of these groins should be at an elevation of 9.5 feet above mean low water, which is the theoretic beach berm elevation, and would extend about 50 feet seaward of the mean-high-water shoreline. The top of the groin should then slope downward on a 1 on 40 slope to an elevation of about 2 feet above mean low water, from which point the groin crest would run horizontally, the toe of the groin reaching the 3-foot depth contour. The groin system would terminate at station 112+00S, beyond which station the shoreline is advancing. The anticipated continued transport of material past the area protected as herein proposed would be more than adequate to satisfy requirements downdrift of station 112+00S. The groin system and the nourishment plan is further described and evaluated in Appendix D.

c. Sand by-passing. Consideration was given to use of a sand by-passing plant as an alternate method of providing nourishment requirements for the study area. A sand by-passing plant at St. Helena Sound could provide a continuous supply of material to nourish the downdrift areas; however, preliminary investigation indicates that this would not be an economically feasible alternate due to exposure conditions, distances to be traversed, and the fact that material for nourishment requirements can be placed more economically from nearby borrow areas. Accordingly, the proposal is not further considered in this report.

d. Tidal current conditions obtaining in the vicinity of Johnson Creek would necessitate the inclusion of a terminal groin at the north end of the study area in conjunction with either plan of improvement herein considered. Function of the terminal groin would be to prevent northward losses of beach nourishment material.

PLAN OF PROTECTION

28. General. Two plans of protection designed for the study area have been evaluated and are described in the following paragraphs. Discussion of design criteria and construction materials is presented in Appendix D, and the plans of improvement, with typical sections, are shown on Plate 2.

29. Plan "A". The principal features of this plan are periodic placement of beach nourishment material, and a terminal groin at station 73+00N extending seaward 700 feet from the mean-high-water line. Nourishment material would be pumped from the borrow area and placed at the feeder beach location between stations 50+00N and 50+00S. The feeder beach volume would be that necessary to provide three years of annual nourishment requirement, or 750,000 cubic yards. It is estimated that periodic

replenishment of the feeder beach at the rate of 250,000 cubic yards annually would be required to provide continued nourishment.

30. Plan "B". The principal features of this plan are the same as Plan "A" except for the inclusion of a groin system, and reduced feeder beach and periodic nourishment requirements. Groins would be located at 1,000-foot intervals between stations 58+00N and 112+00S. The completed groin system would consist of 19 groins, varying in length as required to reach the 3-foot depth contour, except that the terminal groin at station 73+00N would extend 700 feet seaward from the mean-high-water line. The groin profile would be as hereinbefore described, and further described in Appendix D. The feeder beach volume to provide three years' annual nourishment requirement would be 485,000 cubic yards. It is estimated that periodic replenishment of the feeder beach at the rate of 162,000 cubic yards annually would be required to provide continued nourishment.

31. Selection of plan of improvement. Plan "A" is the plan considered most suitable to correct the problem conditions. The annual costs for the groin system in Plan "B" exceed the value of annual nourishment reduction. (The reduction in nourishment requirements attributed to the groin system is estimated in Appendix D.) Stabilization of the beach would be accomplished by periodic nourishment alone, since inclusion of the groin system is not justified. Thus, from the standpoint of economics, Plan "A" is the most favorable of the plans considered, and is the recommended plan.

ECONOMIC ANALYSIS

COSTS

32. Estimate of first cost. Construction costs for the project are estimated on the basis of wage rates and price levels prevailing in 1962. On this basis, construction costs, including 15 percent contingencies, are estimated to be $405,000. Costs of Engineering and Design, and Supervision and Administration, are estimated to be $50,000, based on previous experience on similar projects and prevailing wage rates and overhead rates. Thus, the total initial cost of the project is estimated to be $455,000. A summary of the cost estimate is presented in Table 3, and detailed cost estimates are shown in Appendix D for both the recommended plan and Plan "B".

33. Estimate of annual charges. Estimated annual charges are based on a total investment of $455,000. No interest during construction has been included, since the construction period

should not exceed one year. An interest rate of 2.875 percent was used for costs apportioned to the Federal Government, while an interest rate of 4.0 percent was used for costs apportioned to non-Federal interests. The amortization period used is 50 years. Beach nourishment costs are estimated to be $97,500 annually. Annual costs for replacement of a portion of the terminal groin, at the end of 25 years are estimated at $328. Average annual charges, estimated as herein indicated, are summarized in Table 3. Annual charges for both Plan "A" and Plan "B" are shown in Appendix D.

BENEFITS

34. Estimate of benefits. The benefits to be derived from either of the plans of improvement considered are the prevention of physical damages, and increased use of an improved beach affording free and easy access. Since the area to be protected is publicly-owned and not subject to resale, no benefits are claimed for enhancement of property values. A detailed derivation of the estimate of benefits is presented in Appendix E.

35. Physical damages prevented. The area of land which would be lost over the period of evaluation in the absence of the project is estimated on the basis of the historical rate of shore recession at the study area (see Table C-1 and Appendix E). On this basis it is estimated that the proposed plan of improvement would prevent average annual loss of land in the amount of 7 acres, the value of such lands being estimated at $8,000 per acre which value is commensurate with market value of adjacent lands of similar character. Moreover, developments existing on the land area expected to be lost during the period of evaluation, in the absence of the project, would be destroyed. Existing developments consist of roads, parking areas, buildings, structures, electric facilities, and water works. Based on current price levels for the existing state of development, average annual prevention of damages to existing developments is estimated to be $12,000.

36. Benefits from increased use of beach. Recreational benefits expected to accrue are based on prospective increase in beach patronage, and improved facilities for present users. Placement of the 3-year requirement of nourishment material (750,000 cubic yards) on the 10,000-foot reach of shore between stations 50+00N and 50+00S, at 3-year intervals, would in effect make additional dry beach area available for public use - thus providing adequate recreational area at all conditions of tide. Average annual recreational benefits of $119,000 are estimated to be realized in consequence of improved beach facilities. It is

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TABLE 3

Summary of Cost Estimate

Plan "A"

FIRST COST	
Terminal Groin	$ 60,000
Advance Nourishment	292,500
SUB-TOTAL	$ 352,500
Contingencies (15%)	52,875
Estimated Total Construction Costs	$ 405,375
Engineering and Design (4%)	16,215
SUB-TOTAL	$ 421,590
Supervision and Administration (8%)	33,710
ESTIMATED FIRST COST	$ 455,300
AVERAGE ANNUAL CHARGES	
Interest (2-7/8% - 4%)	$ 14,627
Amortization	3,826
Periodic Beach Nourishment	97,500
Replacement of Groin (Interest and Amortization)	328
ESTIMATED ANNUAL CHARGES	$ 116,281

estimated that patrons would be willing to pay a fee of $0.35 per visit for beach privileges at a private beach comparable to Hunting Island Beach at its present state of development. It is further estimated that the improved beach would justify a charge of $0.50 per person per visit. Thus, the benefit accruing to present users, as a result of improved beach facilities, would be $0.15 per visit, while the benefit to additional users would be $0.50 per visit. Application of these unit benefits to the number of users (see para. 2, Appendix E for derivation of usage and attendant benefits) gives total recreational benefits of (157,000 x $0.50) + (270,000 x $0.15), or $119,000.

37. Summary of benefits. The average annual benefits assignable to the plan of improvement are summarized as follows:

Land losses prevented	$ 56,000
Damages to developments prevented	12,000
Recreational benefits	119,000
ESTIMATED TOTAL AVERAGE ANNUAL BENEFITS	$187,000

38. Justification of improvements. The total annual benefits of $187,000 would exceed the average annual costs of $116,000; the ratio of benefits to costs would be 1.6.

APPORTIONMENT OF COSTS

39. First costs. Detailed apportionment of first costs between Federal and non-Federal interests is shown in Tables D-2 and D-3, and is based upon apportionment in accordance with the provisions of Public Law 826, 84th Congress, as amended by the River and Harbor Act of 1962. The study area meets the following criteria for 70 percent Federal participation: The area is publicly-owned; includes a zone extending landward from the mean-low-water line from which permanent human habitation shall be excluded; includes but is not limited to recreational beaches; has active program for conservation and development of the natural resources of the environment; extends landward a sufficient distance to include natural features which serve to protect the uplands from damage; and provides essentially full park facilities for appropriate public use. Thus the share of the cost to be borne by the Federal Government would be 70 percent of the total estimated first cost of construction.

40. Annual costs. Detailed apportionment of annual costs between Federal and non-Federal interests is shown in Tables D-2 and D-3. The apportionment of annual charges for interest and

amortization to Federal and non-Federal interests was based on the division of total first costs between these interests. Interest and amortization charges were computed using an interest rate of 2-7/8 percent for the Federal share of the investment, and 4 percent for the non-Federal portion of the investment. Non-Federal interests would be required to bear the costs of all maintenance and periodic beach nourishment, except that the Federal Government would bear 70 percent of the cost of annual beach nourishment for a period of 10 years.

COORDINATION WITH OTHER AGENCIES AND LOCAL COOPERATION

41. Coordination with other agencies. Since the inception of the study program, and continuing through the course of the survey and the considered plans of improvement, consultation and discussion were held with representatives of concerned Federal, State, and local agencies. Discussions were held with representatives of the United States Weather Bureau; the South Carolina State Highway Department; the South Carolina Public Service Commission; the South Carolina Wildlife Resources Department; the South Carolina State Commission of Forestry; and the Beaufort County (S. C.) Legislative Delegation. Responses of representatives of agencies with whom the proposed remedial measures were coordinated vary from normal interest to enthusiastic favor and support, no opposition being evidenced.

42. Local cooperation. State and local government representatives have evidenced continuing interest in the survey and the consequent proposed plan of improvement. Beaufort County (S. C.) news media are active in promotion of improvements at the study area. The South Carolina State Highway Department, the cooperating agency, expresses the State's willingness to participate in the project, such willingness and ability being contingent upon legislative action controlling availability of funds. (The statement of the cooperating agency is included as Appendix F.) There is no apparent opposition to the plan of improvement.

43. Federal participation in the cost of the project would require cooperation of local interests to the extent outlined under Section, RECOMMENDATIONS.

CONCLUSIONS

44. The District Engineer concludes that the Hunting Island Beach area has sustained severe recession of the shoreline, with accompanying damages, and dissipation of available beach area in the past, and that such condition is likely to continue in the absence of suitable corrective measures. He further concludes

that the best protection against this condition, commensurate with costs, can be obtained through implementation of Plan "A", which will provide protection against further recession of the shoreline and consequent damages, and generate additional recreational benefits to the public. The recommended plan of improvement is economically justified having a benefit-cost ratio of 1.6.

RECOMMENDATIONS

45. The District Engineer recommends a Federal project to provide for arresting erosion and stabilizing the beach on 18,500 feet of shore at Hunting Island Beach, South Carolina. The District Engineer further recommends that construction be subject to the condition that local interests, through a competent and duly authorized public agency, give assurances satisfactory to the Secretary of the Army that they will cooperate as follows:

a. Assure continued public ownership of the shore upon which the amount of Federal participation is based, and its administration for public use during the amortization period.

b. In the zone subject to flooding by storm tides, extending landward from the mean-low-water line, along the reach of shoreline designated for construction of improvement works, assure continued prevention of development which would result in destruction of natural protective features of the shore area, and development for permanent human habitation, including summer residences.

c. Contribute 30 percent of the first cost of the project, a sum currently estimated at $136,000, as determined in paragraph 39 and Appendix D.

d. Assure maintenance, repair, and periodic beach nourishment during the amortization period as may be required to serve the intended purpose, except that, for a period of 10 years, the Federal Government would bear 70 percent of the annual cost of beach nourishment.

e. Assure that water pollution that would endanger the health of bathers will not be permitted, or that suitable remedies will be provided if usability of the beach should become impaired by water pollution.

f. Provide, without cost to the Federal Government, all necessary lands, easements, and rights-of-way for project to be constructed by the Federal Government.

g. Hold and save the United States free from claims for damages due to the construction works.

46. The proposed improvement has a first cost presently estimated at $455,000, the Federal share of which would be 70 percent, or $319,000. Periodic beach nourishment requirements are currently estimated to average $97,500 annually, the Federal share of which would be 70 percent, or $68,000, for a period of ten years. The recommended construction hereinbefore described is summarized as follows:

a. A terminal groin at station 73+00N extending approximately 700 feet seaward from the mean-high-water line.

b. A feeder beach, consisting of 750,000 cubic yards of material for advance nourishment, located as indicated on Plate 2.

c. Replenishment of the feeder beach to provide nourishment as required. Current estimate of nourishment requirement is 250,000 cubic yards annually.

S. Y. COKER
Colonel, Corps of Engineers
District Engineer

[First endorsement]

SADER (26 March 63)
SUBJECT: Survey Report on Cooperative Beach Erosion Control Study at Hunting Island Beach, South Carolina

U. S. Army Engr Div, South Atlantic, Atlanta, Ga., 29 March 1963

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

The Division Engineer concurs in the recommendation of the District Engineer.

A. C. WELLING
Major General, USA
Division Engineer

APPENDIX C

SHORE HISTORY

1. General. Surveys by the United States Coast and Geodetic Survey since 1851, and by the Corps of Engineers, United States Army, in 1948, 1961, and 1962 were utilized in compiling the shore history of the study area.

2. Shoreline and offshore changes.

a. Considerable variation in the average rate of shoreline recession over the period of record is evident. For the northern section of the beach, from station 0+00 to station 73+00N, the annual recession averaged 24.5 feet during the period 1859 to 1920. The annual recession for the section south of this reach, station 0+00 to station 141+00S, during the same period averaged 2.4 feet, while the annual average recession for the entire shoreline was 10.2 feet (a portion of the shoreline, between stations 40+00S and 90+00S, advanced as much as 400 feet during this period). Comparison of later surveys, in 1933 and 1948, for the same segments shows an annual average recession of 17.7 feet for the north section and 35.9 feet for the remaining section. The annual average for the entire shoreline for this period was 30 feet. For the entire period of record, 1859-1962, the annual recession for the reach from station 0+00 to station 73+00N averaged 22.7 feet, while the remainder of the shoreline receded at the average rate of 9.2 feet per year. The annual average recession for the entire shoreline during the period of record was 14.1 feet. Mean high water shorelines for each of the surveys are shown on Plate C-1. Detailed data are shown in Table C-1.

b. A comparison of the 1857 and 1962 surveys at the study area indicates a net loss of material in the offshore zones. Along the major portion of the coastline it is evident that the 6-foot depth contour has moved landward a distance roughly equivalent to the recession of the mean high water shoreline especially in recent years during which the underwater slopes have not changed appreciably. However, visual observation, and the bearing of the 1961 and 1962 6-foot depth contours together with beach profiles reveal a tremendous gain of material off the southern end of Hunting Island adjacent to the approach to Fripp Inlet. Comparison of the 12- and 18-foot depth contours indicates a net loss of material except that, here too, a gain is indicated in the zone off the southern end of the study area. The 6-, 12-, and 18-foot depth contours, for the period of record, are shown on Plates C-1 and C-2.

c. Shoreline changes along Harbor Island, located across Johnson Creek from the north end of the study area as shown on Plates C-1 and C-2, are considered pertinent to the problem and limited investigation was conducted thereon. Study of this area showed an average annual recession of 23 feet for the south half of the shoreline during the period 1933-1955, while the north half of the shoreline advanced at an average annual rate of 12 feet. Investigation of the area offshore of Harbor Island showed alternate loss and gain of depth since 1934, with the most recent (1958) data evidencing landward movement of the depth contours.

3. Profiles. Surveys performed in 1948 provide beach profile data from station 24+00N to station 24+00S, while the 1961 and 1962 surveys provide data on the entire shoreline under study. Comparative profiles plotted from these surveys are shown on Plates C-3 through C-6, and profile slope data, computed from the surveys, are tabulated in Table C-2. The foreshore slope at 31 profiles averaged about 1 on 44 for both the 1961 and 1962 surveys. The foreshore at 7 profiles run in 1948 for the limited reach of 4800 feet between stations 24+00N and 24+00S averaged 1 on 50. Underwater slopes seaward of mean low water to an average depth of -6.5 feet m.l.w. averaged 1 on 36 for the 1961 survey and 1 on 39 for the 1962 survey. The slight flattening of the underwater slopes indicated by the 1962 survey is likely due to the accelerated erosion occasioned by high water conditions associated with the storm of March 1962. Underwater slopes to an average depth of 6.5 feet m.l.w. for the 1948 limited survey averaged about 1 on 28.

4. Volumetric accretion and erosion.

a. There are no complete littoral barriers located within the study area which would aid in establishing rates of movement of littoral materials. Computations of material losses and gains were made utilizing beach profile data from 1948 to 1962. Results of these computations are shown in Table C-3, and are discussed in the following paragraphs.

b. The 1961 and 1962 survey data covering the 21,400 feet between station 73+00N and station 141+00S, the limits of the study area shoreline, together with the 1948 survey data covering the 4800 feet between stations 24+00N and 24+00S, were used in determining annual volumetric changes. The 1961-1962 data indicated that from the landward side of the backshore area to the 6.5-foot depth contour there has been an average loss of 16.8 cubic yards per lineal foot of shore between stations 73+00N and 112+00S, and an average gain of 10.5 cubic yards per lineal foot of shore between stations 112+00S and 141+00S - or a net average loss for the entire shoreline of 13 cubic yards per lineal foot.

c. Similar consideration of the 1948 and 1962 survey data indicated that, for the 4800-foot reach between stations 24+00N and 24+00S to which the 1948 survey was limited, there has been annual average loss of 17.5 cubic yards per lineal foot of shoreline. Survey data covering a period of much shorter duration (March 1961 - March 1962) for this same reach indicated a 40 percent greater average loss of 24.4 cubic yards per lineal foot of shoreline.

d. For obvious reasons, results of comparative surveys covering a short period of time cannot be regarded as accurate indices to future shore conditions; therefore, adjustment of the deficiency of material indicated by the 1961-1962 surveys, by application of an adjustment factor derived from comparison of the limited 1948 survey and 1962 survey, is believed prudent action. The net rate of loss of material indicated by comparison of the 1948-1962 surveys is 28.5 percent less than the net rate, for the same reach of shoreline, indicated by comparison of the 1961-1962 surveys (see Table C-3). Accordingly, application of a 28.5 percent reduction to the net rate of loss, for the reach of shoreline evidencing progressive erosion, indicated by comparison of the 1961-1962 surveys, suggests that an average annual rate of loss of about 12 cubic yards per lineal foot of shoreline may reasonably be expected in the future.

TABLE C-1

MEAN HIGH WATER LINE CHANGES

STATION	1859-1914	1859-1920	1914-1920	1920-1933	1933-1948	1948-1955	1955-1962	1859-1962
73+00N	-4,740		-300	-900	-300	-200	-100	-6,540
60+00N	-1,500		-110	-250	-350	-110	- 50	-2,370
50+00N	-1,225		-150	-250	-250	-200	-150	-2,225
40+00N	-1,000		-150	-150	-275	- 60	-300	-1,935
30+00N	- 890		-110	-150	-200	-200	-300	-1,850
20+00N	- 650		-120	-110	-175	-150	-350	-1,555
10+00N	- 510		- 60	-100	-275	- 50	-225	-1,220
0+00	- 390		- 60	- 80	-300	0	-160	- 990
(1)	-1,363		-133	-249	-266	-121	-204	-2,336
(2)	- 24.8		- 22.2	- 19.2	- 17.7	- 17.3	- 29.1	- 22.7
0+00		-450		- 80	-300	0	-160	- 990
10+00S		-260		-110	-300	0	-100	- 770
20+00S		-100		-200	-350	0	-110	- 760
30+00S		0		-190	-390	0	-110	- 690
40+00S		+150		-160	-400	0	-200	- 610
50+00S		+260		-150	-510	0	-190	- 590
60+00S		+390		-300	-500	- 50	-150	- 610
70+00S		+400		-310	-525	- 50	-190	- 675
80+00S		+300		-375	-500	-100	-110	- 785
90+00S		+150		-375	-510	-110	0	- 845
100+00S		- 50		-325	-600	- 50	- 25	-1,050
110+00S		-290		-310	-610	0	- 10	-1,220
120+00S		-510		-290	-790	+100	0	-1,490
130+00S		-890		-260	-900	+200	+200	-1,650
141+00S		-1,300		0	-900	+100	+580	-1,520
(3)		-147		-229	-539	+ 2.7	- 38	- 947
(2)		- 2.4		- 17.6	- 35.9	+ 0.4	- 5.4	- 9.2
(4)		-623		-243	-450	- 42	- 93	-1,452
(2)		- 10.2		- 18.7	- 30.0	- 6	- 13.4	- 14.1

(-) Denotes recession (landward)
(+) Denotes advance (seaward)
(1) Average for Sta. 0+00-73+00N
(2) Feet per year
(3) Average for Sta. 0+00-141+00S
(4) Average for entire shoreline

TABLE C-2

PROFILE SLOPES

STATION	MHW-MLW 1 ON:	MLW SEAWARD TO TOE OF SLOPE 1 ON:	TOE OF SLOPE (m.l.w.)
		1948	
24+00N	54.8	30.3	-6.1'
7+00N	50.0	23.0	-5.0'
0+50S	49.2	25.3	-7.2'
3+00S	52.4	26.1	-6.7'
7+00S	50.0	31.4	-7.0'
13+00S	47.6	27.9	-6.8'
24+00S	46.0	33.1	-6.5'
AVERAGE	50.0	28.2	-6.5'
		1961	
73+00N	63.7	16.4	-5.5'
60+90N	32.3	37.9	-6.6'
60+00N	57.3	38.1	-6.3'
55+00N	21.0	22.6	-5.3'
54+38N	33.9	30.0	-6.0'
48+00N	51.6	35.9	-6.4'
36+00N	43.5	31.8	-6.6'
24+00N	46.0	35.8	-6.7'
12+00N	40.3	38.5	-6.5'
6+38N	45.2	30.2	-6.3'
5+87N	43.5	26.9	-8.0'
0+25N	40.3	35.5	-6.2'
0+60S	37.1	42.9	-7.0'
3+00S	38.7	46.6	-7.3'
5+66S	34.7	47.8	-6.8'
6+05S	40.3	39.7	-6.8'
11+66S	42.7	31.9	-7.2'
12+15S	42.7	31.6	-7.6'
24+00S	44.4	34.6	-6.8'
36+00S	45.2	30.5	-6.4'
48+00S	47.6	30.3	-6.6'
60+00S	48.4	30.8	-6.5'
72+00S	49.2	41.7	-6.0'
84+00S	50.0	50.0	-5.9'

TABLE C-2 (Cont'd)

STATION	MHW-MLW 1 ON:	MLW SEAWARD TO TOE OF SLOPE 1 ON:	TOE OF SLOPE (m.l.w.)
		1961 (Cont'd)	
96+00S	48.4	38.4	-4.3'
105+00S	50.0	53.3	-4.6'
112+00S	53.2	41.4	-2.9'
126+00S	-	-	-
138+00S	49.2	-	-
141+00S	-	-	-
AVERAGE	44.3	36.0	-6.3'
		1962	
73+00N	66.1	17.1	-3.5'
60+90N	39.5	59.7	-7.2'
60+00N	49.2	51.5	-6.8'
55+00N	29.0	31.7	-6.0'
54+38N	45.2	34.1	-6.3'
48+00N	46.8	31.7	-6.3'
36+00N	46.0	30.2	-6.3'
24+00N	44.4	33.3	-6.6'
12+00N	40.3	48.2	-8.5'
6+38N	41.1	47.6	-8.2'
5+87N	39.5	51.3	-8.0'
0+25N	37.9	32.7	-7.5'
0+35S	37.1	36.4	-6.6'
0+60S	40.3	32.4	-6.8'
3+00S	45.2	35.6	-7.3'
5+55S	36.3	45.0	-8.0'
6+05S	43.5	41.8	-7.9'
11+66S	41.9	44.9	-7.8'
12+15S	39.5	48.7	-7.5'
24+00S	44.4	34.0	-7.2'
36+00S	45.2	31.6	-6.8'
48+00S	42.7	29.7	-6.4'
60+00S	42.7	36.7	-6.5'
72+00S	43.5	39.2	-6.0'
84+00S	41.1	43.6	-5.5'
96+00S	38.7	38.9	-4.5'
105+00S	52.4	41.4	-3.5'
112+00S	60.5	46.9	-3.2'
126+00S	86.3	-	-
138+00S	37.9	-	-
141+00S	45.2	-	-
AVERAGE	44.8	39.1	-6.5'

TABLE C-3

VOLUMETRIC ACCRETION AND EROSION (CUBIC YARDS)

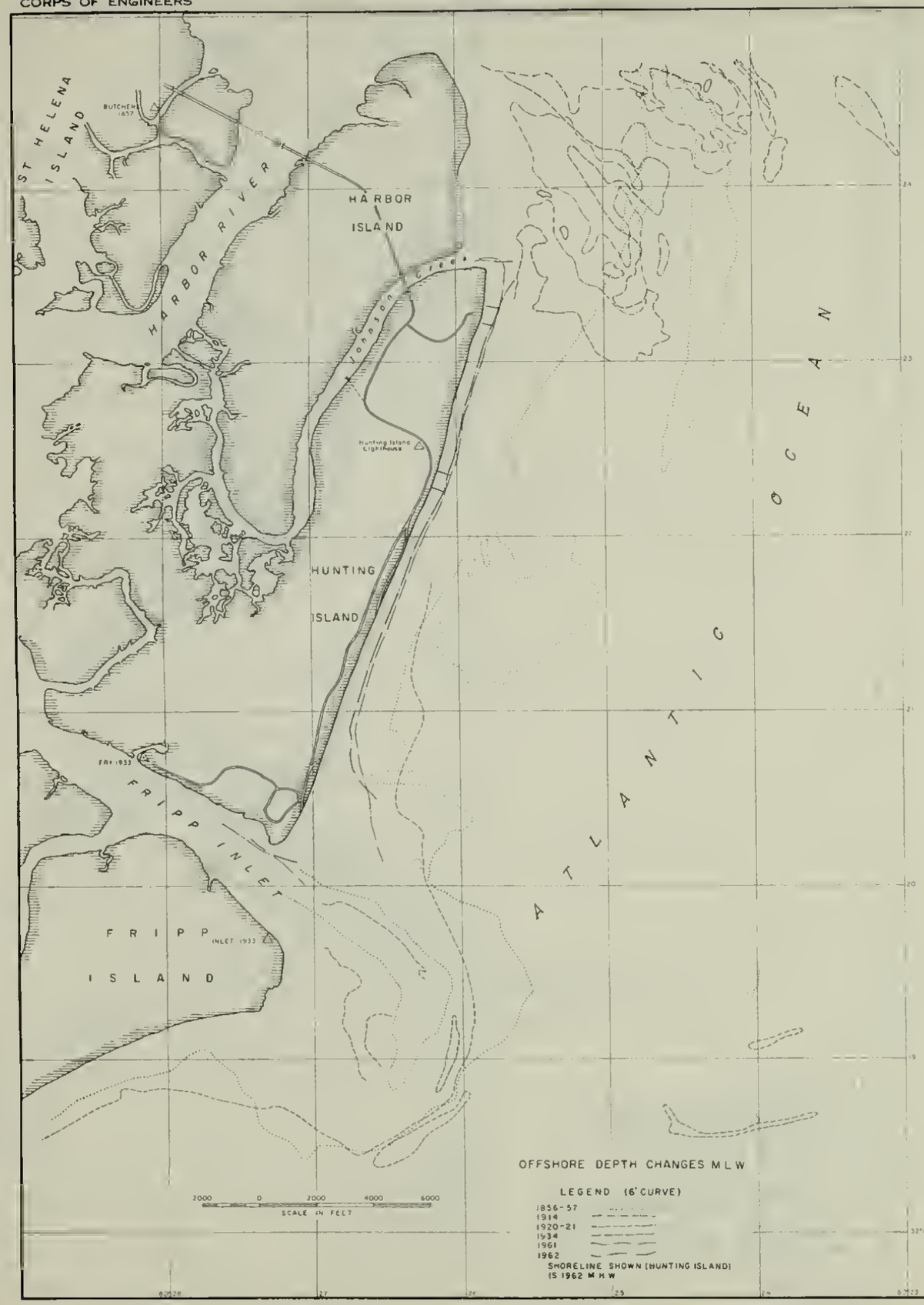
STATION	1961-1962	1948 - 1962
73+00N - 60+90N	- 11,607	-
60+90N - 60+00N	- 697	-
60+00N - 55+00N	- 6,639	-
55+00N - 54+38N	- 799	-
54+38N - 48+00N	- 8,280	-
48+00N - 36+00N	- 18,933	-
36+00N - 24+00N	- 20,222	-
24+00N - 12+00N	- 14,578	- 363,654
12+00N - 6+38N	- 19,868	- 155,853
6+38N - 5+87N	- 2,959	- 11,400
5+87N - 0+25N	- 22,532	- 132,000
0+25N - 0+60S	- 1,036	- 23,058
0+60S - 3+00S	- 418	- 47,824
3+00S - 5+55S	- 1,120	- 19,805
5+55S - 6+05S	- 582	- 55,514
6+05S - 11+66S	- 19,292	- 97,582
11+66S - 12+15S	- 2,377	- 14,840
12+15S - 24+00S	- 32,544	- 252,287
24+00S - 36+00S	- 12,689	-
36+00S - 48+00S	- 18,956	-
48+00S - 60+00S	- 23,044	-
60+00S - 72+00S	- 22,133	-
72+00S - 84+00S	- 18,889	-
84+00S - 96+00S	- 20,089	-
96+00S - 105+00S	- 10,700	-
105+00S - 112+00S	- 285	-
112+00S - 126+00S	+ 570	-
126+00S - 138+00S	+ 22,444	-
138+00S - 141+00S	+ 7,522	-
TOTAL	-280,732	
ANNUAL RATE	-280,732	
RATE PER LINEAR FOOT	- 13.0	
TOTAL BETWEEN STA. 24+00N-24+00S	-117,306	-1,173,817
ANNUAL RATE	-117,306	- 83,844 (1)
RATE PER LINEAR FOOT	- 24.4	- 17.5 (1)

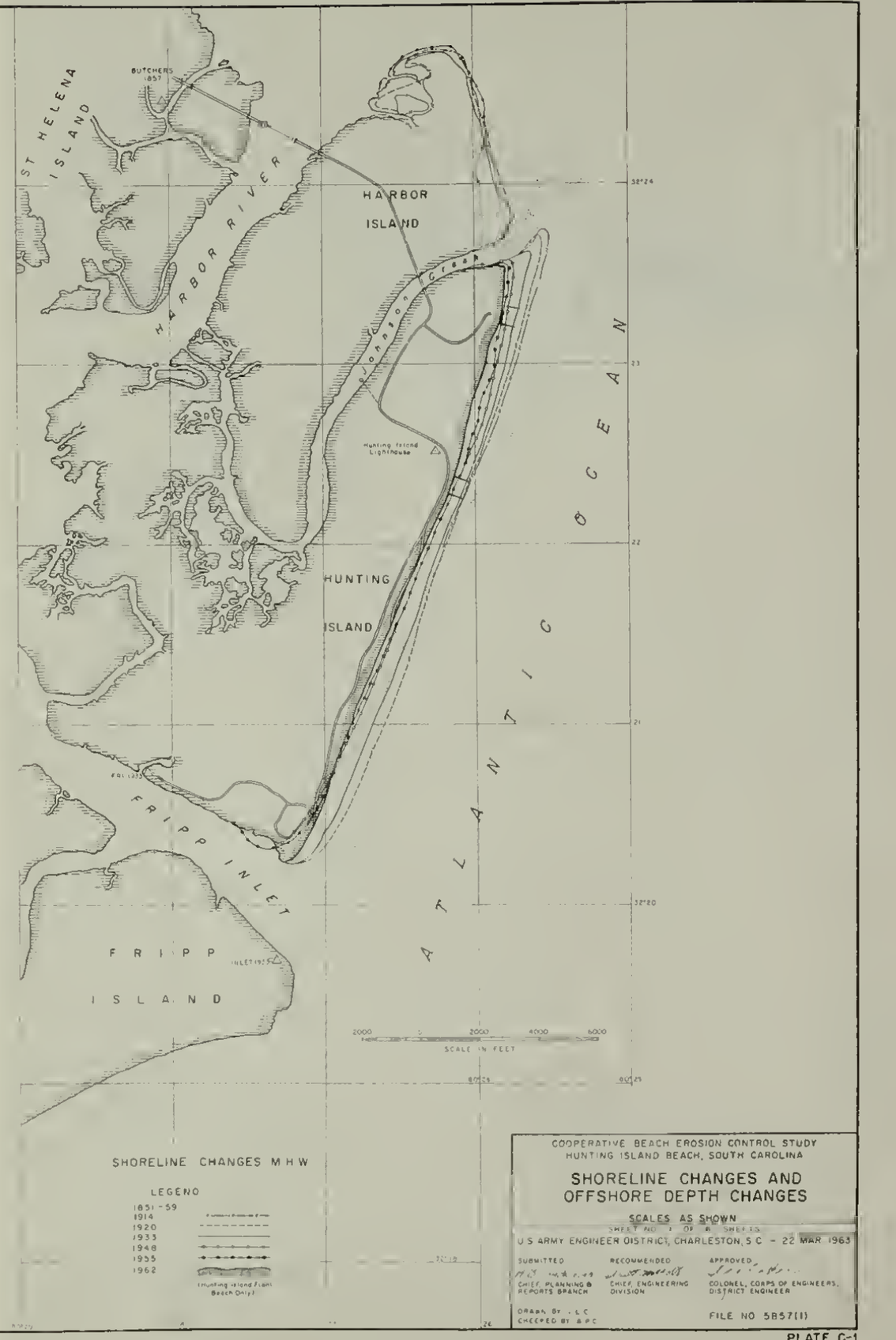
(1) Note that this rate is 28.5 percent less than the 1961-1962 rate for the same reach of shore.
(-) Erosion
(+) Accretion

35-620 O-64 (Face blank p. 38) No. 1

CORPS OF ENGINEERS

U. S. ARMY





COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

SHORELINE CHANGES AND OFFSHORE DEPTH CHANGES

SCALES AS SHOWN

SHEET NO. 1 OF 8 SHEETS

U S ARMY ENGINEER DISTRICT, CHARLESTON, S C - 22 MAR 1963

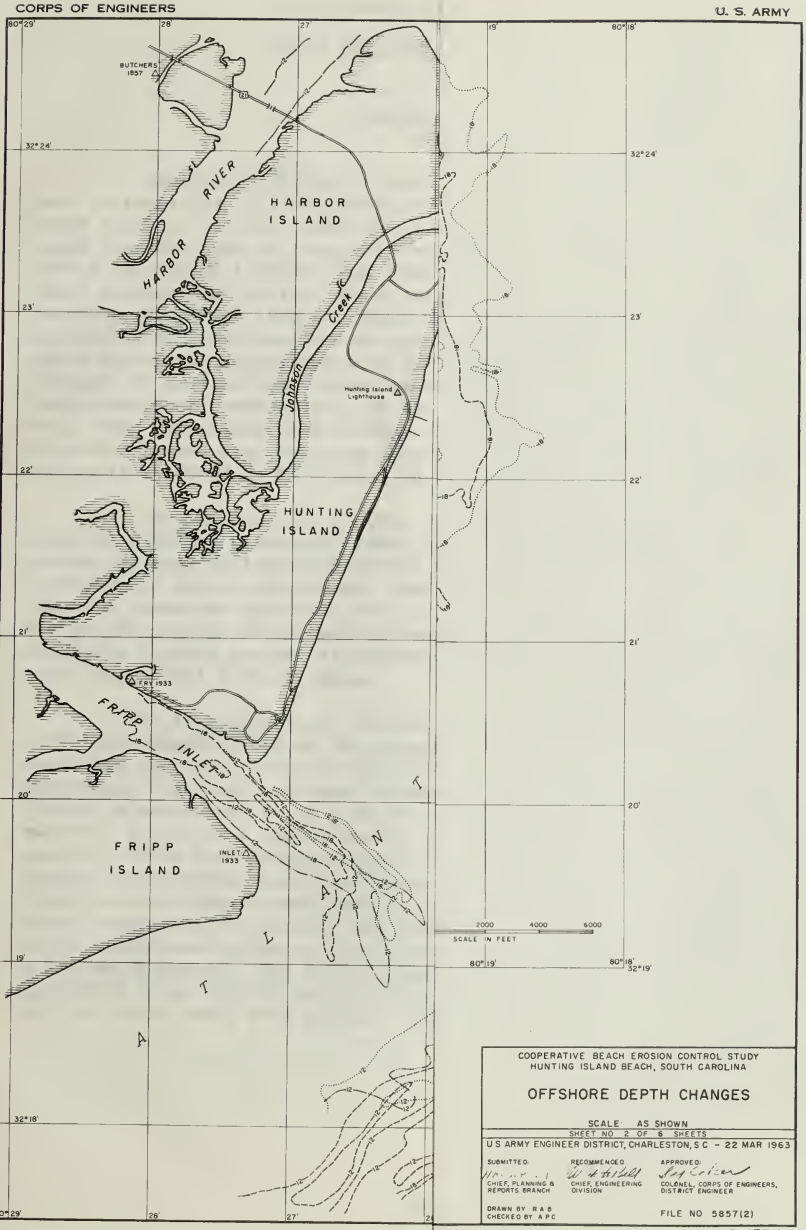
SUBMITTED	RECOMMENDED	APPROVED
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY : L C
CHECKED BY : B P C

FILE NO 5B57(1)

PLATE C-1

35-620 O-64 (Face blank p. 38) No. 1



COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

OFFSHORE DEPTH CHANGES

SCALE: AS SHOWN
SHEET NO. 2 OF 6 SHEETS
U.S. ARMY ENGINEER DISTRICT, CHARLESTON, S.C. - 22 MAR 1963

SUBMITTED:	RECOMMENDED:	APPROVED:
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

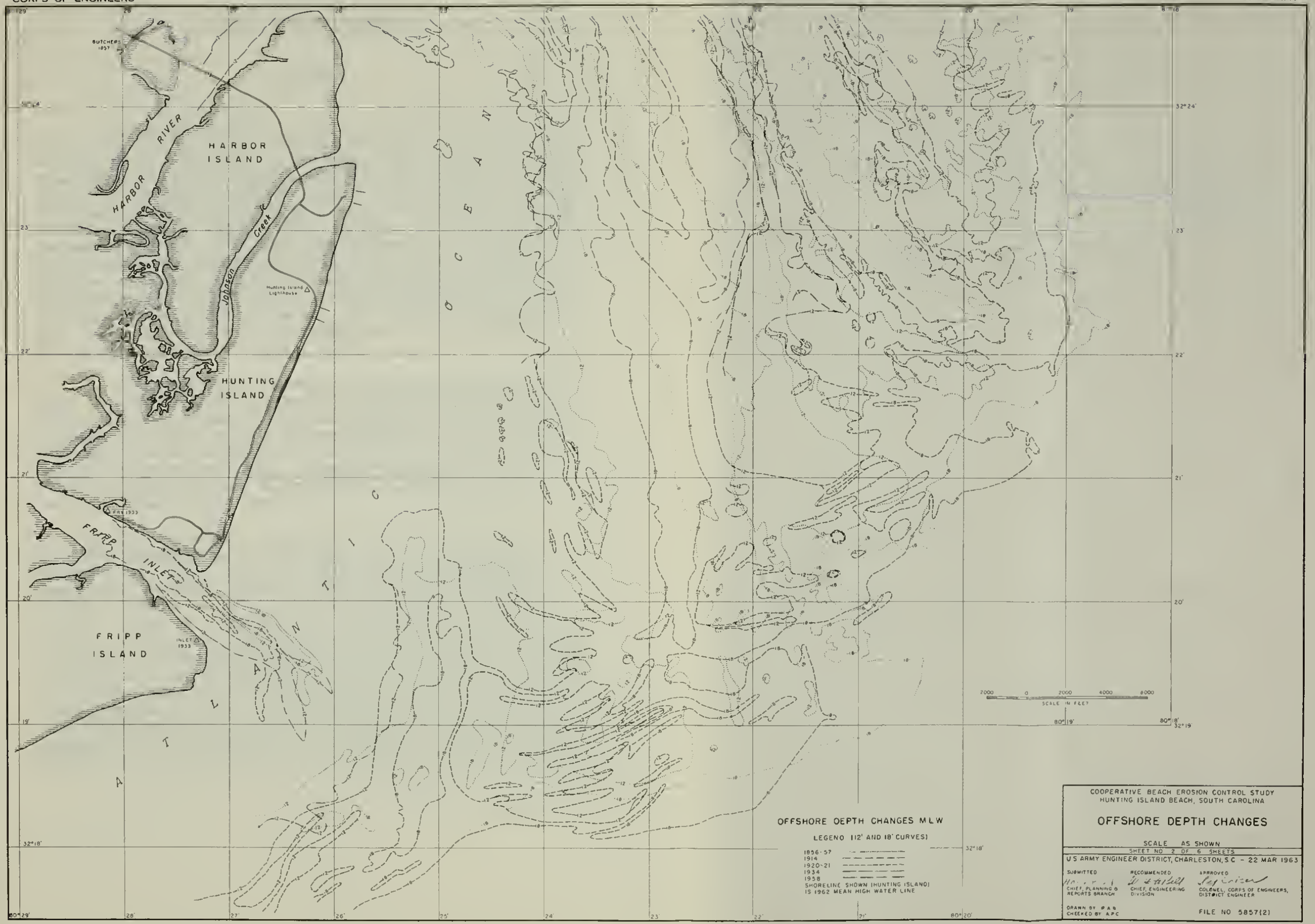
DRAWN BY R.A.B.
CHECKED BY A.P.C.

FILE NO. 5857(2)

PLATE C-2

CORPS OF ENGINEERS

U. S. ARMY



OFFSHORE DEPTH CHANGES M.L.W.

LEGEND (12' AND 18' CURVES)

1856-57
1914
1920-21
1934
1958

SHORELINE SHOWN (HUNTING ISLAND) IS 1962 MEAN HIGH WATER LINE

COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

OFFSHORE DEPTH CHANGES

SCALE AS SHOWN

SHEET NO 2 OF 6 SHEETS

U.S. ARMY ENGINEER DISTRICT, CHARLESTON, S.C. - 22 MAR 1963

SUBMITTED	RECOMMENDED	APPROVED
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY P.A.B.
CHECKED BY A.P.C.

FILE NO 5857(2)

PLATE C-2

APPENDIX D

DESIGN AND COST ESTIMATE

DESIGN

1. Beach nourishment. The average annual deficiency in rate of supply of littoral material for the eroding shore is estimated at about 12 cubic yards per lineal foot of beach. This is based upon the rate of loss for the shoreline area from station 73+00N to station 112+00S, and from the landward side of the backshore area to the 6.5-foot depth contour, as evidenced by surveys covering the period 1948 to 1962. This rate is considered to be indicative of beach nourishment requirements and it is thus estimated that annual nourishment of 250,000 cubic yards would be adequate to sustain the various erosional forces, including the long-term normal wave attack and the short-term wave action and high tides associated with storms. The natural adjusted beach slope below mean high water to intersection with the nearshore bottom is expected to be about 1 on 40.

2. The inclusion of a groin system in the plan of improvement, hereinafter discussed, could be expected to operate to reduce the rate of loss of material at the study area, thereby reducing the annual nourishment requirements. It is estimated that the reduction effected would be about 35 percent. Thus, the annual average deficiency of supply of littoral material utilizing a groin system, is estimated to be about 7.8 cubic yards per lineal foot of shore.

3. It is desirable to provide advance nourishment in sufficient quantity and in the proper location to nourish and stabilize the shore prior to the first periodic nourishment operation. The reach of shore between stations 50+00N and 50+00S is considered to be a suitable location for placement of material to act as a feeder beach. The material would be expected to move both north and south from that area. The initial feeder beach volume should be at least that necessary to provide three years of annual nourishment requirements, such requirements being dependent upon whether the plan of improvement consists of beach nourishment alone, or beach nourishment in conjunction with a system of groins. The initial feeder beach volume required is estimated to be 750,000 cubic yards without a groin system and 485,000 cubic yards with groins. Subsequent periodic replenishment

of the feeder beach would be made at the same location, except that localized points in the study area may indicate need for filling in connection with placing material on the feeder beach.

4. Groins. One plan of improvement considered includes a groin system in conjunction with beach nourishment. The function of the groin system would be to compartment the beach and reduce the rate of loss of material out of the area, thereby reducing periodic nourishment requirements. The landward horizontal section of these groins should be at an elevation of 9.5 feet above mean low water, the theoretic beach berm elevation. This corresponds to the berm crest height of existing beaches in adjacent areas possessing exposure characteristics similar to those prevailing at the study area. The horizontal section would extend about 50 feet seaward of the mean-high-water shoreline, from which point the groin would slope downward on a 1-on-40 slope to an elevation of about 2 feet above mean-low-water, a practicable elevation for construction. From this point the groin crest would run horizontally. Since the functional success of these groins does not depend upon interception of the littoral stream it is considered unnecessary for the outer section to extend beyond the 3-foot depth contour.

5. Due to present limited theoretical and empirical indices regarding this particular operation of groins, it is difficult to arrive at reliable estimates of reduction of rate of loss of material from an area, and consequent reduction of periodic nourishment requirements, occasioned by the use of groins. However, investigation of nearby Edisto Beach where beach fill and groins have proven a deterrent to beach erosion; consideration of groin systems recommended for other coastal areas having exposure characteristics similar to that prevailing at the study area; and taking cognizance of assumptions made by other investigators; it is estimated that a system of groins of the foregoing design spaced at 1,000-foot intervals could reasonably be expected to reduce the rate of loss of material out of the area by about 35 percent.

6. Investigation of the rapid losses from the south end of Harbor Island and the north end of Hunting Island, and accretion of the northern portion of Harbor Island, indicates that tidal currents cause northward movement from a nodal zone in the vicinity of Johnson Creek. Under these conditions, a terminal groin about 800 feet long would be required at the north end of Hunting Island to prevent northward losses of beach nourishment material.

7. Construction materials. Preliminary investigation indicates that sand suitable for beach nourishment exists in

sufficient quantity throughout the length and surrounding area of Johnson Creek, located to the rear of the study area. Laboratory analysis of the material showed a median diameter of about 0.17 millimeter and a sorting coefficient of 1.22 which, when compared to the characteristics of the existing beach material, indicates its suitability for beach-building purposes. (See Appendix B.) Estimated beach nourishment volumes for alternative Plans "A" and "B" are tabulated in Table D-1.

8. Groins would be constructed of creosote-treated 12-inch round timber piles, alternately spaced at 5-foot intervals and bolted through 8-inch x 10-inch creosote-treated longitudinal wales to a triple-thickness curtain of 3-inch creosote-treated timber sheet piles with staggered joints. Generally, the piling would be of such length as to extend from the design elevation of the top of the groin to a depth that would result in two-thirds of the total length being below the sand line that would obtain under the most severe erosion expected to occur.

COST ESTIMATES
(1962 basis)

9. General. Cost estimates presented herein are prepared in accordance with provisions of EM 1110-2-1301. Costs presented are for designs on alternative Plans "A" and "B". The detailed cost estimates are shown in Tables D-2 and D-3.

10. Unit costs. Unit costs presented herein are based on current contract unit costs for similar work in this area, and on past experience with related construction in this area.

11. Contingencies. In accordance with established norms for estimates at the survey stage of planning and design, wherein basic data and information are incomplete, an allowance of 15 percent of the estimated construction costs is added for contingencies.

12. Government costs. Factors considered in preparation of the estimate of Government costs to be added to the estimated direct cost of construction include preparation of information for budgetary purposes; preparation of construction plans and specifications; supervision and inspection of construction; and District overhead rates. Engineering and design is estimated at 4 percent of the estimated total construction costs, and supervision and administration is estimated at 8 percent.

13. Annual costs. Estimated average annual costs are shown in Tables D-2 and D-3. The amortization period used is 50 years. The interest rate used for estimation of Government costs is 2-7/8 percent.

14. Federal and non-Federal costs. Results of apportionment of costs between Federal and non-Federal interests are shown in Tables D-2 and D-3. The interest rate used for estimation of non-Federal costs is 4 percent. Costs are apportioned in accordance with the provisions of Public Law 826, 84th Congress, as amended by the River and Harbor Act of 1962.

TABLE D-1

ESTIMATED BEACH NOURISHMENT VOLUMES

PLAN	LOCATION OF FEEDER BEACH	LENGTH OF ERODING SHORE (FT.)	FEEDER BEACH (CY)	ANNUAL NOURISHMENT REQUIREMENT (CY)
A	Sta. 50N to Sta. 50S	18,500	750,000	250,000
B	Sta. 50N to Sta. 50S	18,500	485,000	162,000

TABLE D-2

COST ESTIMATE - PLAN "A"

ITEM	TOTAL			FEDERAL	NON-FEDERAL
	Quantity	Unit Cost	Amount		
Terminal Groin	800 LF	$75.00	$ 60,000		
Advance Nourishment	750,000 CY	0.39	292,500		
SUB-TOTAL			$ 352,500		
Contingencies (15%)			52,875		
TOTAL CONSTRUCTION COST			$ 405,375		
Engineering and Design (4%)			16,215		
SUB-TOTAL			$ 421,590		
Supervision and Administration (8%)			33,710		
TOTAL INVESTMENT			$ 455,300	$ 318,700	$ 136,600
ANNUAL COSTS (10 years)					
Interest (Fed. 2-7/8% - Non-Fed. 4%)			$ 14,627	$ 9,163	$ 5,464
Amortization			3,826	2,931	895
Periodic Nourishment	250,000 CY	0.39	97,500	68,250	29,250
Replacement of Groin (at end of 25 years):					
250 LF @ $75.00 = $18,750; present worth $7,036					
Interest - Non-Fed. 4%			281	--	281
Amortization			47	--	47
TOTAL			$ 116,281	$ 80,344	$ 35,937

TABLE D-2 (Cont'd)

ITEM	TOTAL Quantity	TOTAL Unit Cost	TOTAL Amount	FEDERAL	NON-FEDERAL
ANNUAL COSTS (40 years)					
Interest			$ 14,627	$ 9,163	$ 5,464
Amortization			3,826	2,931	895
Periodic Nourishment			97,500	--	97,500
Replacement of Groin:					
Interest - Non-Fed. 4%			281	--	281
Amortization			47	--	47
TOTAL			$ 116,281	$ 12,094	$ 104,187

RATIO OF BENEFITS TO COST = 1.6

TABLE D-3

COST ESTIMATE - PLAN "B"

ITEM	TOTAL			FEDERAL	NON-FEDERAL
	Quantity	Unit Cost	Amount		
Groins	9,460 LF	$75.00	$ 709,500		
Advance Nourishment	485,000 CY	0.39	189,150		
SUB-TOTAL			$ 898,650		
Contingencies			134,800		
TOTAL CONSTRUCTION COST			$1,033,450		
Engineering and Design (4%)			41,350		
SUB-TOTAL			$1,074,800		
Supervision and Administration (8%)			86,000		
SUB-TOTAL			$1,160,800	$ 812,560	$ 348,240
Interest (Fed. 2-7/8% - Non-Fed. 4%)			37,291	23,361	13,930
TOTAL INVESTMENT			$1,198,091	$ 835,921	$ 362,170
ANNUAL COST (10 years)					
Interest (2-7/8% Fed. - 4% Non-Fed.)			$ 38,520	$ 24,033	$ 14,487
Amortization			10,061	7,689	2,372
Periodic Nourishment	162,000 CY	0.39	63,180	44,226	18,954
Groin Maint. 1% Cost/LF + 15% Cont.			8,160	--	8,160
Replacement of Groin:					
250 LF @ $75.00 = $18,750; present worth $7,036					
Interest Non-Fed. 4%			281	--	281
Amortization			47	--	47
TOTAL			$ 120,249	$ 75,948	$ 44,301

TABLE D-3 (Cont'd)

ITEM	TOTAL			FEDERAL	NON-FEDERAL
	Quantity	Unit Cost	Amount		
ANNUAL COST (40 years)					
Interest			$ 41,310	$ 24,033	$ 14,487
Amortization			9,448	7,689	2,372
Periodic Nourishment			63,180	--	63,180
Groin Maintenance			8,160	--	8,160
Replacement of Groins:					
Interest - Non-Fed. 4%			281	--	281
Amortization			47	--	47
TOTAL			$ 120,249	$ 31,722	$ 88,527

RATIO OF BENEFITS TO COST = 1.5

SURVEY REPORT
ON
COOPERATIVE BEACH EROSION CONTROL STUDY
AT
HUNTING ISLAND BEACH, SOUTH CAROLINA

APPENDIX E
ESTIMATE OF BENEFITS

U. S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

APPENDIX E

ESTIMATE OF BENEFITS

1. Physical damages prevented. The proposed plan of improvement, consisting essentially of beach nourishment, is designed to arrest erosion of the existing shoreline and stabilize the beach. Physical damages preventable under the proposed plan of improvement are (1) losses of land, and (2) damage to existing developments.

a. Loss of land. The area of land which would be lost over the period of evaluation in the absence of the project is estimated on the basis of the historical rate of shore recession at the study area. From study of shoreline changes over the period of record it is estimated that, in the absence of the project, the shoreline will recede at an average annual rate of about 14 feet. Extending this rate over the period of evaluation (50 years) gives a total loss of land of 344 acres, or an average of 7 acres per year. Assigning a value of $8,000 per acre to these lands, which value is commensurate with market values of adjacent lands of similar character, the resulting average annual damage due to loss of land is ($8,000 x 7) $56,000.

b. Damage to developments. Estimates of future losses to existing developments are based upon recession of the shoreline to be expected, during the period of evaluation, in the absence of the project. Recession of shoreline to be expected is, in turn, based upon shoreline changes evidenced by the period of record. It is thus estimated that during the period of evaluation the high-water shoreline will move landward an average distance of about (14 ft/yr x 50 yrs) 700 feet in the absence of remedial measures. Such recession of the shoreline would result in damages to existing developments estimated as follows (Estimate is prepared at current price level for the existing state of development.):

Roads and parking areas	$ 125,000
Water system	15,000
Buildings and structures	402,000
Electric and telephone facilities	65,000
Total	$ 607,000

Average annual estimated damage = $12,000

c. Due to the comparatively rapid rate of shore erosion at the study area and the resulting concern evidenced by users and potential users, it is unlikely that future development will be significant in the absence of the project. Present conditions are not conducive to expenditure of funds for future development, and estimates thereof would be conjectural. Although every effort is apparently being made toward proper and effective maintenance of existing developments, plans of local governmental units and planning bodies are not sufficiently formulated to establish tangible trends toward significant prospective development if suitable protective measures are not undertaken. In view of the foregoing, no probable damage prevention benefits are estimated for prospective development conditions that would occur in the absence of the project.

2. Benefits from increased use of beach. Attendance records of the State Park Director's office show an annual attendance in excess of 300,000 persons at the study area for the years 1960 and 1961, 90 percent (270,000) of these being summer visitors utilizing the beach. Thus a daily average of about 2,700 persons use the beach during the normal beach season, which extends from the last week in May through Labor Day, a period of 14 weeks or 98 days. Peak crowds in excess of 10,000 persons per day use the beach on weekends and holidays. The beach area available for use at high tide consists of narrow segments of strand separated by segments which are completely inundated, which condition discourages attempts to utilize the beach and users must await the outgoing tide. Placement of the 3-year requirement of nourishment material (750,000 C.Y.) on the 10,000-foot reach of shore between stations 50+00N and 50+00S, at 3-year intervals, would, in effect, make additional dry beach width available for public use. Superimposition of the feeder beach volume on the 10,000-foot reach of shore indicates that the additional beach width thus provided would average about 100 feet over the 3-year period. Allowing the desirable area of 75 square feet per person the widened beach will accommodate in excess of 13,000 persons without crowding. The average increased use of such an improved beach is estimated at 2,000 persons per day. The estimated increase in seasonal patronage after improvements, including a factor of 20 percent for inclement weather, is (2,000 x 7 x 14 x 0.80) 157,000 persons. This increased use and its public benefit may be evaluated in terms of fees the patrons would be required to pay if the beach were a private enterprise. An assessment of $0.35 per person per visit is considered reasonable for a private beach comparable to Hunting Island. The improved beach, with free and easy access and basic facilities for safety and comfort, but with incompletely developed appurtenant facilities, should justify a charge of $0.50 per

person per visit. Therefore, the benefit accruing to present users would be $0.15 per visit, while the benefit to additional users would be $0.50 per visit. Thus, the evaluation of total benefits realized by the public from beach improvement, considered in terms of annual attendance and use, is:

157,000 x $0.50	$ 78,500
270,000 x $0.15	40,500
Total recreational benefits	$ 119,000

3. Summary of estimate of benefits.

Average annual land losses prevented	$ 56,000
Average annual damage to development prevented	12,000
Average annual recreational benefits	119,000
Estimated total average annual benefits	$ 187,000

SURVEY REPORT
ON
COOPERATIVE BEACH EROSION CONTROL STUDY
AT
HUNTING ISLAND BEACH, SOUTH CAROLINA

APPENDIX F
STATEMENT OF COOPERATING AGENCY

U. S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

SOUTH CAROLINA

STATE HIGHWAY DEPARTMENT

COLUMBIA

August 27, 1962

Docket 7.341 - Cooperative Study of Beach Erosion on Hunting Island - Beaufort County

Colonel J. R. Thompson, District Engineer
U. S. Army Corp of Engineers
P. O. Box 905
Charleston, S. C.

Dear Colonel Thompson:

This is in reference to a recent telephone conversation with the Department's Assistant Construction Engineer, Salvador LaTorre, and with your Mr. Bell and Mr. Crouse relative to the submission by the Corp of Engineers of a report relating to the above described study.

In addition to the Department's interest in sharing in the performance of any work which may be recommended by the Corp of Engineers as a means of controlling beach erosion at Hunting Island by virtue of the Department's having shared in the cost of making this study, the Department having allotted $11,000.00 for the latter purpose, the South Carolina Highway Department may proceed with beach erosion measures at this location as may be recommended by the Corp of Engineers if funds become available for such work and when funds become available for erosion control work at Hunting Island.

Your cooperation in this matter is greatly appreciated.

Yours very truly,

W. K. Beckham

W. K. Beckham
State Highway Engineer

SURVEY REPORT
ON
COOPERATIVE BEACH EROSION CONTROL STUDY
AT
HUNTING ISLAND BEACH, SOUTH CAROLINA

Attachment 1

Information Called for by
Senate Resolution 148, 85th Congress
Adopted 28 January 1958

U. S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

1. INTRODUCTION

The information in this supplement is furnished in response to Senate Resolution 148, 85th Congress, 1st session, adopted 28 January 1958.

2. PART (1) - PROJECT DESCRIPTION AND ECONOMIC LIFE

The project recommended by the District Engineer would provide a feeder beach, consisting of 750,000 cubic yards of material for advance nourishment, located between stations 50+00N and 50+00S as indicated on Plate 2 of the report; a terminal groin at station 73+00N extending approximately 700 feet seaward from the mean-high-water line; and replenishment of the feeder beach to provide nourishment as required. Current estimate of nourishment requirement is 250,000 cubic yards annually.

The economic life used in project analysis is 50 years.

3. PART (2) - PROJECT COSTS

Construction costs are estimated on the basis of wage rates and price levels prevailing in September 1962. Costs are apportioned between Federal and non-Federal interests in accordance with the provisions of Public Law 826, 84th Congress, as amended by the River and Harbor Act of 1962. Annual charges in the report are based on interest rate of 2.875 percent for the Federal share and 4 percent for the non-Federal share of the total investment, and amortization over a period of 50 years. Project costs and annual charges based on an economic life of 50 years and 100 years are given in Table 1.

4. PART (3) - BENEFIT - COST RATIO

A summary of costs and benefits for the proposed plan of improvement is presented in Table 1. The ratio of annual benefits to annual costs is given for both a 50-year and 100-year project life. Annual costs, consisting of interest on investment, amortization of investment, replacement of protective structure, and periodic beach nourishment, are based on the same classification of cost items as given in the basic report and Appendix D. Benefits are based on the same classification of tangible benefits as presented in the report and Appendix E.

5. PART (4) - UNEVALUATED PROJECT EFFECTS

In addition to tangible benefits considered in the report, certain unevaluated benefits would likely accrue to the project.

The amount of debris upon the beach resulting from shore erosion would be reduced, and sudden and extensive changes in elevation at the location of the present mean-high-water shoreline would be lessened, thereby removing possible hazard to life and limb.

Stabilization of the shoreline would obviate encroachment of the ocean on the wildlife habitat.

No damaging effects, due to the project, are foreseeable.

6. PART (5) - PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR FUTURE NEEDS

Not applicable

7. PART (6) - ALLOCATION OF COSTS

Cost allocation was not necessary in the basic report and is therefore not included in this supplement.

8. PART (7) - EXTENT OF INTEREST IN PROJECT

State and local governmental agencies, local news media, and local individuals have evidenced continuing interest in the study and the consequent proposed plan of improvement. The cooperating agency expresses its willingness and ability to participate in the project, such ability being contingent upon legislative action controlling availability of funds.

9. PART (8) - REPAYMENT SCHEDULES

The required non-Federal share of first costs of construction would be payable as a lump sum prior to the commencement of construction.

10. PART (9) - EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS

No change in the cost of services normally provided by state and local governments is anticipated as a result of the potential project. Some additional tax revenue may be expected to arise from increased patronage of concessions. No taxes would be foregone as a result of construction of the project.

11. PART (10) - PROPOSED INCREASED APPROPRIATIONS FOR BASINWIDE PROJECTS

Not applicable

12. ALTERNATIVE PROJECT

In addition to the recommended plan of improvement, alternative plans considered include (a) a system of groins; a feeder beach; and periodic beach nourishment; and (b) a sand by-passing plant as an alternate method of providing nourishment requirements for the study area. The plan involving a system of groins was not recommended because the annual costs for the groins exceeded the value of annual nourishment reduction. The sand by-passing plan was not recommended since preliminary investigation revealed it to be economically infeasible. Project costs, annual charges, and the ratio of annual benefits to annual costs for the plan involving a system of groins are shown in Table 1.

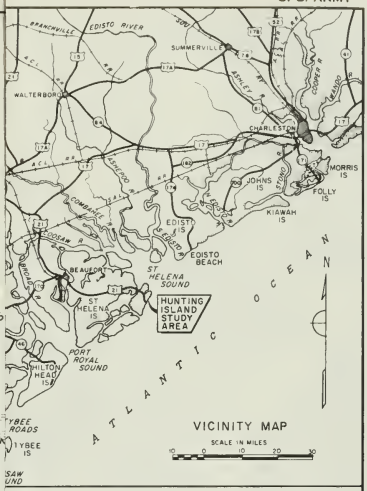
TABLE 1

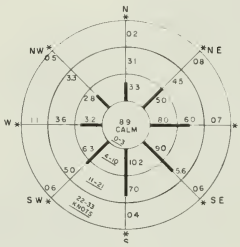
COMPARISON OF PROJECT COSTS AND BENEFITS
50-YEAR AND 100-YEAR ECONOMIC LIFE

	Proposed Project		Alternative Project	
	50-Year	100-Year	50-Year	100-Year
CONSTRUCTION COST	$ 455,300	$ 455,300	$ 1,160,800	$ 1,160,800
Interest during Construction	--	--	37,291	37,291
TOTAL INVESTMENT	$ 455,300	$ 455,300	$ 1,198,091	$ 1,198,091
ANNUAL COSTS				
Interest on Investment	$ 14,627	$ 14,627	$ 38,520	$ 38,520
Amortization of Investment	3,826	683	10,061	1,793
Periodic Nourishment	97,500	97,500	63,180	63,180
Groin Replacement	328	302	328	4,074
Groin Maintenance	--	690	8,160	8,160
TOTAL ANNUAL COSTS	$ 116,281	$ 113,802	$ 120,249	$ 115,727
TOTAL ANNUAL BENEFITS	$ 187,000	$ 187,000	$ 187,000	$ 187,000
RATIO OF BENEFITS TO COSTS	1.61	1.64	1.55	1.62

CORPS OF ENGINEERS

U. S. ARMY





Direction Frequency Bars represent percentage frequency of wind observed from each direction Each circle equals 10%

Speed Frequency Printed figures represent percentage frequency of wind observed from each direction within each speed interval

EXAMPLE 14.7% OF ALL WINDS ARE FROM THE EAST
07.5% OF ALL WINDS ARE FROM THE EAST AT SPEEDS OF 22-33 KNOTS

* Indicates less than 1/2 percent

OFFSHORE SURFACE WINDS

...OURS OF CALM

COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

GENERAL MAP

SCALES AS SHOWN
SHEET NO. 1 OF 2 SHEETS

U.S. ARMY ENGINEER DISTRICT, CHARLESTON, S.C. - 22 MAR 1963

SUBMITTED	RECOMMENDED	APPROVED
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY J.L.C. & R.A.B.
CHECKED BY A.P.C.

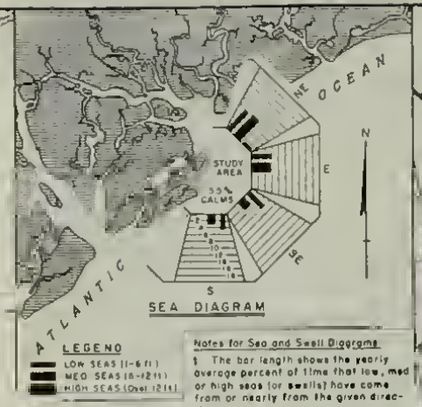
FILE NO. 5856 (1)

PLATE 1

35-620 O-64 (Face p. 64) No. 1

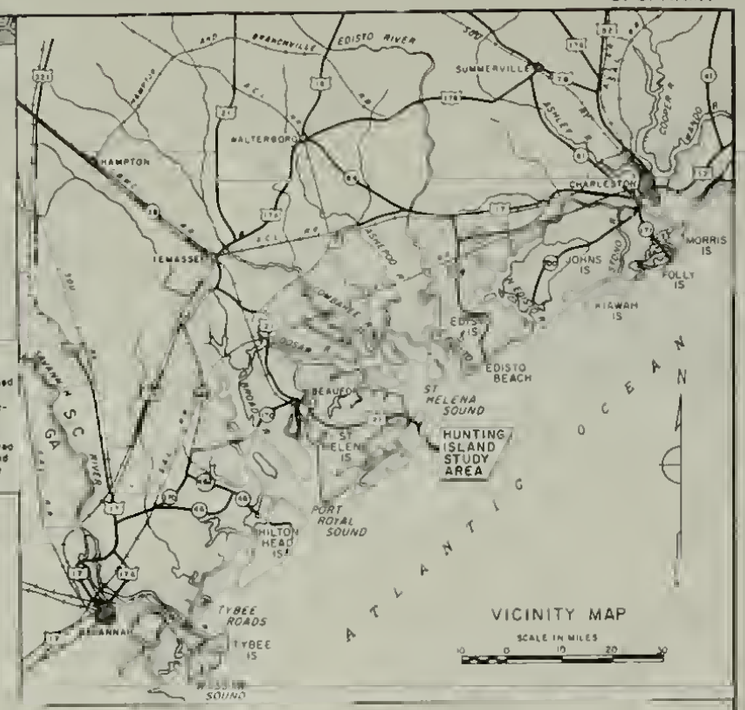
CORPS OF ENGINEERS

U. S. ARMY



Notes for Sea and Swell Diagrams

1. The bar length shows the yearly average percent of time that low, med or high seas (or swells) have come from or nearly from the given direction
2. Data from "1943" Hydrographic Office Sea & Swell Charts for the area lying between latitudes 30° & 35° and between the United States seacoast and longitude 75°



HUNTING ISLAND

SCALE IN FEET

EXAMPLE FOR 1597 HOURS OF AN AVERAGE YEAR WINDS WERE FROM SOUTH AT AN AVERAGE SPEED OF 9 M PH

Note Computed from data by the U S Weather Bureau Charleston South Carolina From January 1, 1951 to December 31, 1958

WIND DIAGRAM 1951-1958

Direction Frequency Bars represent percentage frequency of wind observed from each direction Each circle equals 10%

Speed Frequency Printed figures represent percentage frequency of wind observed from each direction within each speed interval

EXAMPLE 14.7% OF ALL WINDS ARE FROM THE EAST
0.7% OF ALL WINDS ARE FROM THE EAST AT SPEEDS OF 22-33 KNOTS

* Indicates less than 1/2 percent

OFFSHORE SURFACE WINDS

COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

GENERAL MAP

SCALES AS SHOWN

SHEET NO 1 OF 8 SHEETS

U S ARMY ENGINEER DISTRICT, CHARLESTON, S C - 22 MAR 1963

SUBMITTED	RECOMMENDED	APPROVED
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

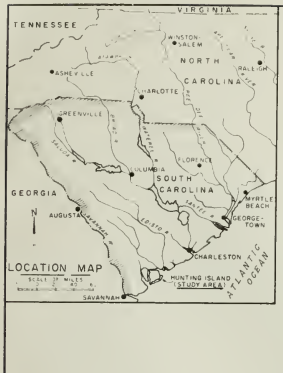
DRAWN BY J L C BRAB
CHECKED BY A P C

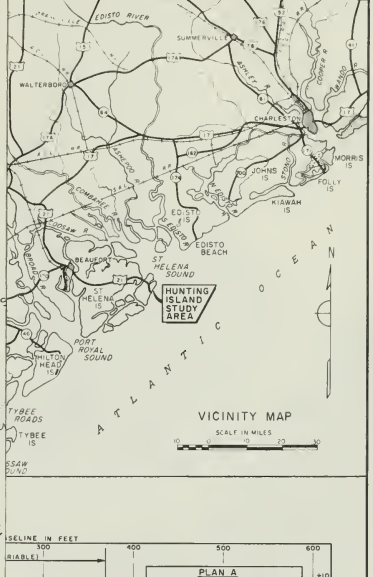
FILE NO 5856(1)

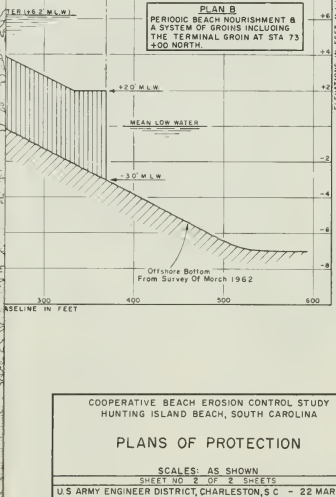
PLATE 1

CORPS OF ENGINEERS

U. S. ARMY







COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

PLANS OF PROTECTION

SCALES: AS SHOWN
SHEET NO. 2 OF 2 SHEETS

U.S ARMY ENGINEER DISTRICT, CHARLESTON, S.C. - 22 MAR 1963

SUBMITTED: H.S. Southward, CHIEF, PLANNING & REPORTS BRANCH

RECOMMENDED: [signature], CHIEF, ENGINEERING DIVISION

APPROVED: [signature], COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY J.L.C. & R.A.B.
CHECKED BY A.P.C.

FILE NO. 5856(2)

PLATE 2

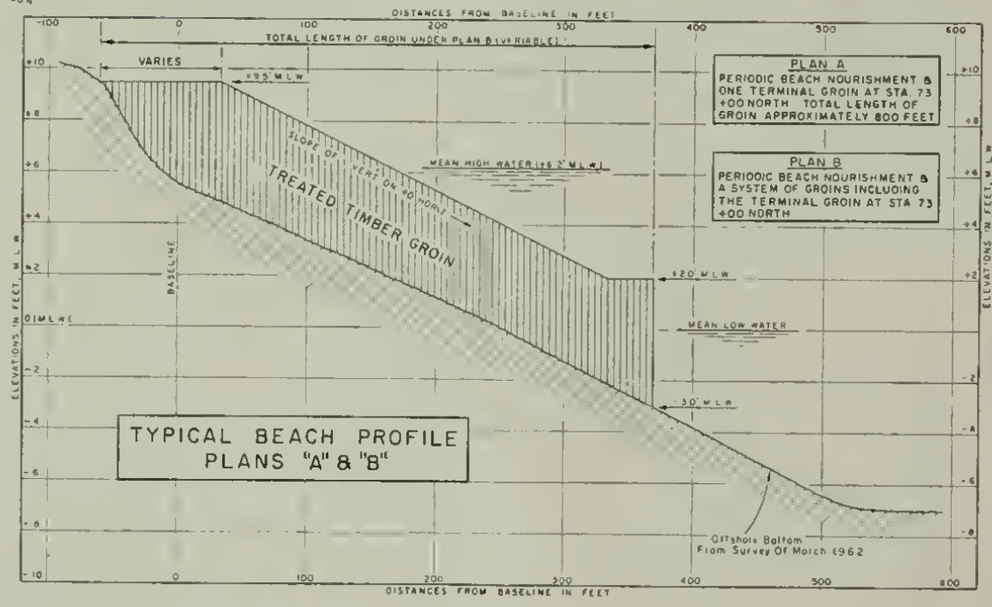
35-620 O-64 (Face p. 64) No. 2

CORPS OF ENGINEERS

U. S. ARMY

HUNTING ISLAND

SCALE IN FEET



• Note
Feeder Beach is included in Protection Plans A & B

COOPERATIVE BEACH EROSION CONTROL STUDY
HUNTING ISLAND BEACH, SOUTH CAROLINA

PLANS OF PROTECTION

SCALES AS SHOWN

SHEET NO. 2 OF 2 SHEETS

U.S. ARMY ENGINEER DISTRICT, CHARLESTON, S.C. — 22 MAR 1963

SUBMITTED	RECOMMENDED	APPROVED
CHIEF PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY J.L.C. & R.A.B.
CHECKED BY A.P.C.

FILE NO 5856(2)

PLATE 2