SHORELINE PROTECTION AND BEACH EROSION CONTROL STUDY

FINAL REPORT: AN ANALYSIS OF THE U.S. ARMY CORPS OF ENGINEERS SHORE PROTECTION PROGRAM

Prepared by

Theodore M. Hillyer
Project Manager

Shoreline Protection and Beach Erosion
Control Task Force
U.S. Army Corps of Engineers

For the

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U.S. Army Institute for Water Resources
Policy and Special Studies Programs

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For further information related to the program, call either:

Dr. Eugene Stakhiv, Chief
Policy and Special Studies Division
703-428-6370

Mr. Kyle E. Schilling, Director
Institute for Water Resources
703-428-8015

Department of the Army Corps of Engineers
Water Resources Support Center
Institute for Water Resources
Casey Building, 7701 Telegraph Road
Alexandria, VA 22315-3868

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PREFACE

This report presents the findings of a task force review of the U.S. Army Corps of Engineers Shoreline Protection and Beach Erosion Control Program. The assessment of the program was in response to Fiscal Year 1994 "Passback Language" from the Office of Management and Budget. The report responds to concerns about the shoreline protection program, particularly concerning costs, benefits, environmental effects and the related influences on shoreline development.

The study was performed in two phases. The initial phase was completed in January 1994 and published as IWR Report 94-PS-1, Shoreline Protection and Beach Erosion Control Study, Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers. The purpose of the first phase report was to provide early input to the Office of the Management and Budget regarding the scope and cost of Federal Civil Works shore protection.

This second and final phase of the study incorporates: additional analysis of project costs and sand emplacements; and overview of risk management in the coastal zone; a comparison of actual versus anticipated benefits; a discussion on environmental considerations; and an analysis of any induced development effects associated with the Federal shore protection and beach erosion control program. Also, included is a summary of study findings and conclusions.

The basis of this report and the data compiled by the task force reflects conditions as of 1 July 1993. Subsequent to completion of the final draft report in June 1995, certain of the data were updated to reflect costs and status of projects and studies as of October 1995. This update is reflected in Chapter 4, Paragraph I "Addendum." As appropriate, the Executive Summary and Chapters 1 and 8 also reflect this update.

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ACKNOWLEDGMENTS

In recognition of the importance of the request for information by the Office of Management and Budget, a task force of U.S. Army Corps of Engineers personnel and consultants with significant shore protection expertise was established to guide the effort and provide relevant information. The task force was established under the guidance and leadership of the Policy Development Branch, Policy Review and Analysis Division, Directorate of Civil Works. Mr. Harry Shoudy and Mr. Donald Barnes served as task force chairmen during the course of the study. While there was some change during the course of the study, the original members of the Task Force are listed below.

Headquarters	Harry Shoudy
	Donald Barnes
	John Housley
	Bill Hunt
	John Lockhart
North Atlantic Division	Edgar Lawson
New York District	Lynn Bocamazo
Philadelphia District	Christine Montoney
South Atlantic Division	Gerald Melton
Wilmington District	Tom Jarrett
Jacksonville District	David Schmidt
Waterways Experiment Station	Joan Pope
Institute for Water Resources	Eugene Stakhiv
	Mike Krouse
	Ted Hillyer
	Anne Sudar
	Lim Vallianos

The U.S. Army Institute for Water Resources was assigned to provide technical and management support to the task force. The staff of the Policy and Special Studies Division of the Institute for Water Resources provided the technical assistance, data collection and analysis for the Task Force. Mr. Ted Hillyer was project manager, assisted by Ms. Anne Sudar and Mr. Lim Vallianos. Dr. Eugene Stakhiv directed the effort as Chief of the Policy and Special Studies Division. The Director of the Institute for Water Resources is Mr. Kyle Schilling.

ACKNOWLEDGEMENTS

In order to support the Shoreline Protection Task Force in the area of induced development, a subcommittee of the following additional members was established.

New York District	Pete Womack
Norfolk District	Mark Mansfied
Wilmington District	William Niesen
Jacksonville District	April Perry
Institute for Water Resources	David Moser
	David Hill
Consultants	
(George Washington University)	Dr. Tony Yezer
	Dr. Joe Cordes

In addition to the individuals participating on the task forces, contributions were made by the following Corps of Engineers personnel:

Headquarters	Bob Daniel
North Atlantic Division	Nahor Johnson
Baltimore District	John Van Fossen
Charleston District	Larry Casbeel
Savannah District	Martin Cooley
Mobile District	Cheryl Ulrich
Lower Mississippi Valley Division	Lexine Cool
New Orleans District	Jay Combe
Galveston District	Sheridan Willey
	Sid Tanner
North Central Division	Charles Johnson
Buffalo District	Tom Bender
	Michael Mohr
Chicago District	Anne Smith
Detroit District	Carla Fisher
North Pacific Division	Dennis Wagner
Alaska District	Stan Brust
South Pacific Division	Hugh Converse
Los Angeles District	Jim Hutchison
Pacific Ocean Division	George Young
Waterways Experiment Station	Dave Nelson
Institute for Water Resources	Theresa Alafita
	Christian Arellano
	John Crumm
	Richard Hartmann

A. INTRODUCTION

This report represents the integrated results of a two-phase study performed by the U.S. Army Corps of Engineers (Corps) in response to a March 1993 request by the Office of Management and Budget for the Army to analyze the effectiveness of the Federally sponsored shore protection program. The first phase effort defined the scope of the Federal shore protection program, including a comparison of actual and estimated quantities of sand used in the restoration and subsequent nourishment of projects, a comparison of actual and estimated project costs, and a projection of future costs. This Phase I effort was published in January 1994 as IWR Report 94-PS-1, Shoreline Protection and Beach Erosion Control Study, Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers. The second phase effort focused on benefits of the shore protection program, the associated environmental effects, and the question of whether or not shore protection projects induce development in coastal areas. It also refined the analysis on project costs and analyzed Federal programs that are involved in risk management in the coastal zone. The basis of this report is a June 1993 survey of Corps divisions and districts and, except as noted, the data presented herein is current as of 1 July 1993. There is no funding mechanism to maintain a national data base of Federal shore protection projects.

B. FINDINGS AND CONCLUSIONS

The findings and conclusions are organized into the following six paragraphs; comparison of projects costs, comparison of sand quantities, benefit analysis, analysis of induced development, level of protection, and environmental effects.

1. Comparison of Project Costs

> **Conclusion:** From a cost performance standpoint, the shore protection program has been effectively managed, considering the highly variable environment, with total program costs being slightly less than estimated.

Finding: The Corps has constructed 82 specifically authorized shore protection projects. Of these 82 projects, 26 were authorized in the 1950s and 1960s and were deleted from detailed comparison because: they were small in scope and cost; would have been included in the Continuing Authorities Program, had it been in effect at that time; or, there was insufficient data available. The analysis focused on the remaining 56 large projects protecting a total shoreline distance of about 210 miles. The cumulative funds expended between 1950 and 1993 on these 56 large shore protection projects have been $670.2 million, with the Federal share of $403.2 million. These actual expenditures were adjusted to 1993 price levels.

The procedure used for this adjustment involved the volumes of sand placed and the current cost in each area for obtaining, transporting, and placing the sand at the respective project sites. Structural costs were adjusted by means of the Engineering News Record Construction Cost Index. When adjusted to 1993 price levels, these Federal and total costs are, respectively, $881.0 million and $1,489.5 million. If all project costs were adjusted using only the Construction Cost Index, the total cost in 1993 dollars would be $1,177.3 million. These expenditures are shown below, disaggregated by type of protective measure.

Total Expenditures Adjusted to 1993 Prices, Shore Protection Program (1950-1993)

Type of Measure	Federal Cost ($ million)	Federal Share (%)	Total Cost ($ million)
Initial Beach Restoration	426.0	58.3	730.4
Periodic Beach Nourishment	270.9	64.4	420.4
Structures	153.9	49.9	308.5
Emergency Measures	30.2	100.0	30.2
Total	881.0	59.1	1,489.5

Expected future expenditures associated with these 56 constructed projects are $505.3 million in 1993 dollars. These expenditures will be spread over approximately the next 50 years, until their individual project authorizations expire. If it is assumed that all authorizations are extended until the year 2050, the future Federal expenditure would be about $880 million in 1993 dollars, or about $17 million per year, and the total expenditure would be about $1,500 million in 1993 dollars, or about $30 million per year.

An update of these costs to 1995 dollars was performed by assuming a 3 percent inflation factor for both 1994 and 1995. In this computation, the total cost becomes $1,580.2 million in 1995 dollars. Next, assuming a $30 million yearly cost (in 1993 dollars), for both 1994 and 1995, the total program cost, adjusted to 1995 dollars, becomes $1,642.9 million. This extension of total program costs to 1995 is summarized below.

Total Actual Expenditures for 56 Large Projects 1950-1995

Item	**1950-1993 $ million**	**Δ 94 [1] $ million**	**Δ 95 [1] $ million**	**Total 1995 $ million**
56 large constructed projects	1,489.5	44.7	46.0	1,580.2
Future costs [2]		30.9	31.8	62.7
Total	1,489.5	75.6	77.8	1,642.9

Footnotes:
[1] Assumes a 3 percent inflation factor per year for 1994 and 1995.
[2] Assumes a $30 million per year cost in 1993 dollars.

At the time of the 1993 survey there were 26 projects which were listed as under construction, authorized/awaiting initiation of construction, or in the preconstruction engineering and design stage Total expenditures over a 50-year period for these potential projects are estimated at $2,055.3 million 1993 dollars. Based on current cost sharing of 65 percent Federal, the Federal share of this expense would be $1,259.2 million. The 1995 update of these categories showed a total of 31 projects with a total cost of $3,316.1 million in 1995 dollars and a Federal cost of $2,195.5 million in 1995 dollars. For this Federal cost, the actual projected cost sharing formula was used. The actual Federal share varied from a low of 13 percent to a high of 100 percent. The actual average Federal share was 66 percent.

When comparing actual costs with the preconstruction estimates for the 56 constructed projects, certain projects could not be included in the totals due to the unavailability of complete cost data or because the constructed project differed significantly from that envisioned at the time of the preconstruction estimate. Thus, while 49 of the 56 projects involve initial beach restoration, only 40 could be compared. The following table shows actual costs and estimated costs at the program level.

Comparison of Actual to Estimated Costs at the Program Level - by Type of Construction Measure

Type of Measure	Number of Projects Included In Totals	Actual Cost ($ million 1993)	Estimated Cost ($ million 1993)	Percent Difference Between Actual and Estimate
Initial Restoration	40	652.4	660.0	(-) 1
Periodic Beach Nourishment	33	389.9	431.6	(-) 10
Structures	35	298.6	311.4	(-) 4
Total		1,340.9	1,403.0	(-) 4

At the individual project level, there was considerably more variation between actual costs and estimates, but the data revealed that nearly equal numbers of projects had underestimated costs as had over estimated costs. Project cost performance was better for large projects (costs greater than $50 million) than for small (under $10 million) and medium projects. Performance was also generally better for more recent projects than for those designed and constructed 20 or more years ago.

2. Comparison of Sand Quantities

Finding: Beach fill projects were also assessed in terms of the quantity of sand placed, a yardstick independent of such factors as price levels and inflation. Of the 56 projects included in this study, 49 involved initial beach restoration and 40 involved periodic nourishment. The total sand volume placed for these projects was 189.7 million cubic yards (110.6 million cubic yards for initial restoration and 79.1 million cubic yards for periodic nourishment). As with the comparison of costs, the analysis was restricted to those projects having adequate detail on both the estimated and the actual quantify of sand used over time. The results of the analysis are shown in the following table. While initial restoration sand quantities were very close to the estimates, periodic nourishment sand volumes exceed estimates by 12 percent. For the program as a whole, actual volumes of sand were 5 percent higher than estimated, even though total costs were slightly lower.

Conclusion: From the standpoint of estimated sand volume emplacement, the shore protection program has performed well within acceptable limits, considering the highly variable and dynamic nature of coastal shorelines, with overall quantities being slightly more than estimated.

Comparison of Actual to Estimated Volumes of Sand at The Program Level - by Type of Construction Measure

Type of Measure	Number of Projects Included in Totals	Actual Volume of Sand (million cu. yds.)	Estimated Volume of Sand (million cu. yds.)	Percent Difference Between Actual and Estimated
Initial Restoration	39	94.5	93.7	(+) 1
Periodic Beach Nourishment	33	72.5	64.7	(+) 12
Total		167.0	158.4	(+) 5

At the individual project level, there was considerable variation in the percentage differences between actual and estimated quantities of sand, and the data reflected that projects were almost evenly split between overestimated and underestimated sand volumes. Small projects received, on average, 8 percent less sand than estimated, medium projects received, on the average, 34 percent more sand than estimated, and large projects required, on average 4 percent less than estimated.

3. Benefit Analysis

Finding: Benefits of shore protection projects fall into three major categories; storm damage reduction, recreation, and other. Projects designed and evaluated prior to 1964 contained significant proportions of both storm damage reduction benefits and recreation benefits. From 1965 to 1979, most projects were justified primarily on the basis of recreation benefits, while storm damage benefits were not evaluated in detail. During the 1980s a reversal occurred as a consequence of changes in

Administration budgetary priorities and in the new project formulation rules of the Water Resources Development of 1986. The result of these changes was to establish hurricane and storm damage reduction as the basis for Federal participation in shore protection projects. As a result, the typical 1990s shore protection project has 73 percent of its benefits in the storm damage reduction category and 26 percent in the recreation category.

Conclusion: The major benefit of shore protection projects is the reduction of storm damages, with recreation benefits comprising a significant proportion of total benefits. Tracking actual benefits of shore protection projects is difficult. Historically, funding has not been provided to perform post-storm surveys of beach nourishment areas. Therefore, Corps districts have been unable to measure project performance of completed projects.

In contrast to the actual cost of a project, "actual benefits" cannot be directly measured, and must be derived from economic models because of the stochastic nature of storms. Eleven projects were selected which had such models available and, in most cases, had several years of operating data. The storm damage reduction benefit comparison for these 11 projects is summarized below.

Storm Damage Reduction (Sdr) Benefits Comparison For 11 Projects

Category	Number of Projects	Average Years Projects Have Been in Place	Average Actual SDR Benefit (avg. annual $ million)	Average Predicted SDR Benefit (avg. annual $ million)	Average Percent Difference Between Actual and Predicted
Actual SDR Benefits Higher	6	12.2	9.2	5.6	+ 92
Actual SDR Benefits Lower	5	20.8	2.2	4.4	- 54

Of the 11 projects evaluated, six had actual storm damage benefits higher than expected and five had actual storm damage benefits lower than expected. Projects which had storm damage benefits higher than expected tended to have experienced several severe storms. Some projects have simply not been subject to severe storms and, hence, have not been able to demonstrate their damage prevention capabilities.

4. Analysis of Induced Development

Finding: Economic theory suggests that shore protection projects have the potential to generate different types of induced development including: additional development that increases total beach development; relocated development that shifts to the shore from more protected inland locations;

Conclusion: Corps projects have been found to have no measurable effect on development, and it appears that Corps activity has little effect on the relocation and/or construction decisions of developers, homeowners, or housing investors.

and relocated development that moves from unprotected beachfront areas to the newly protected area. If induced development relocated from unprotected beachfront areas is significant, then development is likely moving from areas where expected damage is high to those where it is low. This type of relocated development results in a "bonus" of extra reduction in expected damage beyond that which would be calculated based on the initial level of development in the protected area. It also serves to justify even more beach protection and a higher "level of protection."

The theory was tested and empirical research carried out in conjunction with this study on induced development in coastline areas including a survey of residents and two econometric studies of beachfront development. The following findings can be drawn from this work.

a. There is limited public awareness; of the Federal shore protection program, where Federal projects currently exist, and that the Corps has been involved in reducing risks through project construction.

b. The presence of a Corps project has little effect on new housing production. The econometric results presented imply that general economic growth of inland communities is sufficient by itself to drive residential development of beachfront areas at a rapid pace. The statistical evidence indicates that the effect of the Corps on induced development is, at most, insignificant, compared to the general forces of economic growth which are stimulating development in these areas, many of which are induced through other municipal infrastructure developments such as roads, wastewater treatment facilities, etc.

c. The results presented for beachfront housing price appreciation are consistent with the findings from the more general econometric model of real estate development in beachfront communities. The increasing demand for beachfront development can be directed related to the economic growth occurring in inland areas. There is no observable significant effect on the differential between price appreciation in inland and beachfront areas due to Corps activity. The housing price study could not demonstrate that Corps shore protection projects influence development. Corps activity typically follows significant development.

5. Level of Protection

Finding: The term "level of protection" is generally accepted by the public because of its longstanding usage by the Corps and other water resources agencies for inland flood damage reduction projects and because it is a simple way of describing the magnitude of a storm or flood event (wind, waves, storm surge height, etc.). Hence, a specific numerical measure of level of protection for shore protection is difficult to estimate since the return periods (recurrence intervals) are assigned to each measurable characteristic of a storm including maximum winds, radius of maximum winds, pressure deficits, track of the storm and duration.

> **Conclusion:** The Corps currently uses a number of approaches for developing design storm events. The seleced approach is based on project scope, availablility of data, and level of resources. Therefore, the term "level of protection" is not appropriate for a shore protecion project; instead, a set of design storm events is used to evaluate the cost effectiveness of design alternatives. Projects are designed to perform under a continuum of different conditions.

6. Environmental Effects

Finding: Beaches lost to natural erosion, as well as beaches that are protected through a variety of structural measures (both hard and soft), have associated environmental changes. Most fishes and other motile nearshore animals have the ability to migrate from a disturbed environment. Marine bottom communities on most high-energy beaches recover rapidly when disturbed, although recovery rates may be slower for more sensitive and slower reproducing taxa, for animals covered by increased sediment depth, for greater changes in particle size, and for nourishment projects in colder climates. Selected marine organisms such as oysters, clams, sea grasses, mangroves, and corals are particularly sensitive to excessive turbidity, sedimentation, and direct physical alteration. Sea turtles can be affected by burial of their nests and by compaction of sand on their nesting beaches.

> **Conclusion:** Beach restoration and periodic nourishment is the most environmentally desirable shore protection alternative.

These environmental and biological changes caused by shoreline protection activity can be mitigated by selection of certain management practices. A suction dredge without a cutter head has less potential for inducing physical damage and turbidity. Borrow material is selected to match the existing beach, and is place in the intertidal area during fall and winter to avoid sea turtle nesting disruptions. When finer material must be used, it is overfilled with a layer of medium-coarse sand. Compacted sand is softened by tilling the beach. Blowing sand is stabilized by using dune plantings. All Corps studies and projects go through extensive coordination with Federal, state, and local agencies to assure that all environmental concerns are addressed. The impacts of construction activities associated with hard shore protection structures are similar to the impacts of other land-based construction activities. The primary long-term impacts of hard structural projects are associated with their effect on shore processes.

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A. AUTHORITY

This report has been prepared in response to the Fiscal Year 1994 budget "Passback Language" from the Office of Management and Budget. In the passback, the Office of Management and Budget requested that the Army initiate a shoreline protection and beach erosion study. Specifically, it was requested that:

> *"Army should conduct an analysis of the economic and environmental effectiveness of storm damage protection projects. The study should seek to compare and contrast the estimates of project benefits, costs, and environmental effects with current and projected conditions. The study should include a comparison of the anticipated and actual level of protection as well as an analysis of any induced development effects. The Office of Management and Budget should be consulted throughout the study process."*

B. PLAN OF STUDY

This investigation applies to all Congressionally authorized or Federally sponsored studies and projects for shoreline storm damage protection and beach erosion control within the related program administered by the U.S. Army Corps of Engineers (Corps). Included are all beach nourishment projects (with and without groins) and sand bypassing operations as well as any other hard structures (seawalls, breakwaters, groins, etc.) that were designed for shore protection and/or storm damage reduction. The study was completed in two phases. The Phase I effort concentrated on gathering information related to project costs; i.e., the past and future Federal and non-Federal funding commitments for the shore protection program. The first phase also examined the locations and types of shore protection projects being constructed and studied the miles of shoreline being protected by those projects. Data for this effort was collected through a comprehensive questionnaire (Appendix A) completed by the 22 Corps division and district offices having shore protection responsibilities. The information on Corps projects and studies listed in this report is based on the results of this questionnaire. Subsequent to completion of the final draft report in June 1995, certain limited data were updated to reflect October 1995 conditions. Accordingly, except as noted, all data in the report is current as of 1 July 1993. The first phase effort was published in a January 1994 report entitled Shoreline Protection and Beach Erosion Control Study, Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers. The second stage effort concentrated on an analysis of risk management in the coastal zone; additional analysis of costs; a comparison of anticipated and actual benefits of the projects; an analysis of any induced development effects; environmental aspects of shore protection projects; and findings, conclusions and recommendations. This final report integrates information contained in the Phase I Report as well as all of the information developed in Phase II.

C. TASK FORCE

1. Shoreline Protection and Beach Erosion Control Task Force. A 15 member task force comprised of experts in shore protection from the U.S. Army Corps of Engineers Headquarters (HQUSACE), the North Atlantic and South Atlantic Division and District offices, the Waterways Experiment Station, and the Water Resources Support Center, (Appendix B) was established to assist in this study effort. The task force was chaired by the Policy Development Branch of the Policy Review and Analysis Division of the Directorate of Civil Works, HQUSACE. The task force was formed to assist in the development of the detailed questionnaire, collection of cost data, refinement of benefit assessment and induced development methodologies, selection of projects for detailed review, provision of data and analyses of the effectiveness of storm damage protection projects, analysis of induced development effects of projects, and to meet on an as-needed basis to coordinate and review the effort. The task force met on three occasions in 1993 (2-3 June, 9-11 August, and 4-5 November) and also on three occasions in 1994 (9-10 February, 11-12 May and 12-13 October). All of the meetings were held at the Water Resource Support Center, Alexandria, Virginia except for the February 1994 meeting which was held in Jacksonville, Florida.

2. Subcommittee on Induced Development. A subcommittee of Corps personnel was formed to assist the main task force in the area of induced development. This subcommittee (Appendix B) met on two occasions; in Jacksonville, Florida on 6 January 1994 and at the Water Resources Support Center, Alexandria, Virginia on 17 March 1994. The subcommittee on induced development also reviewed the efforts of contractors hired to assist in the effort.

D. BRIEFINGS

Briefings of the Acting Assistant Secretary of the Army for Civil Works (ASA(CW)) and the Office of Management and Budget (OMB) occurred periodically over the course of the study. In 1993, there were three briefings of the Acting ASA(CW). These were on the first phase effort and occurred on 7 May, 21 September, and 10 November. There were also two briefings in 1993 of OMB on the Phase I Report. These occurred on 1 June and on 23 December. Upon completion of the final report, the Acting ASA(CW) was briefed on 1 August 1995 and OMB on 30 August 1995.

E. REPORT SUMMARY

A brief summary of this report is contained in the following paragraphs.

Chapter 2 describes how the shore protection program of the Corps has evolved over the years in direct response to devastating coastal storms and subsequent Federal legislation. The chapter also shows that the Federal shore protection program is minor with respect to the nation's critically eroding shoreline. The different types of project purposes and project features of the shore protection program are described. Because of the minor cost and benefit impacts within the overall Federal shore protection program, coverage of the projects within the Continuing Authorities Program and the Small Scope Specifically Authorized Projects, is confined to Chapter 2. Finally, the operation, maintenance, and monitoring aspects of shore protection projects are covered in this chapter.

Chapter 3 presents the demographics of the coastal zone and a general overview of all the major Federal programs involved in risk management in the coastal zone. Included in this chapter are; a detailed overview of the planning and economic evaluation principles and practices that guide the Corps planning studies for shore protection projects, discussions of the term "level of protection" and how this term in shore protection projects differs from the same term in inland flood control projects, the engineering aspects of beach fill and nourishment, and the impacts on shoreline projects of climate change and sea level rise.

Chapter 4 gets to the heart of the Corps shore protection program through a detailed analysis of project costs and quantities of sand used in beach nourishment projects. Project costs are first provided "as built" and then updated to 1993 price levels. A discussion of the unique "current cost of sand" method of updating the cost of beach nourishment and restoration is described. Comparisons are made between estimated costs and actual costs by project and by type of construction measure, i.e.; initial restoration, periodic, and structures. A statistical analysis at the program level and by project size is also presented in this chapter. Realizing that many factors are present in trying to update costs, a comparison of actual versus estimated sand placement was also made and is presented in this chapter. Comparisons similar to those made for costs are made for quantities of sand. And finally, the future cost of the Federal shore protection program is discussed in terms of presently completed projects as well as those that are authorized awaiting construction and those in the preconstruction engineering and design stage. An addendum has been added to Chapter 4 to incorporate the data collected in October 1995.

Chapter 5 presents the types of benefits attributed to shore protection projects and the benefit estimation procedure. Expected average annual benefits of each of the projects are given. Because Corps shore protection projects are not, in general, examined in detail for after storm benefits (as are inland flood control projects) very little is know about "actual" benefits. What "actual" benefits are shown, are developed through modeling efforts. The "actual" benefits of 11 shore protection projects are discussed in some detail.

Chapter 6 addresses the economic relation between Federally sponsored shore protection projects and development patterns in coastal areas. The chapter is based on a research study undertaken to ascertain whether or not Federally sponsored shore protection projects increase the rate and extent of development in protected areas, i.e., induce development. Sections are provided on economic theory, a survey of beachfront community residents, an econometric model of beachfront development, and an econometric analysis of beachfront housing prices.

Chapter 7 provides a discussion of the environmental considerations for shore protection projects. This chapter outlines the major legislation that supports Federal interest in environmental considerations in shore protection projects, and the environmental considerations for both protective beaches and dunes as well as hard structures and for nonstructural alternatives. The environmental considerations for specific projects are given for several case studies.

Chapter 8 presents study findings and conclusions.

CHAPTER 2 - DESCRIPTION OF THE U.S. ARMY CORPS OF ENGINEERS SHORE PROTECTION PROGRAM

A. FEDERAL INTEREST IN SHORE PROTECTION

1. The Coastal Zone. The shore is a dynamic environment which naturally erodes and accretes over time. The processes that shape the shoreline are extremely complex and diverse and are influenced by waves, currents, wind, and sea level change. As described in Box 2-1, a naturally shaped sand beach is composed of four areas; a nearshore, a foreshore, a backshore, and dunes. (Also see Figure 7-1).

Box 2-1

THE COASTAL ZONE

Area	Description
Nearshore	The nearshore extends from the depth of closure beyond which there is no measured sand movement landward to the ordinary low-water elevation. Littoral currents driven by wind, waves, and tides shape this portion of the natural beach profile.
Foreshore	The foreshore is defined as that part of the beach between the ordinary low-water mark and the upper limit of wave wash at high tide. This area of the beach is ordinarily traversed by the uprush and backrush of waves as the tides rise and fall.
Backshore	The backshore is the part of the shore acted upon by waves only during severe storms, especially when combined with exceptionally high water or storm surge. The backshore is composed of berms. A berm is a nearly horizontal part of the beach formed by the deposit of material by wave action. Some beaches have no berms, others have one or several.
Dune	In many cases a dune is formed behind the berm. A dune is a mound of wind-blown sand, generally in long ridges paralleling the shore and usually above the level of moderate storm waves.

Because of the natural attraction of the seashore, in many areas development has destroyed the natural setting by building too close to the shoreline. In other areas, development that may have been constructed a prudent distance from the shoreline is now threatened by continuing erosion and shoreline recession. During storms, this envelopment is subject to damages that can result in loss of life. People have historically migrated to the shore in increasing numbers, thereby increasing the demand for building protective structures and/or trying to replenish the eroded beaches. This chapter of the report provides a background of the shoreline and beach erosion control program of the U.S. Army Corps of Engineers (Corps).

2. Early History.

a. Interest in shore protection began in New Jersey in the latter part of the 19th century and in the early decades of the 20th century. This stemmed primarily from two factors. The first was that the New Jersey shoreline, being within easy reach of the burgeoning populations of New York City and Philadelphia, was the first to experience intense barrier island development. The second factor was that, during the period of 1915 to 1921, there was intense storm and hurricane activity. During this period, three hurricanes and four tropical storms passed within several hundred nautical miles of the coasts of New Jersey and New York. Although these were not land falling storms[1][1], considerable beach erosion occurred as a result. Millions of dollars were spent in New Jersey on uncoordinated and often totally inappropriate erosion control structures which often produced results that were minimally effective and in some cases, counterproductive. It was soon realized that the efforts of individual property owners were incapable of coping with the problem of coastal erosion and that a broader-based approach was necessary[2].

b. In addition to the storms affecting the New Jersey shoreline, 14 hurricanes made landfall in the United States from 1911 to 1920. The period from 1915 to 1919 was particularly severe, with four category 3 hurricanes and three category 4 hurricanes (see Table 2-1 for a partial "Saffir/Simpson" hurricane scale). The states of Mississippi, Alabama, Texas, Louisiana and Florida were particularly hard hit. The 1919 hurricane was particularly severe, with a barometric pressure of 27.37 inches, which, until 1935, was the most severe storm of record. The 1919 hurricane caused between 600-900 deaths in the United States[3]. Today, this storm still ranks as the third most severe storm of record behind the 1935 "Labor Day" hurricane and Hurricane Andrew in 1992. Hurricane Andrew is listed as "severe" in terms of dollars and loss of life inland; however, there was little damage in the coastal region.

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[1] Numbers in brackets "[ ]" refer to reference numbers. References for Chapter 2 are at the end of the Chapter.

c. In response to the increasing problems of coastal erosion, the New Jersey legislature, in 1922, appropriated money to form an engineering advisory board to study the changes taking place along the state's coastline. At about the same time, a Committee on Shoreline Studies was formed under the Division of Geology and Geography of the National Research Council in Washington, D.C. An outcome of the groups' activities in shore erosion matters was the formation of the American Shore and Beach Preservation Association (ASBPA). An early objective of this association was to persuade the states to accept responsibility for their beaches. However, in 1926, within a year of its formation, the association was lobbying to have the Federal government assume the function of unifying and coordinating the efforts of states with regard to shoreline erosion problems.

Table 2-1 The SAFFIR/SIMPSON Hurricane Scale

Scale No. 1 - Winds of 74 to 95 miles per hour. Storm surge of 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft exposed, anchorage torn from moorings.

Scale No. 2 - Winds of 96 to 110 miles per hour. Storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours prior to arrival of hurricane center. Considerable damage to piers. Marinas flooded. Evacuation of some shoreline and low-lying inland areas required.

Scale No. 3 - Winds of 111 to 130 miles per hour. Storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed. Larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

Scale No. 4 - Winds of 131 to 155 miles per hour. Storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required and of single-story residences on low ground within 2 miles of shore.

Scale No. 5 - Winds greater than 155 miles per hour. Storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escaped routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

d. The period between 1921 and 1930 saw continued intense hurricane activity, with 13 land falling storms, including two category 3 hurricanes and two category 4 hurricanes. Nine of the 13 storms in this period affected Florida. Both category 4 storms, the September 1926 and September 1928 hurricanes caused widespread damage and deaths in Florida. The 1928 hurricane caused 1,836 deaths, ranking it as the second most deadly storm in the United States. It is the fourth most intense storm on record, with a barometric pressure of 27.43 inches[1]. As a result of the severe hurricane activity and resulting death and destruction, as well as to the lobbying efforts of the ASBPA, Congress enacted PL 71-520 in 1930. This 1930 law authorized the Corps to study (but not construct) shore protection measures in cooperation with state governments. The cost sharing was established at the discretion of the Corps (not legislated). Congress also established the Beach Erosion Board, consisting of four officers of the Corps and three civilian engineers to provide technical assistance. This was the first Federal involvement in shoreline protection activities. Cost sharing in studies was subsequently changed to 1/3 Federal and 2/3 non-Federal by a 1946 amendment. The same cost sharing formula was authorized for construction (but not maintenance) in 1956 amendments.

e. The 1930 law, as amended, established the overall program in which the Congress authorized Federal participation to prevent or control shore erosion caused by wind and tide-generated waves and currents along the Nation's coasts and shores, and to prevent damage to property and loss of life from hurricanes and storm flooding. Participation includes research and development, planning, design, construction management and Federal cost sharing. Throughout the evolution of this Federal program, the responsibility for executing the program has been vested in the Secretary of the Army acting through the Chief of Engineers.

f. During the 1930s, ten major hurricanes struck the coastal states: four along the Texas, Louisiana, Florida coasts; three just in Florida; two along the mid-Atlantic seaboard; and one in the New York-New England area. Two of these storms rank among the most severe in terms of loss of life in the Nation's history. The "Labor Day" storm which hit southern Florida in 1935 caused 408 deaths. The September 1938 storm caused 600 deaths in the Long Island, New York and southern New England area[3]. The Federal involvement in shore protection throughout the 1930s was essentially limited to cooperative analyses, planning studies and technical advisory services. These planning efforts were cost-shared between Federal and non-Federal interests. With the onset of the Second World War, the involvement of the Corps of Engineers in shore protection studies virtually ended as its resources were fully committed to the war effort.

3. Evolution of U.S. Army Corps of Engineers Program.

a. Following World War II, the shoreline protection program of the Corps was expanded and consolidated through a series of 20 legislative acts. This legislative activity was in direct response to the damage and loss of life experienced along the Atlantic and Gulf coasts during the latter half of the twentieth century. A chronological listing and summary of these acts are presented in Appendix C. The citations are limited to generic legislation and do not contain listings of the individual study and project authorizations.

b. The period of 1940 to 1945 saw another five major hurricanes (one in the Gulf of Mexico and four along the Atlantic coast). These five storms caused another 122 deaths in Texas, Florida, Georgia and in North and South Carolina[3]. In response to these disasters, Congress enacted PL 79-727 in 1946. This law expanded the use of Federal funds to include one third of construction costs for projects along publicly owned shores. This was a limited authority in comparison to the navigation and flood control programs, and only a few of the authorized projects were actually built.

c. After five category 3 and 4 hurricanes in 1954 and 1955 caused the loss of 200 lives and flood and wave damage totaling more than $1 billion in the New England and mid-Atlantic area [1], Congress enacted PL 84-71. This 1955 law directed concerned Federal agencies to develop shore protection measures. This legislation led to funding for the Department of Commerce to improve hurricane forecasting and warning services, and to authorizations for construction by the Corps of projects for hurricane protection. The 1955 legislation was to have a far reaching effect upon beach erosion control. The Corps was directed to investigate Atlantic and Gulf shores of the United States to determine measures which could be undertaken to reduce damages from hurricanes.

d. In 1956, Congress expanded the authority for shore protection to include privately owned shores where substantial public benefits would result. The law (PL 84-826), also defined periodic nourishment as "construction" for the protection of shores, when it is the most suitable and economical remedial measure. The nourishment period recommended by the Chief of Engineers under the 1956 Act was usually 10 years, unless previous nourishment experience at the site indicated that a longer period would be suitable and economical.

e. For the six year period of 1956 through 1961, four more major hurricanes struck the Atlantic and Gulf coasts. One of these (Hurricane" Donna" in 1960) impacted all east coast states from Florida to Maine. This storm caused 50 deaths and had recorded wind gusts of 175-180 miles per hour. Hurricane "Carla" in 1961 caused 46 deaths in Texas and was the largest and most intense Gulf coast hurricane in many years[3]. Following these storms, major legislation affecting the beach erosion control program was again enacted (Public Law 87-874 in 1962). This law increased Federal aid from 1/3 to 100 percent for shore protection study costs leading to authorization. It also increased Federal participation in the cost of beach erosion and shore protection to 50 percent of construction cost when the beaches were publicly owned or used, and 70 percent Federal participation for seashore parks and conservation areas when certain conditions of ownership and use of the beaches were met. The change from cost shared studies to 100 percent Federally funded shore protection and beach erosion control studies, coupled with the great need to provide protection in areas damaged by the hurricanes of the 50s and early 60s resulted in a large number of studies and subsequent project authorizations. Recognizing the increased need for additional engineering and scientific study in the area of shoreline protection and beach erosion control, Congress established the Coastal Engineering Research Center and the Coastal Engineering Research Board in 1963 (PL

88-172). This Board replaced the Beach Erosion Board that was established by Public Law 71-520 in 1930.

f. During the period from 1962 to 1968, there were nine land falling hurricanes and one particularly severe northeast storm, the "Ash Wednesday" storm of 1962. Of the nine hurricanes, five were category 2 and three were category 3 storms. One of these storms, Hurricane "Betsy", hit Louisiana in 1965 with 136 mile an hour winds and caused 75 deaths. In 1969, Hurricane "Camille" entered at Gulfport, Mississippi, and before exiting Virginia, caused 255 deaths. In June 1972, Hurricane "Agnes" impacted areas from Florida to New York and caused 122 deaths[3]. Major legislation during this period was the River and Harbor and Flood Control Acts of 1968 (PL 90-483) and of 1970 (PL 91-611) which authorized numerous hurricane and beach erosion control studies and projects.

g. The above referenced 1962 and 1968 Acts were also important in that they provided generic legislation. Generally, water resources developments recommended to the Congress in response to study authority may not be implemented without being specifically adopted in law. However, subject to specific limits on the allowable Federal expenditures, Congress has delegated continuing authority to the Secretary of the Army acting thorough the Chief of Engineers for study, approval and construction of small projects for navigation, flood control and shore protection. The authority for the Secretary of the Army to undertake construction of small beach and shore protection projects not specifically authorized by Congress, was included in Section 103 of the 1962 Act. At that time, the project limit was $400,000 and the annual program limit was $3 million. These limits have subsequently been raised and are now $2 million per project and $30 million annually for the program. Section 111 of the 1968 Act, authorized the Chief of Engineers to investigate and construct projects to prevent or mitigate shore damages resulting from Federal navigation works, at full Federal cost limited to $1 million in initial construction costs per project (subsequently raised to $2 million per project with no program limit). See paragraph E of this chapter for additional information on the "Continuing Authorities Program".

h. In 1976, PL 94-587 authorized the placement of sand from dredging of navigational projects on adjacent beaches if requested by the interested state government and in the public interest, with the increased cost paid for by the non-Federal interests. The law also extended to 15 years (from the original 10) Federal aid for periodic beach nourishment.

4. <u>Water Resources Development Act of 1986</u>. The Water Resources Development Act of 1986 (WRDA '86), is a legislative landmark of major significance. In addition to authorizing numerous shore protection projects for study and construction, this Act is most significant in that it ended political gridlock that existed between Congress and several previous Administrations on water resources development programs. At the heart of this legislation were the beneficiary-pay reforms,

cost sharing and user fees that make local sponsors active participants in the development of projects (both in the planning and financing of implementation costs). Major sections of WRDA '86 that pertain to the shoreline protection program are:

a. Section 103 established hurricane and storm damage reduction (HSDR) as a project purpose. Beach erosion control is no longer recognized as a project purpose and the costs of constructing beach erosion control measures are to be assigned to the recognized project purposes with cost sharing in the same percentage as the purposes to which the costs are assigned. The basic cost sharing formula for a project formulated for HSDR is 65 percent Federal and 35 percent non-Federal.

b. Section 402, as amended by Section 14 of PL 100-676 (the Water Resources Development Act of 1988), requires that before construction of any project for local flood protection or any project for hurricane or storm damage reduction, the non-Federal interests shall agree to participate in and comply with applicable Federal flood plain management and flood insurance programs.

c. Section 933 modified Section 145 of PL 94-587 to authorize 50 percent Federal cost sharing of the extra costs for using dredged sand from Federal navigation improvements and maintenance efforts for beach nourishment. In those cases where the additional costs for placement of the dredged material is not economically justified, the Corps may still perform the work if the state or political subdivision requests it and contributes 100 percent of the added cost of disposal.

d. Under Section 934 of WRDA '86, Federal aid for periodic beach nourishment at existing projects may be extended as necessary without further Congressional authorization for a period not to exceed 50 years from the date of start of project construction. The extension to 50 years is not automatic. After notification by the Corps that the nourishment period is about to expire, the project sponsor must request an extension and express a willingness to cost share. A reevaluation for such projects will be made using current evaluation guidelines and policies. Section 934 authority is not used to extend the period of authorized periodic nourishment of projects that use sand bypassing plants.

B. NATIONAL PERSPECTIVE

1. National Assessment. In 1968, Congress reacted to the continuing hurricane and storm activities on the Atlantic and Gulf coasts by authorizing a study, which was completed by the Corps in 1971, entitled the National Shoreline Study[4]. The study showed there are about 84,240 miles of ocean, estuarine, and Great Lakes shorelines, including Alaska, Hawaii, Puerto Rico and the Virgin Islands. Of this total shoreline distance, 20,500 miles were identified as experiencing a significant degree of shore erosion. Significant erosion was further separated into critical and non-critical areas. Critical

erosion was defined as "those areas where erosion presents a serious problem because the rate of erosion considered in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological, and other relevant factors, indicates that action to halt such erosion may be justified." There were 2,700 miles identified as having critical erosion problems. The remaining 17,800 miles of significantly eroding shoreline were designated "non-critical." If Alaska is excluded, the Nation's shoreline distances amount to about 37,000 miles, of which 2600 miles experience critical erosion and 12,800 miles experience non-critical erosion. The erosion estimates for the Great Lakes, Alaska and other ocean shorelines are shown in Table 2-2.

Table 2-2 Status of Coastal Erosion, 1971

Area	Total Shore Miles	Critical Erosion Miles	Non-critical Miles	Total Miles of Significant Erosion
Great Lakes	3,680	220	1,040	1,260
Alaska Only	47,300	100	5,000	5,100
Oceanic, Except Alaska	33,260	2,380	11,760	14,140
TOTAL	84,240	2,700	17,800	20,500

2. Program Status. Based on the results of the study questionnaire (see Chapter 1, Paragraph B and Appendix A), as of 1 July 1993, the Corps has constructed all or portions of 82 specifically authorized shore protection projects. There are another 26 authorized but not constructed projects and projects in preconstruction engineering and design. There are also a total of 29 authorized studies. Twelve shore protection projects and studies have either been placed in the inactive category or have been deauthorized. Table 2-3 is a summary of this program status. The list of these projects and studies is shown in Appendix D.

3. Historical Authorizations of Shore Protection Projects. As shown above, our study includes 118 projects which have been authorized (total of constructed, authorized/PED, and deauthorized projects). Only five of these shore protection projects were authorized prior to 1950. A high of 17 project authorizations occurred in 1954. Ten or more shore protection projects were also authorized in 1958(14), 1962(15), 1965(10), and 1986(13). The large number of projects authorized in the 50s and 60s was the direct result of the numerous major coastal storms that occurred during those years. The large number of coastal projects authorized in 1986, as well as the low number during the 1970s and early 1980s, is largely attributed to the lack of Water Resource Development Acts during the period of 1976 to 1986. These authorizations are shown in Table 2-4 by decade and category.

Table 2-3 Program Status

Shore Protection Project Status	Number of Projects/Studies	Protected Shoreline Distance (miles)
Large Constructed Projects	56	209.86
Small Specifically Authorized Constructed Projects	26	15.97
Subtotal Constructed	**82**	**225.83**
Under Construction	1	0.21
Authorized/Awaiting Initiation of Construction	10	39.89
Preconstruction Engineering Design	15	110.60
Subtotal Authorized/PED but Unconstructed Projects	**26**	**150.70**
Feasibility Phase (GI Study)	12	250.70
Reconnaissance Phase (GI Study)	17	273.25
Subtotal General Investigation Studies	**29**	**523.95**
Total Projects and Studies	**137**	**900.48**
Inactive Studies	2	
Deauthorized Projects	10	
Total Authorized and Deauthorized	**149**	

Table 2-4 Historical Project Authorizations of Shore Protection and Beach Erosion Control Projects

Year	Large Projects	SSSA (1) Projects	Auth. Not Constructed	Subsequently Deauthorized	Total
Before 1950	2	0	0	3	5
1950-1959	15	21	3	1	40
1960-1969	27	5	9	5	46
1970-1979	3	0	2	1	6
1980-1989	8	0	8	0	16
1990-1993	1	0	4	0	5
Total	**56**	**26**	**26**	**10**	**118**

(1). Small scope specifically authorized project. See following paragraph E of this chapter for additional information.

4. National Summary.

a. As previously indicated, the Corps has constructed 82 specifically authorized shore protection projects. These projects cover 226 miles of shoreline. That equates to 0.3 percent of the total shoreline, 1.1 percent of the significant erosion areas and 8.4 percent of critical erosion areas identified in the 1971 National Shoreline Study. If Alaska is excluded, these percentages increase to 0.6 percent of total shoreline, 1.5 percent of significant erosion areas and 8.7 percent of critical erosion areas. Figure 2-1 provides a perspective of the scope of the Federal shore program with respect to the Nation's shoreline. Since all projects of the Corps are in developed areas, by definition (see Chapter 2 paragraph B.1.), all of the projects are considered to be in critical erosion areas. The values displayed in Figure 2-1 do not include projects implemented under the Corps Continuing Authorities Program for small projects or the numerous state, county, city, and privately funded shore protection projects.

b. Shorelines with natural beaches are a relatively limited and special resource. An examination by the National Shoreline Study[4] of the lengths of non-Alaskan shore with and without a beach determined that beaches exist on about 12,200 miles, or 33 percent, of the total 37,000 miles of shoreline. If all 108 projects that are constructed, under construction, authorized/awaiting construction or are in preconstruction engineering and design, are considered as a whole, the program administered by the Corps would cover only 377 miles, or 3.1 percent of the beach area. Even along the heavily developed South Atlantic coast of Florida, only about 27 percent of the developed shoreline is protected by Corps projects. In the reach from Cape Canaveral in Brevard County to Key Biscayne in Dade County, a distance of 195 miles, 145 miles is developed. The Corps has shore protection projects along 39.1 of those miles. There are authorized but not constructed projects covering an additional 31.5 miles of the 145 miles of the developed area most of which are concentrated in Palm Beach County. This is summarized in Table 2-5.

c. The relatively few major Federal projects with respect to the total number of miles of shoreline experiencing critical erosion problems can, in part, be attributed to stringent Federal project feasibility criteria. These criteria, including benefit/cost analysis, virtually limit shore protection projects to densely developed areas with high economic value and public access. For more detail, see Chapter 2, Paragraph C, "Project Purposes".

Figure 2-1

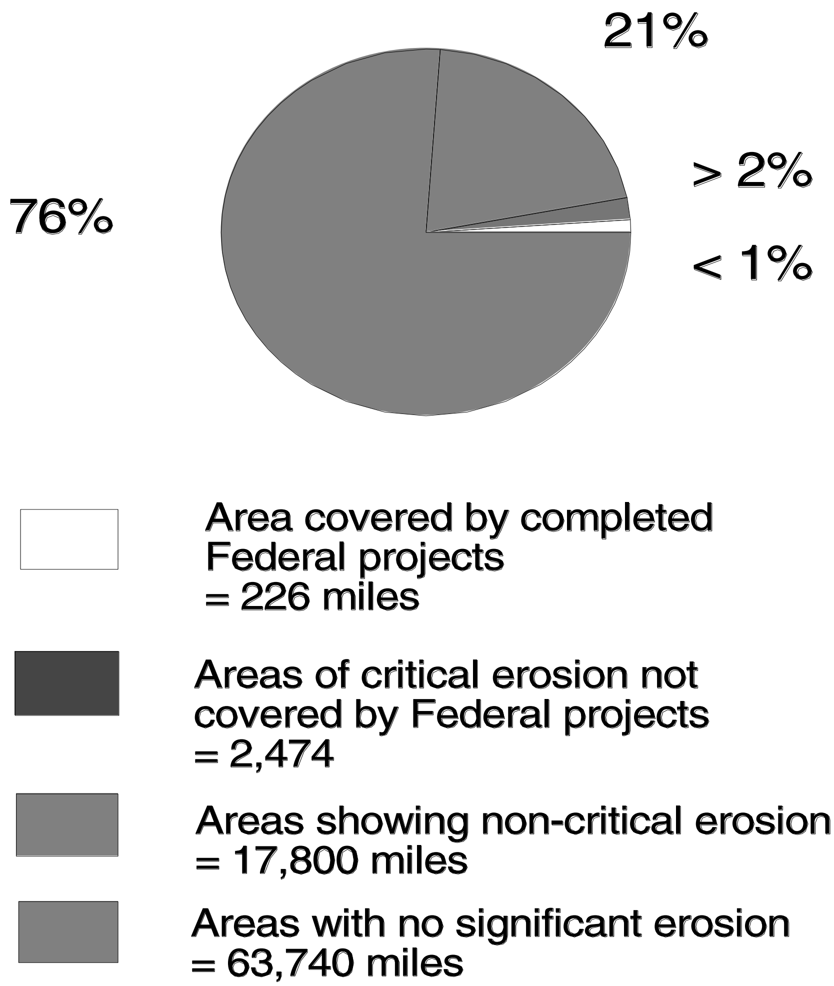

Figure 2-1 - Federal Program With Respect to Nation's Shoreline (84,240 miles)

Table 2-5 Federal Shore Protection Projects State of Florida Between Canaveral Harbor and Key Biscayne

County	Total Shoreline (miles)	Approximate Developed Shoreline (miles)	Constructed Federal Shoreline Projects (miles)	Authorized Not Constructed Federal Shoreline Projects (miles)
Brevard (S. of Canaveral Hbr.)	40.0	29	4.4	0.0
Indian River	22.3	7	0.0	3.4
St. Lucie	22.0	8	1.3	0.0
Martin	21.0	13	0.0	4.0
Palm Beach	44.9	44	4.1	22.4
Broward	24.0	24	11.3	1.7
Dade (N. of Key Biscayne)	20.8	20	18.0	0.0
TOTAL	**195.0**	**145**	**39.1**	**31.5**

5 . Regional Summary

a. The bulk of the Corps coastal projects are on the Atlantic coast. A regional perspective of project distributions for completed projects is given in Table 2-6. This project tabulation compares the number of completed projects and miles and percent of critically eroded coastline protected, against the total miles of shoreline and the miles of shoreline with critical erosion problems as identified in the 1971 National Shoreline Study[4]. The distribution by region of these 82 completed projects is shown on Figure 2-2.

b. Another 26 projects covering an additional 151 miles of coastline are either under construction, authorized but not yet constructed, or are in the Preconstruction Engineering and Design (PED) stage. In addition, there are 29 studies underway for 524 miles of shoreline. Table 2-7 gives the number and regional distribution of these projects and studies. The length of shoreline protected includes reaches of coastline under study. In most cases this length will be reduced when actual projects are identified. Of the total 674.6 miles identified, 524.0 miles or 78 percent is attributed to reconnaissance and feasibility studies.

Table 2-6 Regional Assessment of Completed Shore Protection Projects (1)

Region	Total (2) Shoreline (miles)	Significant (2) Shoreline (miles)	Critical (2) Shoreline (miles)	Number of Projects	Critically Protected Shoreline (miles) / (%)
North Atlantic	8,620	7,460	1,090	41	77.4 / 7.1
South Atlantic-Gulf	14,620	2,820	980	22	107.0 / 10.9
Lower Mississippi	1,940	1,580	30	1	7.0 / 23.3
Texas Gulf	2,500	360	100	2	4./5 / 4.5
Great Lakes	3,680	1,260	220	6	14.8 / 6.7
Alaska	47,300	5,100	100	0	0.0 / 0
North Pacific	2,840	260	70	0	0.0 / 0
California	1,810	1,550	80	10	15.1 / 18.8
Hawaii	930	110	30	0	0.0 / 0
Total	**84,240**	**20,500**	**2,700**	**82**	**225.8 / 8.4**

(1). Does not include small shore protection projects in the Continuing Authorities Program.
(2). Mileage from the 1971 National Shoreline Study.

Table 2-7 Regional Assessment of Authorized But Not Constructed Projects and Studies[1]

Region	Total[2] Shoreline Distance (miles)	Significant[2] Erosion Distance (miles)	Critical[2] Erosion Distance (miles)	Number of Projects/ Studies	Critical Protected Shoreline Distance (miles) / (%)
North Atlantic	8,620	7,460	1,090	22	397.2 / 36.4%
South Atlantic-Gulf	14,620	2,820	980	25	204.2 / 20.8%
Lower Mississippi	1,940	1,580	30	0	0 / 0%
Texas Gulf	2,500	360	100	1	8.0 / 8.0%
Great Lakes	3,680	1,260	220	1	2.0 / 0.9%
Alaska	47,300	5,100	100	1	0.2 / 0.2%
North Pacific	2,840	260	70	0	0 / 0%
California	1,810	1,550	80	5	62.3 / 77.8%
Hawaii	930	110	30	0	0 / 0%
Total	**84,240**	**20,500**	**2,700**	**55**	**674.6 / 25%**

1 Includes projects in PED but does not include shore protection projects/studies in the Continuing Authorities Program.
2 From 1971 National Shoreline Study.

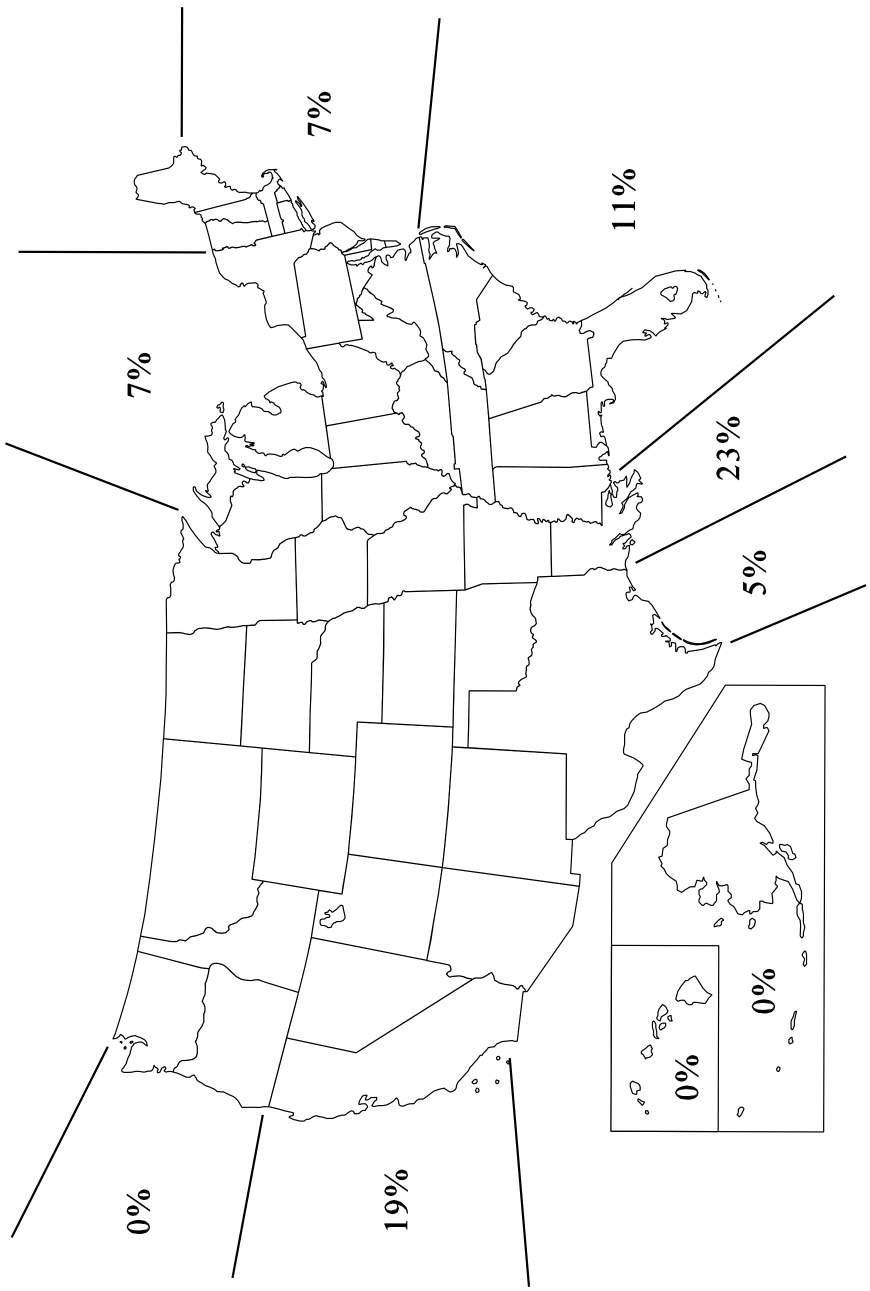

Figure 2-2 - Percent of Critically Eroding Shoreline Protected by 82 Specifically Autorized and Constructed Projects

c. Table 2-7 does not include the "Coast of Florida Erosion and Storm Effects Study" (COFS) [5]. This study, authorized in 1985 by PL 98-360, includes the entire 1,020 miles of the Florida coastline. The National Shoreline Study[4] identified 543 miles of Florida's shoreline as having storm damage problems. The 16 completed projects in the state of Florida as identified in our current study, protect 68 miles, or about 13 percent of the erosion problem areas. The COFS will result in developing a comprehensive body of information on regional coastal processes around Florida, through the collection and analysis of new and existing data. The information will lead to selected regional plans or alternatives for each of the five regions of the study and establish a central database available to the public for monitoring the assessment of future coastal changes, whether naturally induced or man induced. The COFS will result in decision documents (feasibility reports) directed toward presenting sufficient rationale to support recommendations to seek authorization for new projects, and/or to authorize modifications in existing Federal navigation and shore protection projects. This approximately $22 million study cost is being shared on a 50-50 basis between the Federal Government and the State of Florida.

6 . Deauthorizations. Prior to 1974, projects could be deauthorized only by specific Acts of Congress. This was changed by Section 12 of Public Law 93-251, The Water Resources Development Act of 1974. This section established a procedure for deauthorization of projects that had not received any Congressional appropriations within eight years. This law was superseded by Section 1001 of Public Law 99-662, The Water Resources Development Act of 1986. Subsection 1001(a) provides that any project authorized for construction in the 1986 Act shall be deauthorized as of the fifth anniversary of its enactment if funds have not been allocated for construction prior to that date. Subsection 1001(b) establishes a new procedure, replacing the procedure established by Section 12 of PL 93-251, for deauthorization of previously authorized projects or separable elements for which no funds have been obligated for a period of ten fiscal years. Similarly, Section 710 of PL 99-662, establishes a procedure for deauthorization of studies that have not received any Congressional appropriations for five years.

C. PROJECT PURPOSES

1. Introduction. The term "project purpose" is a generally accepted term which describes a type of project or management measure and the reason for which it is to be, or was, constructed. For example, a "shore protection" project implies the use of management measures, such as berms, dunes, groins, revetments, breakwaters, etc., along the oceans and Great Lakes of the United States to prevent or reduce hurricane, tidal and lake flood damages, improve recreation and/or stop land loss. The Water Resources Development Act of 1986 significantly changed the way that shore protection projects are formulated and cost shared.

2. Shore Protection Projects Prior to WRDA '86.

a. Beach Erosion Control. Federal participation in the cost of restoring and protecting eroding shores of the United States was authorized under various statutes. The extent of Federal participation was based upon shore ownership and use, and the type and incidence of the benefits. Without public use or benefits, no Federal funds could be used. The costs of measures protecting Federal shores were Federal. Federal participation in protecting non-Federal public shores was 50 percent, but could be a maximum of 70 percent under special conditions for certain park and conservation areas. Private shores were eligible for Federal participation of up to 50 percent, if there were benefits from public use.

b. Hurricane and Abnormal Tidal Flooding. Federal interest in projects to protect against hurricane and abnormal tidal flooding was established case-by-case based upon specific Congressional authorizations. Although projects were usually similar to beach erosion control works, hurricane projects were viewed as being more like flood control projects. Public use was not a condition for Federal participation in protecting against hurricanes. The Federal share of hurricane projects was limited to a maximum of 70 percent.

c. Recreation. Projects for beach erosion control produce significant recreation benefits. In some projects, recreation benefits provided for most of the economic justification. During the mid-1980s, as budget deficits increased, projects considered to be "primarily recreation" were assigned a lower priority in the budgetary process. Consequently, the emphasis on recreation diminished.

3. Shore Protection Projects After WRDA '86.

a. Beach Erosion Control. Subsection 103(d) of WRDA '86 discontinued this project purpose by directing the costs of measures for beach erosion control to be assigned to appropriate project purposes and shared in the same percentages as the purposes to which the costs are assigned. In accord with this direction, damages resulting from coastal erosion are now included along with the damages from inundation and waves, and the projects which reduce these damages are hurricane and storm damage reduction projects.

b. Hurricane and Storm Damage Reduction (HSDR). Subsection 103(c) of WRDA '86 established a HSDR project purpose and legislated a 35 percent non-Federal cost sharing requirement. Non-Federal interests were also to provide all lands, easements, rights-of-way, relocations, and dredged material disposal areas (LERRD), and perform all operation and maintenance. The value of LERRD contributions are included in the non-Federal share. Periodic nourishment by the placement of material on a beach at suitable intervals of time, is considered "construction" for funding and cost sharing purposes, in accord with PL 84-826. By including hurricane protection into storm damage reduction, Congress established public use as a precondition for Federal participation.

c. Recreation. Since WRDA '86, shore protection projects have been formulated for HSDR. These projects will generally produce significant recreation benefits which are included in the economic analysis and used for project justification. However, if over one-half of the benefits required for justification are recreation, current Department of Army budgetary policy precludes Federal participation. In addition, any additional beachfill over that required for the project formulated for HSDR, to satisfy recreation demand, is a separable recreation feature. Federal participation in a separable recreation feature for shore protection projects, even though economically justified, is precluded under the current Department of Army policy.

4. Navigation. Incidental to the Corps mission of maintaining the Nation's rivers and harbors, in certain instances, is that material dredged from such activities can be used for beach fill purposes. Authority for such operations was first contained in Section 145 of Public Law 94-587 (Water Resources Development Act of 1976). This authority was subsequently amended by Section 933 of WRDA '86 and Section 207 of PL 102-580 . Currently, this authority and related regulations allow Federal participation in 50 percent of the added costs (in relation to the least cost navigation disposal alternative) of dredged material placement for beach nourishment purposes, providing the placement is economically justified, and other conditions common to Civil Works storm damage reduction projects are met. Where all of these conditions cannot be met, placement can still be accomplished if non-Federal interests provide all of the added costs, and the placement is environmentally acceptable and in the public interest.

5. Report Summary of Project Purposes.

a. A list of completed projects by project purpose is presented in Table 2-8. As shown in the table, the majority, 70 of the 82 projects (85 percent), contain beach erosion control as a project purpose, either as a singular purpose or as part of a multipurpose project. The next most prevalent purposes are recreation (53 projects/65 percent) and hurricane and storm damage reduction (52 projects/63 percent). Navigation is considered in only four projects and mitigation in only two projects. The predominance of beach erosion control and recreation projects in the totals is attributable to older projects which were authorized and constructed before WRDA '86. The information is subdivided into the categories of "Regular" and "Small Scope Specifically Authorized (SSSA)" projects. For additional information on SSSA projects, see paragraph F.

Table 2-8 Project Purpose - Completed Projects

Shore Protection Project Purpose	Number of Projects			Protected Shoreline Distance (miles)		
	Regular	SSSA	Total	Regular	SSSA	Total
Hurricane and Storm Damage Reduction (HSDR)	3	1	4	10.32	0.13	10.45
HSDR/Recreation (REC)	3	1	4	13.14	0.42	13.56
HSDR/REC/Beach Erosion Control (BEC)	21	9	30	95.44	8.39	103.83
HSDR/REC/BEC/Navigation	1	0	1	2.65	0	2.65
HSDR/REC/BEC/Mitigation	1	0	1	1.30	0	1.30
HSDR/BEC	10	0	10	33.65	0	33.65
HSDR/Navigation	1	1	2	4.28	1.00	5.28
Recreation	0	2	2	0	0.53	0.53
Recreation/BEC	8	7	15	15.20	1.74	16.94
Beach Erosion Control (BEC)	6	5	11	17.93	3.76	21.69
BEC/Navigation	1	0	1	0.95	0	0.95
BEC/Mitigation	1	0	1	15.00	0	15.00
Total	**56**	**26**	**82**	**209.86**	**15.97**	**225.83**

b. Authorized projects for which construction has not been completed, as well as projects in PED and authorized studies, are listed in Table 2-9. As shown in the table, hurricane and storm damage reduction is a project purpose in 51 of the 55 unconstructed projects/studies (93 percent), while beach erosion control is in 28 projects (51 percent) and recreation in 27 projects (49 percent). The single purpose recreation project is the Charlotte County, Florida project and was authorized in WRDA '86. For the 1993 data base of this report, the Charlotte County project is listed under the category of “awaiting funds.” However, for the current 1995 fiscal year the project is classified as “inactive.” The single purpose navigation project is the Sargent Beach, Texas project. This project, authorized in WRDA '92, is currently in preconstruction engineering and design.

Table 2-9 Project Purpose - Authorized But Not Constructed Projects and Studies

Shore Protection Project Purpose	Number of Projects/Studies	Protected Shoreline Distance (miles)
Hurricane and Storm Damage Reduction (HSDR)	17	221.30
HSDR/Recreation (REC)	7	142.19
HSDR/REC/Beach Erosion Control (BEC)	14	65.66
HSDR/REC/BEC/Navigation	1	4.60
HSDR/REC/BEC/Mitigation	4	11.96
HSDR/BEC	7	211.73
HSDR/Environmental Restoration	1	1.50
Recreation	1	1.10
Beach Erosion Control	1	6.16
BEC/Navigation	1	0.50
Navigation	1	7.95
Total	**55**	**674.65**

This shift in project purposes from beach erosion control to hurricane and storm damage reduction, and the reduction in the number of recreation projects, is summarized in Box 2-2.

Box 2-2

Shift in Project Purpose

PURPOSE	PURPOSE AS % OF COMPLETED PROJECTS	PURPOSE AS % OF AUTHORIZED PROJECTS/STUDIES
BEC	85%	51%
REC	65%	49%
HSDR	63%	93%

D. PROJECT FEATURES

1. General. The features of shore protection projects usually consist of one or a combination of the following functional elements: beach fills and dune fills (soft structural measures); and groins, seawalls, revetments, breakwaters, bulkheads and sand transfer plants (hard structural measures). There is no specific or singular functional feature that can be applied universally to solve all shore protection problems. Most project sites have some unique characteristics and must be evaluated on the basis of their particular attributes in order to develop project plans that afford the best balance between functional performance, cost-efficiency, return of economic benefits, and environmental acceptability. The protection of relatively long reaches of shoreline, more often than not, involves the placement of beach fill and the provision of subsequent periodic nourishment. However, even in these cases, many project sites require detailed assessments to determine, for example, whether or not groins are needed for all or part of the fill or how much fill to place, how long the fill will last before needing to be renourished, and whether a dune fill or seawall should be used to account for storm tide effects[6].

2. Shift from Structures to Beach Nourishment.

a. In the United States, as elsewhere prior to the Second World War, the main approach to beach erosion and storm damage problems was through the use of fixed structures, usually groins, jetties and seawalls. A groin is constructed perpendicular to the shore to stabilize the shoreline position and minimize erosion by trapping longshore moving sediment. A jetty is also built perpendicular to the shore and is constructed at mouths of rivers or tidal inlets to stabilize a navigation channel and assist in maintaining project depths by preventing shoaling of littoral materials. A seawall is built along a bank or shore to prevent loss of land and damage to landward structures caused by wave action or currents. A classic example of this early type of structure is the Galveston, Texas seawall which was begun in 1902 by local interests. Most of the hard structural shore protection projects are built of concrete or steel sheet pile and stone rubble mounds. Wooden cribs with concrete caps and steel cells are other types of structures that are used. These structures met with varying degrees of success. By the 1920s and 1930s, use of fixed structures had proliferated along certain resort sections of the Nation's coastline to such an extent that these structures, while protecting both public and private property, impeded the recreational use of the beaches.

b. In the late 1940s and early 1950s, an important change evolved in the basic concept of shoreline protection. Rather than relying solely on the traditional coastal defense structures of the past, it was increasingly realized that, in many situations, results would be more cost-efficient and functionally successful if techniques were used which replicated the protective characteristics of natural beach and dune systems. This concept, pioneered in the early 1960s by the Corps' Coastal Engineering Research Center (CERC), placed emphasis on the use of artificial beaches and dunes as economically efficient and highly effective dissipators of wave energy. Other important considerations were the aesthetic and recreational values of artificially created beaches.

c. The broad public acceptance which now exists in the use of artificial beaches as a primary means of shore protection was initially gained through the experience and performance of Federal beach nourishment projects. Prior to 1956, periodic nourishment was considered to be a form of maintenance, which was totally a non-Federal responsibility. Recognizing that beach nourishment resulted in considerable benefits to adjacent shorelines, Congress in 1956 passed legislation which classified beach nourishment as a continuing construction feature, eligible for Federal cost sharing participation. Reshaping the beach with existing sand and moving the sand around on the beach is considered beach maintenance and is a non-Federal responsibility. Only when new sand is placed on the project is it considered periodic nourishment.

d. Originally, sand for beach nourishment came from the inland waterways or rivers and estuaries. Early beach projects in Florida that had been built by local interests as early as 1949-1951 used sand dredged from estuaries behind the barrier islands. Many of the early projects authorized for Florida (1958-1968), originally had bays and estuaries identified as the borrow area locations. These sources of sand were later abandoned after the environmental tradeoffs were considered by many as too costly compared to the benefits realized.

e. Shore protection studies underway or completed on the east coast by 1964 showed that, if the Federal or local governments were to come to grips with the erosion problems, a comprehensive program was needed to locate sand deposits offshore in the Atlantic Ocean. Recognizing the need for new sand sources for beach nourishment, CERC initiated the Inner Continental Shelf Sediment Study in 1964. This study, completed in 1978, was funded by CERC with research funds appropriated by Congress. The purpose of the study was to develop an inventory of potential offshore borrow sites for the increasing number of authorized beach nourishment projects. The U.S. Geological Survey is continuing sampling and analysis in deeper areas offshore of and including state territorial waters.

f. Once offshore sources of sand for beach nourishment projects were identified, it was immediately apparent that existing dredges only had limited capacity to dredge sand from offshore borrow areas. This was due to lack of capability to move sand from long distances in the high energy offshore wave climate. Very few dredges met U.S. Coast guard certification requirements for operations offshore. Most hopper dredges in the 1960s did not have pumpout capability. Along with the need to dredge offshore sand for beach nourishment, a trend started in the late 1960s and early 1970s to place material dredged from maintenance of Federal navigation projects on adjacent beaches. In order to meet these new dredging demands, many dredging companies constructed dredges to new designs. As shown in Box 2-3, eight of the industry's 13 dredges constructed between 1971 and 1983 have direct pumpout capability, and 10 of the 13 dredges have split hulls that will allow disposal of dredged material in the nearshore zone. The Corps' four hopper dredges (McFarland, Yaquina, Weeler, and Essayons), all have both bottom door and direct pumpout capability. In accordance with P.L. 95-269, the Corps maintains a minimum dredge fleet in order to perform emergency and national defense dredging, and supplements private industries' capability as necessary to accomplish river and harbor maintenance work. In addition to the four hopper dredges, the Corps also maintains three dust pan dredges, two sidecast dredges and one pipeline dredge.

Box 2-3

INDUSTRY HOPPER DREDGE DATA

Hopper Discharge System	Direct Pumpout		
	Yes	**No**	**Optional**
Split Hull	7	3	0
Bottom Door	1	1	1
Total	8	4	1

g. The significant shift from a strong reliance on fixed structures to beach restoration and nourishment by the Corps is demonstrated in Figure 2-3. In this figure, the cost of initial beach restoration and periodic nourishment have been combined to show the percent of costs spent on beach nourishment versus the percent spent on structures. Since 1960, approximately 90 percent of total Federally sponsored shoreline protection costs have been spent on beach restoration and periodic nourishment.

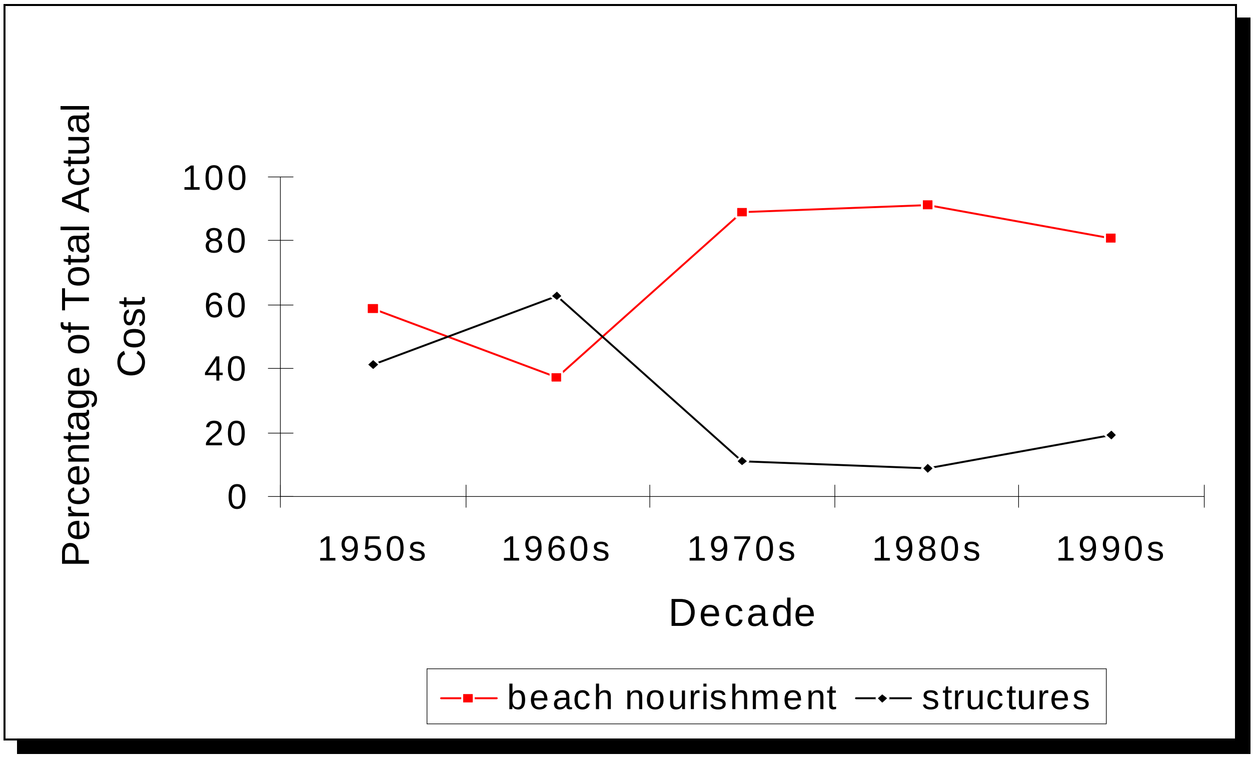

Figure 2-3 - The Shift From Fixed Structures to Beach Restoration and Nourishment

3. Report Summary of Project Features.

a. A list of constructed projects, by project feature, is presented in Table 2-10. In reference to 82 projects, 20 (24 percent) involve only beach restoration and/or nourishment, 10 (12 percent) rely solely on hard structural measures, and the remaining 52 (64 percent) involve a combination of hard and soft measures. See Chapter 2, paragraph F for information on "SSSA" projects.

b. Project features for authorized projects for which construction is not complete, and for projects in PED and authorized studies, are listed in Table 2-11. As shown in the table, the authorized projects and studies have a higher percentage of soft structural features. Of these newer 55 projects and studies, 30 (55 percent) are soft structural, three (5 percent) are hard structural and 22 (40 percent) are a combination of soft and hard.

Table 2-10 Project Feature-Completed Projects

Shore Protection Project Feature	Number of Projects			Protected Shoreline Distance (miles)		
	Regular	SSSA	Total	Regular	SSSA	Total
Initial Beach Restoration (IBR)	4	0	4	13.15	0	13.15
IBR/Nourishment (N)	9	6	15	43.21	5.13	48.34
IBR/N/Groin Field (GF)	7	4	11	12.63	2.37	15.00
IBR/N/GF/Breakwater	1	0	1	3.60	0	3.60
IBR/N/GF/Breakwater/Revetments	1	0	1	0.99	0	0.99
IBR/N/GF/Revetments	1	1	2	1.48	0.25	1.73
IBR/N/Sand Bypassing	1	0	1	0.66	0	0.66
IBR/N/Terminal Groin	8	7	15	43.76	3.85	47.61
IBR/N/Terminal Groin/Breakwater	1	0	1	0.28	0	0.28
IBR/N Terminal Groin/Revetments	2	0	2	4.10	0	4.10
IBR/N/Breakwater	2	0	2	2.01	0	2.01
IBR/N/Revetments	1	1	2	8.40	1.00	9.40
IBR/N/Tidal Surge Protection	2	0	2	25.15	0	25.15
IBR/N/Other	3	0	3	14.05	0	14.05
IBR/GF	4	0	4	12.88	0	12.88
IBR/GF/Revetments	1	0	1	1.61	0	1.61
IBR/Terminal Groin	1	2	3	0.15	1.27	1.42
Nourishment	1	0	1	6.16	0	6.16
N/Terminal Groin	0	1	1	0	0.28	0.28
Groin Field	1	0	1	1.86	0	1.86
GF/Breakwater	0	1	1	0	0.95	0.95
GF/Revetments	0	1	1	0	0.38	0.38
Sand Bypassing	1	0	1	0	0	0
Terminal Groin	0	1	1	0	0.36	0.36
Revetments	4	1	5	13.73	0.13	13.86
Total	**56**	**26**	**82**	**209.86**	**15.97**	**225.83**

Table 2-11 Project Feature - Authorized But Not Constructed Projects and Studies

Shore Protection Project Feature	Number of Projects/ Studies	Protected Shoreline Distance (miles)
Initial Beach Restoration (IBR)/ Periodic Nourishment (N)	29	396.71
IBR/N/Groin Field (GF)	4	57.33
IBR/N/GF/Terminal Groin (TG)	1	7.00
IBR/N/GF/TG/Breakwater	2	50.00
IBR/N/Sand Bypassing	1	0.50
IBR/N/TG	7	121.67
IBR/N/TG/Revetments	1	2.70
IBR/N/Revetments	2	0.50
IBR/N/Revetments/Tidal Surge Protection	1	21.00
IBR/N/Tidal Surge Protection	2	3.50
Periodic Nourishment	1	(1)
Periodic Nourishment/Revetments	1	0.21
Revetments	3	13.53
Total	**55**	**674.65**

(1) Section 934 study to nourish a portion of the Virginia Beach, VA, project. The mileage is listed under "Constructed Projects."

This shift in project features from hard to soft measures is summarized in Box 2-4.

E. CONTINUING AUTHORITIES PROGRAM

1. Authorization. There are six legislative authorities under which the Secretary of the Army, acting through the Chief of Engineers, is authorized to plan, design, and construct certain types of water resources improvements without specific Congressional authorization. These authorities are called the "Continuing Authorities Program" when referred to as a group. The following three of these authorities pertain partly or entirely to hurricane and storm damage reduction.

Box 2-4

Shift in Project Feature

FEATURE	FEATURE AS %OF COMPLETED PROJECTS	FEATURE AS %OF AUTHORIZED PROJECTS/STUDIES
Soft Structural	24%	55%
Hard Structural	12%	5%
Combination	64%	40%

a. Section 14, Flood Control Act of 1946 (PL 79-526), as amended (emergency streambank and shoreline erosion protection for public facilities and services). This program applies only partly to the shore protection and beach erosion control projects. The Federal funding limit per project is currently $500,000 with a program limit of $12,500,000 per year.

b. Section 103, River and Harbor Act of 1962 (PL 87-874), as amended (storm damage reduction). This program authorizes Federal participation in the cost of protecting the shores of publicly owned property and private property where public benefits result. The Federal funding limit per project is currently $2,000,000 with a program limit of $30,000,000 per year.

c. Section 111, River and Harbor Act of 1968 (PL 90-483), as amended (mitigation of shoreline erosion damage caused by Federal navigation projects). The Federal funding limit per project is currently $2,000,000 for initial construction, with no yearly program limit or limit Federal participation beyond/after initial restoration.

2. Extent of Program. The survey performed by this study did not include projects under the continuing authorities program. Headquarters, U.S. Army Corps of Engineers, was queried concerning its records of constructed projects for this program. The only records readily available were for the Section 103 program and only for as far back as 1987. According to those records, since 1987 the Corps has constructed only 14 projects that relate to shore protection and beach erosion control under the Section 103 Continuing Authorities Program. The projects and the related total cost are provided in Table 2-12. This total program cost in actual dollars since 1987 has been

only $19.5 million or less than $3 million per year. This is about 7.5 percent of the approximately $263 million spent on the 56 large projects during this same time period (1987-1993). The Federal expenditure has been much less. Since historical data is limited and the total program is minor with respect to the specifically authorized program, these projects are not included in the report totals.

Table 2-12 Continuing Authorities Program - Section 103
Projects Completed or Under Construction Since 1 January 1987

Division/ District	Authority[1]	Project	Total Project Cost ($000)
NED	103	Prospect Beach, West Haven, CT	2,268
	103	Sea Bluff Beach, West Haven, CT	450
	103	Woodmont Beach, Milford, CT	1,184
NAP	103	N. Shore Indian River Inlet., DE	886
	103	S. Shore Indian River Inlet.,DE	1,029
NAB	103	North Beach, Calvert Co., MD	835
	103	Colonial Beach, VA	1,711
NCB	103	Century Park, Lorain, OH	604
	103	Sims Park, Euclid, OH	1,345
NCC	103	Lake Bluff-Sunrise Park, IL	300
NPS	103	Lincoln Park Beach, Seattle, WA	3,423
SPN	103	Emeryville Point Park, CA	1,088
POD	103	Lepua Area, AS	1,959
	103	Sand Island, Oahu, HI	2,452
Total		**14 Projects**	**19,532**

1 Section 103 of the 1962 River and Harbor Act, as amended (Beach Erosion Control).

F. SMALL SCOPE SPECIFICALLY AUTHORIZED PROJECTS

1. Overview. Prior to enactment of Section 103 of the 1962 River and Harbor Act and Section 111 of the 1968 River and Harbor Act, several shore protection projects were authorized which were small in size and cost. If a "Continuing Authority Program" (see above paragraph E) had been in

effect at that time, these projects would have been constructed under those authorities. There were a total of 26 of these types of projects constructed; 21 in the New England Division and five in the Los Angeles District. The individual projects which comprise the "Small Scope Specifically Authorized" projects are identified in Table 2-13. Table 2-13 also provides the authorization, project length and cost data or these 26 projects.

2. Elimination. A summary of the mileage and cost for the 26 small scope specifically authorized projects is presented in Table 2-14. As shown, these 26 projects protect about 16 miles of shoreline (only 7 percent of the total 226 miles being protected). The 26 projects average about 0.6 miles in length compared to the remaining 56 projects which average 3.75 miles in length. At the time of construction, the 26 projects had a total Federal cost of about $1.75 million, or an average Federal cost of about $67,300 per project. The total Federal cost, adjusted to 1993 price levels, for the New England Division projects is $5.6 million and for the Los Angeles District projects $3.9 million. This total Federal cost of $9.5 million is about 1.1 percent of the remaining total 1993 Federal program cost (see Chapter 4) and equates to an average of about $365,000 per project for the 26 projects, compared to an average Federal cost of about $15.7 million for the remaining 56 projects.
In addition to their relatively small size and costs, there is limited historical data on these projects, all of which were built during the 50s and early to mid 60s. The small 26 projects were very different from the majority of the projects studied and were interpreted as not representing the intent of the OMB directive to study Congressionally authorized shore protection projects. Accordingly, these 26 projects were excluded from the data base used to conduct the detailed analysis and will not be discussed further in this report. During a briefing on 23 December 1993, OMB concurred in the exclusion of these projects from further consideration. The location of the remaining 56 projects is shown on Figure 4-1.

G. OPERATION, MAINTENANCE AND MONITORING

1. General. Under the provisions of WRDA '86, the non-Federal sponsor must operate, maintain, repair, replace and rehabilitate (O&M), a completed shore protection project. A unique aspect of beach fill projects is the provision for continuing Federal participation in the periodic nourishment of such projects where sand is placed on the beach, berm, or dune to replenish eroded material. Under PL 84-826, enacted in 1956, periodic nourishment is considered to be a continuing construction feature for funding and cost sharing purposes and not an operation and maintenance feature when it is the most suitable and economical remedial measure. It is undertaken when necessary to replace storm-induced sand losses and to prevent excessive erosion of the authorized beach design profile.

Table 2-13 Small Scope Specifically Authorized Projects, Authorization and Cost Data

Dist.	Project	Type of Authorization(1)	Length of Shoreline (Miles)	Year Authorized	Year Completed	Original Cost of Construction ($000)		Adjusted Construction Cost, 1993 Prices Levels ($000)	
						Federal	Total	Federal	Total
NED	Compo beach, CT	Beach Erosion	0.70	1950	1962	82	246	513	1540
NED	Silver Beach to Cedar Beach, CT	Beach Erosion	3.24	1954	1964	63	333	357	1900
NED	Cove Island, CT	Beach Erosion	0.23	1958	1961	49	145	294	882
NED	Calf Pasture Beach Park, CT	Beach Erosion	0.42	1958	1963	57	177	352	1102
NED	Cummings Park, CT	Beach Erosion	0.19	1958	1963	28	83	158	475
NED	Burial Hill Beach, CT	Beach Erosion	0.09	1950	1958	6	18	41	124
NED	Cuilford Point Beach, CT	Beach Erosion	0.08	1958	1961	15	45	86	256
NED	Gulf Beach, CT	Beach Erosion	0.23	1954	1958	21	64	145	433
NED	Hammonasset Beach, CT	Beach Erosion	1.89	1954	1956	171	513	1271	3814
NED	Sand Hill Cove Beach, CT	Beach Erosion	1.00	1954	1959	39	118	272	827
NED	Jennings Beach, CT	Beach Erosion	0.36	1950	1955	14	43	112	337
NED	Light House point Park, CT	Beach Erosion	0.28	1958	1960	4	12	25	74
NED	Middle Beach, CT	Beach Erssion	0.13	1954	1958	9	28	63	188
NED	Sasco Beach, CT	Beach Erosion	0.17	1950	1961	23	69	150	445
NED	Short Beach, CT (2)	Beach Erosion	0.47	1954	1955	0	0	0	0
NED	Southport Beach, CT	Beach Erosion	0.13	1950	1960	18	53	119	358
NED	Woodmont Beach , CT	Beach Erosion	0.76	1954	1959	54	166	347	1067
NED	North Scituate Beach, CT	Beach Erosion	0.47	1960	1969	107	214	473	948
NED	Town Beach MA	Beach Erosion	0.25	1960	1963	6	17	31	94
NED	Wessagusselt Beach, MA	Beach Erosion	0.49	1960	1969	181	381	733	1544
NED	Misquamicut Beach, RI	Beach Erosion	0.63	1958	1963	15	45	86	256
SPL	Imperial Beach, CA	Beach Erosion	0.95	1958	1961	69	157	434	997
SPL	San Diego Beach, Sunset Cliffs, CA (3)	Beach Erosion	0.38	1966	1973	185	370	501	1003
SPL	Ocean Beach, CA (4)	Mitigation	0.32	1958	1955	8	24	62	187
SPL	Dohemy Beach, CA	Beach Erosion	1.16	1960	1967	377	753	1915	3829
SPL	Anaheim Bay, CA	Mitigation	0.95	1954	1959	148	486	957	3135

Footnotes:
(1) Type of Authorization

a. Beach Erosion. This signifies small beach erosion control projects authorized prior to the general authority provided by Section 103 of the River and harbor Act of 1962. The updated Federal cost is less than $2,000,000 at 1993 price levels.

b. Mitigation. This signifies small navigation mitigation projects authorized prior to the general authority provided by Section 111 of the River and Harbor Act of 1968. The updated Federa cost is less than $2,000,000 at 1993 price levels.

(2) No cost of construction charged to this project. Material input on the beach was from dredging a navigation channel.

(3) Authorized as part of a larger project with a cost in excess of $2,000,000. The more expensive part of the project was deauthorized, leaving a $37,000 revetment and dike project. Due to the scope of the completed project and the lack of information available, this project was designated as "Projects Which Are Continuing Authority Types."

(4) Authorized as part of a larger project with an estimated cost of $289,000. This particular $24,000 increment of the project was a reimbursement to the local interests for work they had previously accomplished as part of the authorized project.

Table 2-14 Summary - Small Scope Specifically Authorized Projects

Corps office	Number of Projects	Total Length of Shoreline (miles)	Original Cost of Construction ($000)		Cost of Construction Adjusted to 1993Price Levels ($000)	
			Federal	Total	Federal	Total
NED	21	12.21	962	2,770	5,628	16,664
SPL	5	3.76	787	1,790	3,869	9,151
Total	**26**	**15.97**	**1,749**	**4,560**	**9,497**	**17,575**

2. Operation. Operation activities of a beach fill project would include assuring public access and safety, providing basic amenities, protection of dunes, prevention of encroachments, and monitoring of beach design section conditions. Operation of the project should also assure that no acts of man erode or damage the integrity of the beach fill, berm and/or dune, or any structure that may be a part of the project[7]. Recent Corps regulations[8] require the non-Federal sponsor to: perform at least one complete survey of beach berm, foreshore profiles and protective dune each year prior to the storm season; be certain that the dry beach width above normal high tide is measured periodically; and make post storm surveys of the protective dune and coastal structures as required by the operations and maintenance manual.

3. Maintenance. Maintenance of a shore protection project includes not only maintaining, but also periodic replacement, repair, or rehabilitation of the measures/structures comprising the project. For a beach fill project, the primary maintenance responsibility would be to maintain the beach, berm, and dune design section by sand relocation (moving sand laterally along the beach) and profile reshaping (moving sand perpendicular to the shore), but excluding beach nourishment that is incorporated in the project as deferred construction. Maintenance would also include the maintenance, replacement and repair of dune walk overs, dune vegetation or sand fencing and all necessary repairs to assure the integrity and working order of any fixed structure[7]. The non-Federal sponsor must also provide such maintenance as is required to insure safety and serviceability of required public access, parking areas and sanitary facilities during periods of recreational use of the project beach. Additionally the non-Federal sponsor must inspect the facilities 20 to 30 days prior to the recreation season, and at least once a month during the recreation season, to insure that all required facilities are providing safe, serviceable public use[8]. Provision of all recreational amenities including access and parking is a non-Federal responsibility at all times.

4. Monitoring.

a. The Department of Army regulation on the monitoring of coastal projects was updated in 1993[9]. The objective of the regulation is to assure the collection of adequate information as a basis for improving project purpose attainment, design procedures, construction methods and operations and maintenance techniques. This objective is to be achieved through: normal monitoring and inspection of projects maintained by the Corps; cooperative efforts on beach fill projects maintained by others, but periodically nourished or reconstructed as part of a Federal shore protection project; and, a national program for intensive monitoring of selected Civil Works coastal projects maintained by the Corps (Monitoring of Completed Coastal Projects (MCCP) program). Project-related monitoring programs should continue to be included in the authority for new or modified projects and funded as a part of the project. Emphasis should be placed on developing a monitoring plan as an integral part of every coastal project. Protective beach fills require close monitoring (inspection) to ensure that damage reduction benefits are realized. Such monitoring (a necessary part of these projects) should be covered in a project operations and maintenance manual and accomplished as part of the beach nourishment effort. Monitoring for the projects included in the MCCP program is funded entirely by the Federal Government. Funding of selected projects under the MCCP program will be through Operation and Maintenance (O&M) appropriations. Since there is no authority for Federal participation in the O&M of shore protection projects, these type projects cannot be included in the MCCP program. Federal monitoring at these projects must, therefore, be funded from General Investigations or Construction General appropriations.

b. The engineer manual[10] that describes the MCCP program provides guidance on instruments that are available and procedures to be used in monitoring physical processes at coastal projects. The manual describes equipment, data handling, and site selection that must be incorporated into a coastal project monitoring effort. Guidance is provided on how various physical phenomena can be measured and analyzed. Detailed instructions are given on wave measurements, water level monitoring, current measurements, water temperature observations, salinity measurements, sediment sampling, littoral environmental observations, topographic and bathymetric surveys, structural surveys, visual observations, photographic documentation, ice conditions and meteorological monitoring. Examples presented in the manual transfer technical knowledge obtained from recent research activities to the Corps field offices.

5. Report Summary on Operation, Maintenance and Monitoring. The study questionnaire contained three questions with respect to operation and maintenance: is there an O&M manual; if not, is there periodic monitoring and/or inspection; and, what is the frequency of monitoring and/or inspection? The results of the questionnaire are shown in Table 2-15. In summary, of the 56 major projects that have been constructed, 16 have an O&M manual. Of the 36 projects that do not have an O&M manual, 18 are monitored and/or inspected periodically. For those that are inspected, the frequency of periodic inspection varies from once every month to "as needed". Of the 34 projects that either

have an O&M manual and/or are inspected, about 80 percent are inspected at least once every year. Four of the questionnaire forms were left blank for this series of questions.

Table 2-15 Operation and Maintenance Summary

Number of Projects	Type of Project	O&M Manual? Yes	O&M Manual? No	If no O&M Manual, is there Periodic Monitoring?
4	Initial Beach Restoration	1	3	1
1	Nourishment	0	1	1
9	Initial Beach Restoration/Nourishment	1	8	6
6	Initial Beach Restoration/Hard Structures	1	5	1
30	Initial Beach Restoration/Nourishment/Hard Structures	10	17(1)	9
6	Hard Structures	3	2(2)	0
56	**TOTAL**	**16**	**36**(3)	**18**

Notes: (1) 3 forms were left blank
(2) 1 form was left blank
(3) plus 4 blank forms

H. SUMMARY

The U.S. Army Corps of Engineers shoreline protection program has evolved over the last 50 years in response to coastal storms and the resulting Federal legislation. As of July 1993, the program consisted of 82 specifically authorized projects along 226 miles of ocean and Great Lakes shoreline. These projects account for less than one percent of the nation's total shoreline and about eight percent of the critically eroding shoreline. Over this period of time, the projects have changed from primarily hardened structures (groins, breakwaters, seawalls, etc.) to soft structures (sand fills) and from primarily beach erosion control projects with an emphasis on providing for recreation demand, to storm damage reduction projects providing incidental recreation benefits. Of the 82 projects, 26 were specifically authorized in the late 1950s and early 1960s, but were small in scope, having an average Federal cost at the time of construction of about $67,000 and an average length of only about 0.6 miles. Because of the small size and lack of information on these old projects, they were deleted from further detailed discussion in this report. In addition to the constructed projects, there are another 26 projects either under construction (1), authorized/awaiting initiation of construction (10), or are in the preconstruction engineering and design phase (15). These 26 projects, if all are constructed, will protect another 151 miles of the Nation's critically eroding coastline.

I. REFERENCES

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3. National Oceanic and Atmospheric Administration, Some Devastating North Atlantic Hurricanes of the 20th Century, 1993.

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6. U.S. Army Corps of Engineers, Report on the Advisability of Enacting the Provisions of Section 309 of PL 101-640 Draft Report, March 1994.

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9. U.S. Army Corps of Engineers, Engineer Regulation No. 1110-2-8151, Monitoring Coastal Projects, 29 January 1993.

10. U.S. Army Corps of Engineers, Engineer Manual No. 1110-2-1004, Coastal Project Monitoring, 30 November 1993.

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CHAPTER 3 - RISK MANAGEMENT IN COASTAL ZONES - OVERVIEW OF PROGRAMS

A. PHYSICAL SETTING

1. Beach Types. Shorelines of the United States cover a broad range of processes, geology, morphology, and land usages. There are five United States coastlines; Atlantic, Gulf of Mexico, Pacific, Great Lakes, and the Arctic. Although the processes of waves, water levels, tides, currents, and winds affect the coasts, they vary in intensity and relative significance. Variations in sediment supply and local geological setting result in coastal diversity. The common image of a long, straight, fine-sand "beach" with a gently-sloping offshore and a regular surf, is not the normal shore type. Not all "beaches" are sandy, nor are all shores dominated by wave action. Some shores are clay bluffs or rocky headlands, while others are shallow mud flats or lush wetlands. For some shores, tidal currents or river discharge dominate sediment transport and the shore character. Shore materials include muds, silts, sands, gravels, cobbles, and erosion-resistant bedrock. In portions of the United States, the coastal area is sinking and gradually becoming ocean bottom. In other areas, new shore lands are developing or rising out of the sea.

2. Erosion Characteristics. Not all shores are in equilibrium with the present littoral system. Shores with a character inherited from previous non-littoral processes (i.e., glacial or deltaic materials) may experience significant rates of erosion under present conditions. Some shores exhibit short-term seasonal or episodic event-driven cyclic patterns of erosion and accretion. Other shores demonstrate long-term stability (balanced sediment supply and no relative sea level rise influences). Accretion and erosion are natural responses to the processes of the shore. Shores which have been heavily modified by man's activities usually require a continuing commitment to retain a status quo.

B. DEMOGRAPHY OF THE COASTAL ZONE

1. Population. The present rate of growth in coastal areas is the single driving force behind all of the Federal programs that deal with risk management in that particularly populous area of extremely small size. A 1988 national assessment by the National Oceanic and Atmospheric Administration[1][2] confirms this increasing development trend along the Nation's shoreline. According to the report, almost one-half of our population now lives in coastal counties. Using the projections of the 1988 report and current information obtained from the United States Census Bureau, coastal population is expected to grow from 80 million in 1960 to approximately 135 million people by the year 2010, an increase of almost 70 percent. While the percent of the population living in coastal counties is

[2] Numbers in brackets "[ ]" refer to reference numbers. References for Chapter 3 are at the end of the Chapter.

projected to remain constant over the next 20 years, it must be recognized that the land area encompassed by these coastal counties is much smaller than that of the non-coastal counties, resulting in a decidedly denser population.

2. Population Density. Coastal counties are those identified by either the Federal Coastal Zone Management Program, managed by the National Oceanic and Atmospheric Administration (NOAA), or by individual state coastal management programs[1]. This encompasses the 30 coastal states, including the states around the Great Lakes, the District of Columbia, boroughs of census areas of Alaska and independent cities in Virginia and Maryland. The 451 coastal counties (out of a national total of 3,143) account for 20 percent of the Nation's total land area. If the land area of Alaska is excluded, the coastal county land area comprises only 11 percent of the remaining national total. In 1960, population density of the United States was 61 persons per square mile; in coastal states it was 100 persons per square mile; and in coastal counties it was 248 persons per square mile. By 1988, population density in coastal counties reached 341 persons per square mile, more than four times the U.S. average. Continued population growth in coastal areas portends increased crowding of the relatively small, but densely populated, portion of the Nation[1]. Seventeen of the 20 states with the largest statewide population increases are coastal. In Florida, which is defined as entirely coastal, population is expected to increase by 11 million, a 230 percent change between 1960 and 2010[1]. The population density for this time period is shown in Table 3-1.

Table 3-1 Coastal and Non-Coastal Population and Density Change, 1960-2010

County	1960		1990		2010	
	Population	Density	Population	Density	Population	Density
Coastal	80	250	112	350	135	420
Non-Coastal	101	39	138	53	165	64
Nation	181	62	250	86	300	103

While the percentage population change between 1960 and 2010 for coastal counties is not much greater than for non-coastal counties (69% versus 63%), this is not indicative of the true nature of the development. In coastal counties, the density of development is even greater along the shoreline than it is for the county as a whole.

3. Building Permits. Results of this coastal area trend in increased density can be seen in building permit activity. While the construction of single-family homes, offices, and shopping centers is usually seen as a sign of healthy economic growth, the dilemma of balancing this growth and

protecting coastal areas through sound management is increasingly becoming a national concern. Building permit data has recently been tabulated by NOAA[2]. The report by NOAA used data derived from the permit database of the Bureau of the Census. The database represents the number of residential units and non-residential buildings authorized by building permits between 1970 and 1989. Across the United States, an average of 16,000 permits were issued each year during the 20-year period. The report compiled the data for the following categories; residential construction, commercial and industrial construction, and hotel and recreation construction. A summary of the findings is shown in Table 3-2.

Table 3-2 Building Permits 1970-1989

Item	**Coastal States**		
	Coastal Counties	**Non-Coastal Counties**	**Non-Coastal States**
Housing Units	47%	36%	17%
Commercial & Industrial	40%	40%	20%
Hotel & Recreational	45%	36%	19%

While there were data limitations listed in the NOAA report, it is obvious that in every sector of construction, activities were more intense in coastal states, and further, most of those activities were in the narrow 11 percent of the Nation's coastal margin shoreline.

4. Impacts of Demographic Trends.

a. With population growth, has come development and a corresponding increase in vulnerability to coastal hazards, storms and hurricanes. For example, the property-casualty insurance industry has estimated that its insured property exposure in residential and commercial coastal counties in the 18 Gulf and Atlantic Coast States increased 65 percent, from $1.13 trillion to $1.86 trillion, over the period from 1980 to 1988. These figures do not include amounts for the Pacific Coast, or near-coastal cities such as Houston and Philadelphia, that could be (and have been) affected by coastal storms, or any uninsured property or self-insured government property. This change is a result of increasing property values, as well as of greater numbers of properties insured. Insurance-industry liabilities in some states have grown much faster during this period than the coastal-state average. For example, because of Hurricane Hugo in 1989, South Carolina had an 83 percent increase in insurance claims. Many insurance companies decided to pull out of Florida coverage after Hurricane Andrew hit Florida in 1992, and others are increasing premium rates significantly, perhaps an indication of future trends[3].

b. Hurricanes and severe coastal storms are among the most destructive and costly of natural phenomena. Flooding, erosion, and wind damage caused by such storms result in many lost lives and hundreds of millions of dollars of property damage every year. The Atlantic and Gulf coasts of the United States are especially vulnerable to hurricanes. Since 1871, roughly 250 hurricanes of varying intensity have struck parts of the coast between Maine and Texas. Virtually no segment of this coast has been spared[3]. The destructive potential of a hurricane is a function of both its intensity and the density of development in the area affected. Applied Insurance Research, Inc., in Boston, Massachusetts, has developed estimates of total losses for major U.S. cities if a major hurricane should strike. They estimated, for example, that a category 5 hurricane (see Chapter 2, Table 2-1 for the "Saffir/Simpson Hurricane-Intensity Scale") could generate $43 billion (in 1993 dollars) in losses at Galveston, Texas and a category 4 hurricane could create $41 billion dollars in losses on Long Island, New York (see Table 3-3)[3]. As a point of reference, both Hurricane Andrew when it hit south Florida in August 1992 and Hurricane Hugo which hit South Carolina in 1989 were category 4 hurricanes.

Table 3-3 Estimated Cost of a Major Hurricane Striking Densely Populated Areas or Major Cities

Saffir-Simpson Category	Landfall Location	Estimated Total Loss (Billions of 1993 Dollars)
5	Galveston, TX	43
5	New Orleans, LA	26
5	Miami, FL	53
5	Ft. Lauderdale, FL	52
5	Hampton, VA	34
4	Ocean City, MD	20
4	Asbury Park, NJ	52
4	New York City, NY	45
4	Long Island, NY	41

c. Even with the known dangers, Americans continue to migrate to beach areas. Recent surveys of coastal-property owners suggest that many have a solid appreciation for the dangers and risks of building and living in coastal areas, but see hurricanes and coastal storms as simply a necessary part of the tradeoff for the benefits of coastal living. Box 3-1 shows the results of a questionnaire mailed to owners of beachfront property in South Carolina heavily damaged by Hurricane Hugo in 1989[4]. This survey shows that fully 80 percent of the respondents will continue to live with the risks.

Box 3-1

Results of a Mail Survey of 132 Owners of Beachfront Property in South Carolina After Hurricane Hugo That Asked the Question:
"Now that you have experienced the effects of a Hurricane, has this had any influence on your feelings about owning beachfront property?"

Answer	Percent
1. Yes, would not buy beachfront property again.	6
2. Yes, would like to sell my property and buy property in a safer location.	7
3. No, hurricanes are just a normal risk in beachfront areas.	39
4. No, the benefits and enjoyments of beachfront living outweigh the potential risks.	42
5. Other.	6

Even those who were devastated by such events did not generally have regrets or plan to move to safer locations. A related obstacle is the economic advantage of beachfront locations. Owners of beachfront property may be reluctant to relocate structures at risk until they have nearly collapsed into the surf because the income from renting these units on the beach is substantially higher than it would be on sites farther inland. Also, equivalent beach front property is often unavailable or too expensive[3].

d. Since population near the coast is growing faster than other regions of the Nation, the infrastructure needed to support that population is also rapidly expanding. This expansion results in a corresponding decrease of valuable natural habitats as well as the imposition of other direct and indirect adverse environmental impacts. The continued population increase in the coastal area and its associated pressure on the limited resources of the Nation's coastal zone has, over time, resulted in an array of Federal, state, county and municipal programs aimed at managing the associated risks. Risks are posed to concentrated populations and related properties by the natural hazards characteristic of coastal areas and also by development on limited coastal zone resources.

e. From an abstract social standpoint, flood damages and/or erosion do not have adverse consequences unless they threaten something deemed to have social value (economic, environmental, aesthetic, recreational, health or safety, etc.). There are many ways to protect development located in coastal areas. Damages from flooding and shore erosion include loss of beaches for recreation; loss of waterfront land; damage to highways, residences, commercial development and other waterfront structures; and, loss of wetland and other habitats important to marine and coastal life forms. Developmental pressures can aggravate the natural dynamics and exacerbate the problem, as can an array of solutions designed to mitigate the damages. Ironically, coastlines such as barrier islands, which can least withstand development pressure, attract strong development interest[5].

C. FEDERAL PROGRAMS

1. General.

a. Any Federal program is the direct result of Congressional legislative activity. While there is no single, comprehensive program that addresses the many problems of risk management in coastal zones, there are various programs in place at each level of government and within the private sector which are directed at the identified problems.

b. In 1930, Congress authorized the Corps, in cooperation with states and local governments, to research and investigate problems concerning the effects of erosion and storms on developed coastal areas. This evolved into the Federal shore protection program being covered by this report. By comparison, other major Federal programs, relevant to risk management in coastal zones, are of more recent origins in time. Specifically: (1) the National Flood Insurance Act of 1968, administered by the Federal Emergency Management Agency; (2) the Coastal Zone Management Act of 1972, administered by the National Oceanic and Atmospheric Administration; (3) the Coastal Barrier Resources Act of 1982, administered by the Department of Interior, U.S. Fish and Wildlife Service; and, (4) in 1990, the National Coastal Geology Program, administered by the Department of the Interior, U.S. Geological Survey.

c. Brief descriptions of these programs, starting with the most recent, are provided below. This is followed by a general discussion of: (1) the principles and practices used by the Corps in planning and evaluating the economic feasibility of shore protection projects; (2) policies pertaining to the Federal shore protection program; and, (3) a brief discussion of the engineering aspects of beach fill and nourishment, as this is now the primary method of shore protection.

2. National Coastal Geology Program.

a. The National Coastal Geology Program (CGP) is a component of the U.S. Department of the Interior, Geologic Survey's Marine and Coastal Geologic Surveys. Its purpose is to increase the understanding of coastal problems by improving predictive capabilities required to rationally manage and utilize the Nation's coasts. Specifically, the program's intent is to improve the ability to predict future erosion, the fate of wetlands, the accumulation and dispersal of polluted sediments, and the locations of economically valuable hard minerals including sand. This program duplicates, to some degree, the Corps' shore protection program. Studies of physical processes, measuring and predicting erosion, societal impact of the problems, storm frequencies, sand searches and borrow area locations are all facets of both programs.

b. An initial research plan to address coastal issues nationwide was prepared in Fiscal Year 1990 in response to a request from the Congress. In the Committee report accompanying the Fiscal Year 1993 Department of the Interior appropriations bill, the Congress directed the U.S. Geologic Survey to evaluate and update the existing plan. As in the 1990 plan, information on research needs and data gaps has been gathered from the coastal states and island territories. The updated plan outlines a broad-based research program composed for four sub-groups; (1) Coastal Erosion, (2) Wetlands Deterioration, (3) Coastal Pollution, and (4) Hard- Mineral Resources (such as sand sources).

c. During Fiscal Year 1993, the CGP supported nine regional studies in ten states, with four addressing erosion, two addressing pollution, and three addressing wetlands deterioration. In addition, a comprehensive investigation was begun on the impact of hurricane Andrew on the barrier islands of Louisiana. All studies are funded on a 50/50 cooperative basis with other Federal or state agencies, and/or universities. Fundamental studies, regional studies and catastrophic event studies are included in the program.

d. This program duplicates to a considerable degree the U.S. Department of the Army shore protection program. Studies of physical processes, measuring and predicting erosion, societal impact of the problems, and storm frequencies, sand searches and borrow area locations are all facets of the Corps' program.

3. Coastal Barrier Resources Act.

a. The Coastal Barrier Resources Act (CBRA) was passed by the Congress in 1982 (PL 97-348). The purposes of the Act are to minimize loss of human life, wasteful expenditures of resources, and damages to fish and wildlife resources associated with coastal barriers. The Act established the Coastal Barrier Resources System (CBRS). The CBRS consists of 182 units on undeveloped coastal barriers along the Atlantic and Gulf coasts (totalling 656 miles of ocean front shoreline and encompassing 454,000 acres). The Act prohibits Federal expenditures for construction, purchase or stabilization of projects within the protected area (including the denial of Federal flood insurance and disaster assistance).

b. This legislation was passed because of the concerns over past and possible future damage costs, along with environmental and public safety concerns and the realization that Federal programs have historically encouraged and assisted development of barrier islands with resulting losses of natural, cultural, recreational, and other resources[6]. The program is administered by the Secretary of the Interior through the Fish and Wildlife Service. The Act precludes Federal expenditures that induce development on coastal barrier islands and adjacent nearshore areas. Except for maintenance of existing projects, no new Federal expenditures or financial assistance are allowed for the areas within the system.

c. Section 6 of the Act sets forth several exceptions to the general prohibitions of Federal expenditure. Exceptions to the Act are permitted if the expenditure is for non-structural projects for shoreline stabilization that are designed to mimic, enhance or restore natural stabilization systems. In June 1994, the Department of the Interior clarified its position of exceptions to the Act. Sand cannot be taken from a system unit and placed outside of that same unit. The entire project must be within the unit and cause no damage to the unit, for exceptions under Section 6 to apply.

d. The CBRS was expanded in 1990 under the coastal Barrier Improvement Act (PL 101-591) to include 560 units comprising 1.3 million acres and 1200 shoreline miles. In addition, under the 1990 Act, the Department of Interior was directed to map all undeveloped coastal barriers along the Pacific Coast for eventual inclusion by Congress in CBRS[3].

e. Several studies have sought to evaluate the effectiveness of the CBRA at discouraging barrier-island development. These studies are: (1) Godschalk, D., <u>Impacts of the Coastal Barrier Resources Act: A Pilot Study</u>, Washington, DC: Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, 1984; (2) Godschalk, D., <u>The 1982 Coastal Barrier Resources Act: A New Federal Policy Tack</u>, in: "Cities on the Beach", Platt (ed.), Chicago: University of Chicago, 1987; (3) Jones, E., and W. Stolzenberg, <u>Building in Coastal Barrier Resource System</u>, Washington, DC: National Wildlife Federation, 1990; and (4) U.S. Congress, General Accounting Office (GAO), <u>Coastal Barriers: Development Occurring Despite Prohibition Against Federal Assistance</u>, GAO/RCED-92-115, Washington, DC: GAO, July 1992. These studies suggested that the CBRA has not stopped development pressures on undeveloped coastal barriers, although the withdrawal of Federal subsidies has had some effect on discouraging new development. The General Accounting Office, in its July 1992 report, noted that the "availability of accessible coastal land is limited [and] populations of coastal areas are expected to increase by tens of millions by year 2010. This population increase will further spur market demand, providing an incentive for developers, owners, and investors to assume the risks associated with owning and building in these storm-prone areas"[3].

4. <u>Coastal Zone Management Act</u>.

a. The Coastal Zone Management Act (CZMA) of 1972 (PL 92-583) is administered by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) through the Office of Ocean and Coastal Resource Management. The Act declares a National interest in the effective management of the coastal zone; and that primary responsibility rests with state and local governments. The CZMA authorizes Federal grants to states for development and implementation of coastal management programs for water and land resources in coastal zones. When the CZMA was amended in 1980, goals for both flood loss reduction and protection of natural resources were incorporated in the coastal management goals. States were required to provide for "the management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas of subsidence and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands and barrier islands." As part of the most recent reauthorization of the CZMA, in 1990, the states were encouraged to provide for "the study and development, in any case which the Secretary [of Commerce] considers it to be appropriate, of plans for addressing the adverse effects upon the coastal zone of land subsidence and of sea level rise..."[6].

b. Section 307 of the 1972 Act requires that proposed Federal activities in the coastal zone shall require state certification that the activity complies with the states's approved coastal zone management program. No Federal license or permit shall be granted without the state's concurrence. The 1990 Coastal Zone Management Act Amendments clarifies that all Federal activities, whether in or outside of the coastal zone, are subject to the consistency requirements of Section 307 of the 1972 Act, if they affect natural resources, land uses or water uses in the coastal zone.

c. The 1990 modification to Section 309 of the 1972 CZMA also established Coastal Zone Enhancements Grants. The purpose of this was to encourage the states to undertake improvements to their existing coastal management programs to address one or more of eight identified objectives. One of these objectives is "preventing or significantly reducing threats to life and destruction of property by eliminating development and redevelopment in high-hazard areas, managing development in other hazard areas, and anticipating and managing the effects of potential sea level rise and Great lakes level rise." The Enhancement Grants, which are 100 percent Federally funded, are supported by a percentage of funds appropriated for support of the basic coastal management program[6].

d. Since 1972, the states have had funds available through the U.S. Department of Commerce for the development and implementation of coastal zone management programs. Although the program is voluntary, participation has been very high. All of the coastal states now have Federally approved plans except for Texas, Georgia, Illinois, Indiana, Minnesota, and Ohio. Georgia and Minnesota have coastal regulatory programs, but not Federally approved coastal management programs. Coastal management programs in California and Oregon predate the Federally supported effort[6]. There is significant natural diversity in shore types throughout the United States. Consequently, engineering, land use, and shoreline policy strategies have developed regionally and are flexible to the local situation. Successful and implementable legislation developed for general coastal application tends to be sensitive to this diversity. Each coastal state with a Coastal

Zone Management Plan (CZMP) defines its coastal zone in a way to suit its own particular needs, and each state has in place a set of laws and regulations designed to address the needs of that state in controlling the uses of its coastal zone. There are significant differences between one states CZMP and another; however, all programs must meet the procedural requirements of the CZMA.

e. Through their coastal management programs, the states have adopted a great variety of measures that directly or indirectly address coastal floodplains and natural resources. Some have adopted comprehensive legislation that includes various provisions for restoration and preservation of living resources, natural areas, floodplains, and other resources. Other examples of measures include: beach and sand dune protection plans, ordinances, and regulations; wetland mapping and regulatory standards; use standards for critical areas; designation of areas for preservation/restoration; and, site plan reviews for development in the coastal areas.

f. As shown in Table 3-4 all but two coastal states have some form of state mandated regulatory mechanism, though not necessarily an erosion setback line, by which they prohibit or otherwise restrict certain types of new development in designated portions of their coastal zones. Almost all coastal states restrict construction of new structural stabilization projects, but few specifically restrict reconstruction of shoreline protection and erosion control structures damaged by 50 percent or more. Only about half the states have any explicit provision in their coastal zone management programs for the relocation of structures in erosion prone areas, as distinguished from provisions relating the National Flood Insurance Program. Direct state permitting is more common with respect to coastal floodplains than riverine floodplains [6].

g. Virtually all coastal states have public policies assuring or encouraging public access to their respective coastal water, although not expressly related to renourishment projects funded by the United States.

h. The CZMA has stimulated considerable coastal planning and management that may not otherwise have occurred or would have occurred more slowly. Funding levels at the Federal level have remained fairly constant since the early 1980s. Some states have aggressively managed and controlled coastal development, whereas others have done little. NOAA has not as yet applied sanctions available under Section 312 to states that do not fully implement their adopted and approved programs[3].

Table 3-4 State Regulations for Coastal and Lakeshore Floodplains

State	Coast	Lakeshore	Sand Dunes	Erosion
Alabama	S		S	
Alaska				
California	S		S	
Connecticut	S,L		S,L	
Delaware	S,L		S	S
Florida	L		S,L	S,AL
Georgia	S		S	L
Hawaii	S			
Illinois		AS		
Indiana		S		
Louisiana	A	L		
Maine	AS,L	S,L	AS,L	S
Maryland	S			S
Massachusetts	SL	SL	L	
Michigan		AS	S	L+
Minnesota		L		
Mississippi	S			
New Hampshire	L	S		
New Jersey	S		S	
New York	L+	L+	L+	L+
North Carolina	SL		S,L	S,L
Ohio				
Oregon	L	L	L	L
Pennsylvania	L			
Rhode Island	S		S	
South Carolina	S			
Texas	A,S			
Virginia	S			
Washington	L	L		L
Wisconsin		L		

A = Rules apply only in certain areas, e.g.,Illinois and Michigan lakeshore regulations apply only to the Great Lakes
L = Local regulations must meet state requirements
S = State directly regulates development
\+ = State will directly regulate if local governments do not

Source: Association of State Floodplain Managers. "State Floodplain Management Programs. Results of a Survey Conducted by the Association of State Floodplain Managers for L.R. Johnson Associates," 1988.

5. National Flood Insurance Program.

a. The National Flood Insurance Program (NFIP) was authorized under the National Flood Insurance Act, PL 90-488. This program was created by Congress in 1968 to provide Federally backed flood insurance coverage to property owners since it was generally unavailable from private insurance companies. The program is administered by the Federal Insurance Administration (FIA), a unit of the Federal Emergency Management Agency (FEMA). The program was intended to reduce future flood losses by ensuring that new development is adequately protected from flood damages and to place a greater share of the costs of flood damages on those most at risk rather than the taxpayers nationwide. The NFIP is based on a mutual agreement between the Federal government and communities that have been identified as flood-prone. In administering the program, FEMA makes flood insurance available to those communities that adopt land-use regulations, with adequate enforcement provisions, which would reduce future flood losses. This is accomplished through a local floodplain management ordinance that meets or exceeds the minimum requirements of the NFIP(7). Of approximately 18,000 communities nationwide that have been identified as flood-prone, approximately 1,800 are subject to coastal hazards produced by storm-surge or erosion. As a condition of making flood insurance available, the NFIP requires that a community regulate new and substantially improved construction so that it is designed to withstand hydrostatic, hydrodynamic and other forces produced during a flood with a 1 percent annual probability of occurrence (i.e., the 100-year flood)[8].

b. Some criticism has been directed toward the NFIP as a primary cause of rampant development experienced along coastlines during the past several decades. However, a 1982 report by the U.S. Government Accounting Office[9] concluded that the effect of NFIP was "marginal, added incentive" for new coastal construction and renovations. Other studies indicate that flood insurance availability is not a significant stimulus for coastal development[10]. Factors providing more impetus for development than insurance are the psychological value of ocean front property ownership; real estate investment return; rental income remuneration; Federal and state financial assistance for infrastructure emplacement, and Federal tax policies such as casualty loss deductions. Without the NFIP, coastal development would occur regardless, but much of it without the mitigating aspects of prudent coastal construction standards. The other important, but often overlooked, purpose of flood insurance is to help defray the cost of repairing flood-damaged buildings, rather than complete reliance on disaster relief funds and Federal income tax deductions for uninsured property losses. New and substantially improved construction in coastal flood-hazard areas is rated actuarially, based on flood risk. The actuarial rates, however, are based on flood hazards in existence when a building is constructed, and do not consider the increase in flood risk associated with long-term, coastal erosion[8].

c. In the recent 2nd Session of the 103rd Congress, lawmakers did not vote on legislation that gradually would have increased premiums and denied coverage to new construction in the 30-

year erosion zone, the most vulnerable part of the United States coastline. Instead, the lawmakers approved a measure requiring a two-year study to map erosion rates along selected coastlines. The bill would also require the government to take action against lenders who provide mortgages in flood-prone areas without requiring flood insurance coverage[11].

6. Corps of Engineers Shore Protection Program. The U.S. Army Corps of Engineers has been given a very different mission by the Congress, i.e., It is authorized to plan, design and construct shore protection projects. The Corps is also authorized to perform basic research in coastal engineering and is the preeminent coastal organization, public or private, in the United States. The Corps' shore protection program is limited to densely developed coastal areas and is directed at producing gains in economic efficiencies through hazard mitigation, and to establish project protection lines which preclude any future seaward advance of coastal development. Details of this program, as it addresses risk management, are given in the following paragraphs of this chapter.

7. Summary of Federal Programs . In summary, the Federal programs described above address risk management in terms of natural resources and development in the following manner:

a. The National Coastal Geology Program, by improving predictive capabilities and understanding of large-scale coastal erosion problems;

b. The Coastal Barrier Resources Act, by economic disincentives to development for the purpose of preserving the natural characteristics of coastal barrier units and preventing or reducing the risk of development in the high hazard coastal zone;

c. The Coastal Zone Management Act, by encouraging state and local regulatory constraints to attain an appropriate balance in coastal resource uses and to minimize coastal hazards exposure to developments (e.g., set-back lines);

d. The National Flood Insurance Program, by economic (insurance premiums) incentive approach to foster adoption of state and/or community building codes and set-backs in the interest of hazards mitigation; and,

e. The Corps of Engineers Shore Protection Program, by research, design, and construction of economically and environmentally sound projects.

8. The Tax Code.

a. Only briefly mentioned in the above Federal Programs affecting beach front development is the matrix of Federal, state and local taxes. Taxes can and have been used to encourage and discourage construction in flood-prone areas. As noted by the U.S. Department of Treasury in 1984, "The United States income tax is not used simply to raise revenue. Instead it is used to subsidize a long list of economic activities through exclusions from income subject to tax, adjustment to income, business deductions unrelated to actual expenses, deferral of tax liability, deductions of personal consumption expenditures, tax credits and preferential tax rates" [6].

b. The Tax Reform act of 1986 made major changes in the tax code. These changes were in large part designed to reduce the code's interference with economic decisions made by individuals and businesses. Still, several major coastal-development subsidies are available in the U.S. Tax Code. It must be noted, however, that similar tax code "subsidies" apply to all property no matter where it is located. Everyone who has uninsured damages benefits, e.g., wind, earthquake, rainfall, tornado, etc. Within certain limits, the casualty-loss deduction allows coastal property owners to deduct the cost of uninsured damages resulting from hurricanes and other natural disasters. Other Federal tax subsidies include interest and property-tax deductions for second homes (which comprise much of coastal development) and accelerated depreciation for seasonal rental properties[3]. An article titled "Rentals by the Sea" in the July 30, 1994 Washington Post, outlined the importance of taxes on oceanfront rental property and stated that taxes are a key part of any purchase.

c. Many state, county and municipal governments base their tax codes on the Federal tax code (as well as developing some of their own) and, accordingly, increase development incentives. The total impact of taxes on encouraging development in the coastal area is unknown and estimates of their aggregate cost are hard to assess. There is little doubt, however, that the extent of implicit public subsidy is substantial[3].

D. AN OVERVIEW OF PLANNING AND ECONOMIC EVALUATION PRINCIPLES AND PRACTICES THAT GUIDE THE U.S. ARMY CORPS OF ENGINEERS

1. Introduction.

a. The Corps has a number of programs, derived from various Congressional authorities, to undertake a wide variety of studies and provide other services in the interest of developing and managing certain of the Nation's water resources. Planning programs and studies include those funded in the General Investigations Program part of the Corps budget and the Continuing Authorities Program.

b. Studies for project authorization are undertaken in response to either a study-specific authority or a standing authority. Study-specific authorizations may be a resolution from either the House or Senate Committee on Public Works and Transportation, or included in a public law.

Standing authorities provide the Secretary of the Army, acting through the Chief of Engineers authority to plan, design and construct certain types of water resources projects without specific Congressional authority. Six legislative authorities make up this standing authority, more commonly known as the Continuing Authorities Program (see Chapter 2, Paragraph E.). Studies undertaken in response to these authorities are now conducted in two phases in accordance with the provisions of the Water Resources Development Act of 1986 (WRDA '86). This process encourages significant non-Federal participation in studies, thus concentrating limited Federal funds on studies which will lead to implementation projects with strong Federal support. The first study phase is the reconnaissance phase. This phase is conducted at full Federal expense and is limited to 18 months in length. The objective of reconnaissance studies is to enable the Corps to determine whether or not planning to develop a project should proceed to the more detailed feasibility study phase. Feasibility studies are conducted to investigate and recommend solutions to water resources problems. Feasibility studies are cost shared 50/50 with a non-Federal study sponsor.

c. The process that has evolved on a Federal level to assist in formulating and evaluating water resource projects is the National Economic Development objective, or NED. The underlying fundamental economic problem is that we cannot do everything. The NED principle is a policy developed to guide Federal water resource planners in their choice of problem solutions. Choice is the fundamental business of economics. Because all resources are scarce, we are forced to make choices when they are used. Choose more of one thing and you simultaneously are choosing less of another. The process of developing a plan for the use of a water resource is an exercise in dealing with the fundamental economic problem of scarcity. The NED principle ensures that a project will be constructed only if the project outputs - the benefits to the Nation from the use of the resource - exceed the cost of using it.

d. Widespread use of the benefit-cost analysis as a test of a project's economic worth is generally considered to have grown out of the Flood Control Act of 1936. In this Act, Congress required that the U.S. Army Corps of Engineers recommend a project only "if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are not otherwise adversely affected."

e. If there is an economically justified project, decisions on whether and to what extent there should be Federal participation are guided by a concept of the Federal interest that has evolved from legislation, from precedent in project authorization and construction, and from budget priorities. Federal participation must be otherwise warranted. Federal participation is limited in circumstances where there are special and local benefits which accrue to a limited number of identifiable beneficiaries. The Federal government does not participate in facilities which produce outputs incidental to basic project purposes. Federal funds are not budgeted for a project unless a significant proportion of the project outputs have a high budget priority.

2. Basic Evaluation Principles.

a. The principle guidelines for planning by Federal agencies involved in water resource development are governed by the March 10, 1983, Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, better known as "The Principles and Guidelines" (P&G). Although each project and project setting presents unique problems and opportunities, the Corps applies a consistent set of decision criteria to participation in project planning and construction. The P&G states that "the Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements." In other words, economic benefits to the Nation must exceed project costs, without unnecessary sacrifice of environmental resources.

b. The Corps complies with all environmental laws and Executive Orders. The Corps carefully considers and seeks to balance the environmental and development needs of the Nation in full compliance with the National Environmental Policy Act of 1969 (NEPA) and other authorities provided by Congress and the Executive Branch. Alternative means of meeting competing demands generated by human water resources needs are identified and their environmental values examined fully, along with the economic, engineering and social factors. Those significant adverse impacts that cannot be avoided are mitigated as required by Subsection 906(d) of the WRDA '86. This subsection requires the Secretary of the Army to include in reports submitted to Congress for authorization of construction, a specific plan to mitigate fish and wildlife losses or a determination that the project will not have a significant adverse impact on fish and wildlife resources.

c. Participation in shore protection projects is limited to beach restoration and protection, not beach creation or improvement, unless such improvement is needed for engineering purposes. The term "restoration" was substituted for "improvement" in the amendment of July 28, 1956 (P.L. 826, 84th Congress) so that the basis for Federal concern became "restoration and protection" as opposed to creation of new lands. Accordingly, Federal participation in restoration is limited to the historic shoreline. It does not provide for Federal cost sharing in extending a beach beyond its historic shoreline unless required for protection of upland areas.

3. Planning Process.

a. Systems Approach. The Federal planning process is a systems approach and consists of a series of steps directed toward formulation of an array of alternative plans. The plans each address, in some measure, the water and related land resources problems and opportunities, and respond to the state and county and municipal concerns. The key to the systems approach is that erosion and storm damage problems do not stop at political or municipal boundaries, but rather have natural or physical limits. The physical boundaries of the problem area are first described. These limits are selected in relation to natural physical processes in combination with geophysical characteristics. The study area is often divided into adjacent reaches bounded by natural or manmade inlets, which serve to substantially interrupt or limit the continuity of natural longshore littoral processes. The reaches are selected so that within a given reach, or littoral cell, similar natural processes occur such as wave energy, geotechnical properties, littoral transport and associated beach/inlet processes. Using this approach, alternative plans can be developed and impacts considered within a systems context. The ultimate goal is to optimize the combined effectiveness and economic efficiency of the shore protection, navigation maintenance and dredged material disposal and other activities in each reach and adjoining reaches.

b. Six Planning Steps. The Federal planning process consists of the following six major steps:

(1). Specify Problems and Opportunities. The problems and opportunities statements should be framed in terms of the Federal objective as well as identifying commensurate state and local objectives. The statements should be constructed to encourage a wide range of alternative solutions with identifiable levels of achievement. Statements should encompass current as well as future conditions and the planner should be cognizant that initial expressions of problems and opportunities may be modified during the study evolution.

(2). Inventory and Forecast of Conditions Without a Plan. The inventory and forecast step quantifies and qualifies the planning area resources important to the identified water resources problems and opportunities, now and in the future, in the absence of a plan. This step is a statement of the without-project condition.

(3). Formulate Alternative Plans. Alternative plans are to be formulated in a systematic manner during the entire study process to ensure that all reasonable alternative solutions are evaluated. Usually, a number of alternative plans are identified early in the planning process and are refined in subsequent iterations. However, additional alternative plans may be introduced at any time. A plan that reasonably maximizes net national economic development (NED) benefits, consistent with protecting the nation's environment, is to be identified as the NED Plan. Other plans which reduce net NED benefits in order to further address other Federal, state, local and international concerns should also be formulated.

(4). Evaluate Effects.

(a). Four accounts are established to simplify the evaluation and display effects of alternative plans. These four accounts encompass all significant effects of a plan on the human environment as required by NEPA. They also encompass social well-being as required by Section

122 of the 1970 Flood Control Act. The NED account is the only required account. Other information that will have a material bearing on the decision-making process is included in the other accounts listed below:

((1)). The national economic development (NED) account displays changes in the economic value of the national output of goods and services;

((2)). The environmental quality (EQ) account displays non-monetary effects on ecological, cultural, and aesthetic resources;

((3)). The regional economic development (RED) account registers changes in regional economic activity. Evaluation or regional effects are to be carried out using nationally consistent projections of income, employment, output, and population; and,

((4)). The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

(b). Display of the NED account is required; appraisal is applicable only to EQ, RED, and OSE evaluations. Planners shall also identify areas of risk and uncertainty in their analyses and describe them clearly, so that decisions can be made with knowledge of the degree of the reliability of the estimated benefits and cost and effectiveness of alternative plans.

(c). The cost of mitigation measures is developed along with other costs of alternative plan features. Monetary values are to be expressed in average annual equivalents by appropriate discounting and annualizing techniques using the applicable water resource discount rate. The same period of analysis is used for all alternative plans, which for most studies, is selected to be 50 years. The period of analysis does not include the implementation or construction period. All benefits and costs are expressed as of the beginning of the period of analysis.

(5). <u>Compare Alternative Plans</u>. Plan comparison focuses on the differences among the alternative plans determined in the evaluate effects step. Monetary and non-monetary effects should be comparably represented in narrative or display.

(6). <u>Plan Selection</u>. A plan that reasonably maximizes net NED benefits, consistent with the Federal objective, is the goal of the Federal plan formulation and analysis process. This plan will be identified as the NED plan. The NED plan is formulated and compared using the following criteria:

(a). <u>Completeness</u>. The extent to which a given project proposal provides and accounts for all necessary investments or other actions to ensure the realization of storm damage reduction;

(b). Effectiveness. The extent to which a given project proposal contributes to a solution to the shoreline erosion and storm damage problems and achieves protection from storm damages;

(c). Efficiency. The extent to which a given project proposal is the most cost effective means of providing storm damage protection, consistent with protecting the Nation's environment; and,

(d). Acceptability. The viability of a given project proposal and its acceptance by the non-Federal project sponsor, the state, county and municipal entities and the public, and compatibility with existing laws, regulations, and public policies.

4. Coastal Evaluation Principles.

a. The Corps has a long history of planning coastal protection measures as well as other types of water resources development projects. By providing protection against coastal hazards, gains in economic efficiency can be achieved that result in an increase in the national output of goods and services. There are also additional regional and local economic gains that result from the transfer of economic activity from some other location(s). A comprehensive guide for calculating NED benefits primarily for storm damage reduction and shore protection projects is contained in IWR Report 91-R-6 National Economic Development Procedures Manual - Coastal Storm Damage and Erosion, U.S. Army Corps of Engineers, Institute for Water Resources, September 1991.

b. Adaptive responses to the hazards of storm-tides and waves can be classified into four approaches or options:

(1). Hard engineering structures -- bulkheads, groin fields, seawalls, revetments, and breakwaters;

(2). Soft engineering options -- beach nourishment and dune stabilization;

(3). Non-Structural/Management options -- set-back requirements, building codes and land use controls; and,

(4). No Action or Passive options -- no systematic response, whereby all attempts to protect against hazards are made on an individual basis.

c. Coastal protection projects, like all investments, involve an outlay of capital at some point in time in order to gain predicted benefits in the future. In addition, certain types of projects, particularly beach fill and periodic nourishment projects, require a commitment to substantial future spending to sustain the projects and continue to gain the related benefits. In 1956, Congress defined periodic nourishment as construction for the protection of shores when it is the most suitable and economical remedial measure. One advantage to soft engineering options, such as beach fill, is that they do not represent an irrevocable commitment of funds. They can be discontinued at any future point in time, eventually allowing a return to the pre-project condition, without further expenditures.

d. In all evaluations, the aspect of future costs and benefits requires that the current and future dollar costs and benefits be compared in a common unit of measurement. This is typically accomplished by comparing their present values or the average annual equivalent of their present values. Therefore, the discount or interest rate used to determine the present values influences the relative economic feasibility of alternative project types. Since high discount rates reduce the influence of future benefits and costs on present values, high interest rates generally favor the selection of projects with low first costs but relatively high planned future expenditures over those with high first costs but low future cost requirements. This factor, among other important considerations, tends to favor the wide use of beach fills, dunes, and accompanying renourishment relative to an extensive use of hard structural shore protection measures.

e. One standard for identifying and measuring the economic benefits from investments in a water resources project such as shore protection, is each individual's willingness to pay for that project. For coastal projects, this value can be generated by a reduction in the cost to a current land-use activity or the increase in net income possible at a given site. A project generates these values by reducing the risk of storm damage to coastal development. Conceptually, the risk from storms can be viewed as incurring a cost to development, i.e., capital investment, at hazardous locations. Thus, the cost per unit of capital invested at risky locations is higher than at lesser risk locations.

f. Economic theory predicts that the risk of storm damage and/or progressive long-term erosion, at a given location, results in less intensive development and lower values as compared with development and land values at otherwise equivalent but risk-free locations. The risk component of the marginal cost of capital is composed of the expected value of the per unit storm and erosion damages plus a premium for accepting the existing risk. This risk premium results from the attitudes or preferences of the individual decision-maker toward risk. If the individual is averse to risk-taking, the risk premium is positive, indicating that capital must earn a return not only to cover expected storm damages but also to compensate the investor for taking the risk.

5. Natural Sources of Risk and Uncertainty.

a. Storms and severe erosive processes damage coastal property in several ways. In addition to direct wind-related damage, which is ignored for purposes of this discussion, a storm typically produces an elevated water surface or surge above the normal astronomical tide level. This storm-driven surge is often sufficient, even without the effects of waves, to be life-threatening and/or to cause substantial inundation damages to property.

b. In addition to the surge, coastal storms generate large waves. Properties subject to direct wave attack usually suffer extensive structural and content damages as well as foundation scouring which can totally destroy structures. Storms also produce at least temporary physical changes at the land-water boundary by eroding the natural beach and dune that serve to buffer and protect shorefront property from the effects of storms. Increased wave energy during storms erodes the beach and carries the sand offshore. At the same time, the storm surge pushes the zone of direct wave attack higher up the beach and can subject dunes and, in turn, upland structures to direct wave action.

c. It is obvious that many components of coastal project evaluation are stochastic, so that the evaluation can be computationally complicated. For example, the damages from storms are dependent on characteristics which must be described in probabilistic terms, such as storm intensity, duration, wind direction, the elevations of the normal tide levels during the course of a storm surge, and the position and state of the beach and dunes prior to the storm event. Since these characteristics influence the storm surge levels, wave intensities and the degree of pre-storm exposure of developments, these factors, in terms of storm damage potential, are also stochastic.

6. Frameworks for Deterministic and Risk-Based Evaluations.

a. The first step in a project feasibility evaluation is to assess the baseline conditions, i.e., the conditions that would likely exist if a project was never implemented to address the existing problems in a systematic fashion. In the deterministic approach, which is currently the basic approach used by the Corps, a single forecast defines physical, developmental, cultural, environmental and other changes expected to occur under the baseline or "without-project" condition. These changes are considered to occur with certainty in the absence of any systematic adaptive measure of the type being considered as a project. This approach does allow, however, for individual property owners to respond to storm and erosion threats by constructing protective measures or by abandoning property. It also takes into account other systematic measures that are in place or expected to be instituted such as existing state, county or municipal protective measures, evolving building codes and changing land-use controls.

b. The development of the "without-project" condition requires assumptions to determine when responses of various types will occur over time. In a risk-based approach to evaluations, which the Corps is in various stages of development for water resources project studies, the relatively simple definition of the "without-project" condition used in the deterministic methodology, is being gradually modified to incorporate uncertainties about such factors as storm frequencies, the distribution of wave heights and the extent of geomorphic changes and property losses produced by storms and waves.

c. The final component for both the deterministic and risk-analysis techniques, incorporated within the benefit evaluation framework for shore protection as specified by the P&G, is to compare the future economic development and land values if the project is implemented with the baseline values. Without a public coastal protection project, property owners are presumed to repair structural losses, with the damages from storms assumed to be capitalized into the value of the land. In addition, property owners are assumed to construct individual protective structures when the costs are less than the value of the preserved property and the avoided expected damages to improvements. Under the "with-project" condition, landowners realize increases in economic rental values of land at protected locations. This rental value increase is typically considered to be equivalent to the annualized expected present value of avoided property losses with the project or the avoided costs of individual protective structures.

d. Implicitly in the deterministic approach and explicitly in a risk-based analysis, the time stream of the "with-project" benefits relative to the "without-project" condition will reflect the stochastic nature of storm events. An important consideration in this respect, particularly with regard to the "without-project" condition, stems from the chronological order of storms and damages. A large storm may result in damages that are so extensive that the destroyed or severely damaged buildings are not or cannot be rebuilt. Therefore, succeeding storms will inflict smaller losses if preceded by large storms.

e. The increase in rental value of land is location-based, resulting from a reduction in the external costs imposed by storms. The increase represents a NED benefit, as required under the P&G by whatever method of analysis. It is this type of economic benefit that is compared to project costs to determine the economic feasibility of any proposed Federal project.

f. Benefits produced by a project depend on the project's type, scale, and storm parameters. Even if two alternative projects constructed side by side experience the same storm, benefits will differ, depending on the magnitude of residual losses if the storm exceeds the alternatives' design dimensions. As an example, a sea-wall normally will fail catastrophically, leaving almost no residual protection after failure. A beach fill, even when inundated during a storm, still provides significant residual protection. Another significant factor is that in the coastal process, the wide range of storm parameters (wind direction, wind velocity, storm surge, storm duration, etc.) results in multiple storm damage mechanisms.

g. In addition to NED benefits, a second major consideration in applying benefit-cost analysis in choosing a particular type and size project is the stream of future project costs. The appropriate costs used in the analysis should provide a measure of all the opportunity costs incurred to produce the project outputs. These NED costs may differ from the expenses of constructing and maintaining the project. For coastal protection projects, expenses would include the first costs of project construction, any periodic nourishment and maintenance costs, and future rehabilitation costs.

Further, the project may incur environmental or other non-market costs whose monetary value can be imputed.

h. In effect, the determination of project costs involves a systems analysis which also includes areas geographically outside, but within the influence, of a project. For coastal projects, the adjoining areas are usually referred to as "updrift" and "downdrift" coasts to indicate the net direction of movement of littoral material, i.e., from up-coast to down-coast. A project may influence the adjoining area in negative and/or positive ways. The "downdrift" coast is particularly vulnerable to negative impacts, since any disruption of the natural movement of littoral material, induced by a shore protection project, is likely to be manifested in erosion or increased erosion along the downdrift coast, with an attendant cost in property damages. This, for example, is a situation which is commonly associated with the improper use of groin fields and breakwaters. Conversely, placement of beach fill along a project site often results in beneficial "nourishment" effects to the adjoining shorelines, especially the "downdrift" coast.

i. Where adverse conditions can be identified, the associated costs of damage, or the addition of mitigation features, to the project are determined and included in the project's economic analysis. On the other hand, beneficial effects outside the project area can be substantial. Congress recognized this when it authorized Federal participation in the periodic nourishment of a project. Benefits to shores beyond project limits, if trivial in amount, may be omitted from cost sharing considerations. If these benefits are significant (i.e., required for project justification) they should be included in cost sharing considerations.

j. The nature of future costs depends on the type of project. For instance, a structural type of project, e.g., a stone revetment, typically has high first costs and high future rehabilitation costs but low future maintenance costs. On the other hand, when compared to a hard structure project, a beach fill type project is composed of relatively low first costs, but larger recurring future maintenance costs (periodic nourishment).

k. Each of the time streams of costs must be converted into present-value terms using the prevailing Federal water resource discount rate. Note that the stream of future costs for both types of projects (low and high future cost types), should to the extent possible, be defined in probabilistic terms, since the realized amount and timing of all future expenditures depends on the number and severity of storms experienced at the project site in the future. Thus, in the ideal case analysis, the expected future cost stream would be based on the estimated probability density function for storm events and the attendant effects on the specific type of project being evaluated. At present, it is not possible to conduct an ideal probabilistically based analysis in all cases due to lack of data as well as deficiencies in the present state of knowledge of coastal wave processes and interrelated phenomena. For example, while the short-term response of a beach fill to extreme events can be treated probabilistically, the evolution of a beach fill, say to long-term erosive processes, can only be treated deterministically at this point in time. Therefore, reconstruction of dunes to repair damages from storm effects can often be computed on the basis of probabilistic analysis, while long-term beach nourishment needs are almost always based on an estimated average annual amount of long-term erosion derived from recorded changes of shoreline positions and/or beach profile volume changes.

l. Once the alternative formulated plans are evaluated in economic terms, the expected net benefits can be calculated. Following the project selection criteria in the P&G, the recommended type and scale of plan should be the one that reasonably maximizes net NED benefits. This is a key conceptual point in both the deterministic and risk analysis evaluation methodologies. Both methods apply the net benefits decision rule for selecting the economically optimal project. However, the risk analysis approach has the advantage of determining the damages prevented by a particular project and the level of residual risk simultaneously. By varying the scale of each type of project in a risk analysis, a benefit function can be derived for the respective projects. Deviations from the NED plan can be recommended to incorporate risk and uncertainty considerations in addition to the explicit risk analysis used in the economic evaluation. These could involve considerations for human health and safety or non-monetized environmental values.

7. Summary of The Planning Process. The planning process used by the Corps is systematic, and consists of six major steps: (1) identifying problems and opportunities, and developing objectives; (2) establishing the base condition; (3) formulating plans; (4) evaluating their effects; (5) comparing them; and, (6) recommending the best plan to alleviate problems and realize opportunities. This systematic approach is dynamic and iterative and enables the public and decision makers to be involved and fully aware of the rationale employed throughout the planning process. This process is the same, whether it is a flood damage reduction project, navigation project, shoreline protection project, etc. While there are different rules, criteria and perspectives on how to account for damages, benefits, and costs, the principles of evaluation are the same and all project formulations follow the P&G.

E. SUMMARY OF U.S. ARMY CORPS OF ENGINEERS PROJECT-RELATED POLICIES

1. General. Shore protection programs of the Corps have been used to provide Federal assistance in reducing damages to shorefront development and coastal resources from storm damages, hurricane and abnormal tidal and lake flooding, and shore erosion by undertaking shore protection projects. Prior to WRDA '86, projects were formulated for hurricane protection, beach erosion control, and recreation. The enactment of WRDA '86 established hurricane and storm damage reduction (HSDR)

and recreation as the basis for Federal participation, and the only two purposes for which Federal shore protection projects could be formulated.

2. Hurricane and Storm Damage Reduction. Prior to enactment of WRDA '86, Federal projects for hurricane and abnormal tidal flooding were established case-by-case, based on specific Congressional authorizations. The Federal share of hurricane projects was limited to a maximum of 70 percent. The enactment of WRDA '86 legislated a Federal cost share of 65 percent for HSDR.

3. Beach Erosion Control. Historically, shore protection legislation was directed to the prevention and control of beach erosion. Federal participation in beach erosion control measures was based on shore ownership, use, and type and incidence of benefits. Public use or benefit was a prerequisite for Federal participation, and the maximum Federal share was 50 percent of project costs, except for special park and conservation areas where the Federal share could be a maximum of 70 percent. The enactment of WRDA '86 discontinued beach erosion control as a project purpose. All reductions in damages, whether from inundation, wave attack, or erosion, are now classified as HSDR benefits, and the costs of protective measures are cost shared in accord with the HSDR purpose (65% Federal, 35% non-Federal maximum).

4. Recreation. Prior to enactment of WRDA '86, for many projects, the recreation purpose provided a majority of project benefits. During the mid-1980s, Department of Army budgetary policy placed a lower priority on projects considered to be primarily recreation. This policy resulted in an increased emphasis on formulating projects for damage prevention, with less focus on recreation. Although the WRDA '86 identifies recreation as an acceptable project purpose along with HSDR, the Department of Army has continued its HSDR only policy due to continuing Federal Budget deficits. Additional beach fill over that required for the project formulated for HSDR, to satisfy recreation demand, is a separable recreation feature which is not supported for Federal participation under current Department of Army budgetary policy. This policy is intended to focus Federal funds on the objective of reducing damages to coastal facilities. However, it does not preclude the use of recreation benefits in the economic analysis. Projects formulated for HSDR may produce substantial recreation benefits, and these are valid national economic development benefits that can be used for economic justification. However, the extent to which recreation benefits can provide for economic justification, is limited by current Department of Army budgetary policy. If over one-half of the benefits needed for economic justification are recreation, a project is considered to be "primarily recreation", and will not be accorded budget priority. This "threshold" test is not a limitation on the total recreation benefits which can be claimed. For example, a project with annual benefits of 50 for HSDR and 150 for recreation and with an annual cost of 100, has a benefit-cost-ratio of 2.00, would receive a budget priority because the recreation benefits needed to produce a benefit-cost-ratio of unity (1.00) are not above the 50 percent threshold.

5. Periodic Nourishment. Placement of beach fill at suitable intervals of time is considered "construction" for funding and cost sharing purposes when it is a more suitable and economical method of shore protection than retaining structures such as groins, seawalls, etc., in accord with Public Law 84-826.

6. Impact of Shore Ownership and Use on Cost Sharing. Although the basic cost sharing formula for HSDR projects is 65 percent Federal and 35 percent non-Federal, adjustments are made based on shore ownership and use. The WRDA '86 specifies that all costs for benefits to privately owned shores (where use of such shores is limited to private interests) or to protection of losses of undeveloped private lands shall be borne by non-Federal interests, and that all costs assigned to the protection of Federally owned shores shall be borne by the United States. The costs to protect Federal lands are normally borne by the agency which owns the land. Thus, Federal participation in the protection of private undeveloped shores is precluded by statute, and Federal participation in the protection of developed private shore is possible only where there is public use of the constructed project. Public use is defined as open for recreational use by all on equal terms regardless of origin or home area. Lack of sufficient parking for the general public located reasonably near and accessible to the shore protection project and lack of pedestrian right-of-way to the shore at suitable intervals would constitute de facto restriction on public use, thereby precluding Federal participation. Costs assigned to the protection of non-Federal public shores used for park and recreation purposes are normally shared 50 percent Federal and 50 percent non-Federal.

7. Other Non-Federal Responsibilities. The WRDA '86 assigns non-Federal interests the responsibility for all lands, easements, rights-of-way, relocations, and dredged material disposal areas required for shore protection projects. The project sponsor receives credit for the value of these contributions against the 35 percent non-Federal cost share. Non-Federal interests are also responsible for 100 percent of the costs of operation, maintenance, repair, replacement and rehabilitation (OMRRR).

8. Use of Public Law 84-99 Funds for Restoration of Shore Protection Projects. Public Law 84-99 provides authority for the repair or restoration of completed Federal shore protection structures damaged or destroyed by wind, wave, or water action of other than an ordinary nature when the Chief of Engineers determines such repair and restoration is warranted for the adequate functioning of the structure for shore protection. Public Law 84-99 funds are used only at projects which have been completed and turned over to local interests for OMRRR. Funding of beach fill projects eligible for restoration under PL 84-99 is limited to projects where the risk to life and property require immediate action.

F. LEVEL OF PROTECTION

1. Introduction. One of the most misunderstood concepts regarding flood damage reduction and shore protection projects is the concept of "level of protection". This term is generally accepted by the public because of the longstanding usage by the Corps and other water resource agencies for flood damage reduction projects, and because it is a simple way of describing a flood event. However, the use of a specified level of protection for shore protection is extremely difficult to estimate since recurrence intervals are assigned to each measurable characteristic of a storm. Where a level of protection is estimated for the design project, it is misleading and does not represent a particular storm event. The problem is compounded when it is viewed as a "true" value and treated by some as if it were perfectly accurate. The Corps develops best estimates of key variables, factors, parameters, and data components in the planning and design of projects, and these estimates for shore protection projects are particularly challenging because of the variable characteristics which describe design storms and alternative protective structures. For example, some of the major differences between shore protection and riverine flooding are summarized in the following paragraphs.

a. Cause of Flooding. Although not a prerequisite to coastal flooding, ocean effects eroding the natural protection of dunes, beach or barrier islands over a period of months or years may increase the susceptibility of a shoreline to flooding or increase the severity of flooding from a given storm event. The cause of coastal flooding is often related to ocean water being driven overland by the force of wind, waves, and high tides. Rainfall, however, may also have a major impact on coastal flooding when conventional drainage or storm water systems are blocked by storm surge. Rainwater ponds during the storm duration and releases slowly as the storm surge drops. Flood damages in riverine environments are normally caused by precipitation and snowmelt which result in high flows in channels of insufficient capacity. Natural protection (i.e., channel capacity) is usually assumed to remain relatively constant over the period of analysis.

b. Storm Velocity. In riverine flooding, the velocity of the storm is related to the movement of water and is determined by stream gradient, flood plain characteristics, natural storage and the volume of water. On the other hand, coastal storm velocity is primarily determined by a combination of wind and tidal action. While either can have devastating effects, high winds by themselves often cause catastrophic property damage not related in any respect to flood waters. The "Saffir/Simpson" hurricane scale (see Chapter 2, Table 2-1), which combines wind speed and tidal surge, is the accepted gauge to determine the destructive potential of a coastal storm.

c. Flood Predictability. In most coastal areas, erosion and storm damage records are less frequently available and less reliable than those for stream flow. The nature of hurricanes is such that these storms can promote uncertainties in terms of location of landfall, maximum winds, and maximum surge flood heights. Northeasters are typically broad in their area of influence and follow general storm tracks that, while not predictable, can be anticipated. Riverine flooding, on the other hand, is characterized by, and displayed in, frequency curves or tables. The display indicates how often a given annual peak flow or stage is exceeded. The more historical information from past floods available, the more certainty there is in the frequency analysis. Gathering and recording information on precipitation and river levels is more institutionalized than information on coastal storm events. Coastal events are always linked to a combination of events such as local wind-driven waves, ocean swells, extremely high tides, and high river flows in adjacent coastal streams.

d. Erosion Losses. In the riverine environment, erosion (usually bank erosion) is sometimes predicted as a function of flow, but more often is a result of repeated cycles of high and low flows over a period of years. In the coastal environment, beach profiles often shift both in and out seasonally as well as in response to storms, making annual (and seasonal) changes a "normal" situation.

2. Past Practice.

a. Coastal storms affect all shorelines in the United States. The most famous of these are the hurricanes and extratropical events ("northeasters") which influence the Atlantic and Gulf Coasts. However, winter front passages, typhoons, and "Arctic Expresses" can cause damaging events on the Great Lakes and Pacific coasts. Storms which can cause flooding and erosion damages to the degree that facilities are endangered are often referred to as "extremal events."

b. Historically, coastal design criteria were based on the specification of a "design storm", in which the path of the storm of record was altered in order to define a worst-case scenario at the location of interest. This practice provides no information on probability-of-occurrence. For urban coastal areas, protection was designed for the Standard Project Hurricane (SPH) as defined by the National Weather Service, or some other rare event, often the storm of record. The design storm was adjusted to coincide with high tide for the project site under consideration. Long periods of record for tidal gages were frequently not available near the area of interest and exceedance determinations were based on best estimates. Although the approach will produce a worst-case condition for design purposes, the event may well have a negligible probability of occurring and result in an overly conservative design, i.e., not cost effective. Early beach fills were often designed to protect against erosion and to provide recreation. In such cases, no claim was made for provision of coastal flood protection. The design of berm widths were set to prevent long-term erosion and to optimize recreation.

3. Current Practice.

a. Current practice of the Corps is to utilize a set of design storm events to evaluate the cost effectiveness of design alternatives. These defined events are chosen to reflect realistic combinations of the various parameters which are descriptive of historic storm events which have impacted the location of interest. For tropical events; the storms should define the range of durations, maximum winds, radius of maximum winds, pressure deficits, track, etc., which have impacted that area. For extratropical events; duration, stage hydrograph, wave heights, and wind speeds are appropriate descriptors. Frequency relationships are then assigned to the set of storms and/or their damages.

b. Recurrence relationships cannot be assigned directly to a storm; they are assigned to some measurable characteristic of the storm such as maximum surge. However, in cases such as dune recession, additional factors such as hydrograph shape or duration can measurably contribute to storm-related damage. Because storms are characterized by these multiple properties, the design set of events concept is the preferred approach for analysis and has been shown to be more accurate and realistic than the single design storm method.

c. The Corps currently uses a range of approaches for developing design storm events. The selected approach is based on project scope, availability of data, and level of resources. In the simplest case, hypothetical or historically based surges, which reflect a limited combination of storm parameters, are scaled to define a design set of events. Recurrence relationships are then obtained from existing elevation-frequency curves. If frequency relationships are not available, this approach is of limited use.

d. In large scale projects, a more comprehensive design procedure involves applications of numerical models to : (1) use historical events to define a set of storms; (2) compute storm damage for each event; and, (3) use statistical procedures to compute damage frequency relationships and associated error estimates. This more rigorous approach can be used to generate continuous frequency-of-occurrence relationships for any parameter in the design evaluation process as well as provide error band input for risk-based design criteria.

G. ENGINEERING ASPECTS OF BEACH FILL AND NOURISHMENT

1. General. An extensive body of literature and case examples exist with respect to the protective values afforded upland developments by the presence of large natural coastal dunes and broad frontal beaches. Because of this, as well as the inherent natural values of beaches and dunes, most states have enacted laws (see Table 3-5) which, in various ways, regulate developmental practices which could possibly degrade or otherwise adversely effect these natural features, where they exist. Federal guidance on planning and design for beach fills and dune construction, as well as all other types of shore protection measures, can be found in the Shore Protection Manual, U.S. Army Coastal Engineering Research Center, 1984, 2 Vols., [12] and the recently released EM 1110-2-3301 dated 30 June 1994 [13].

2. Basis of Protective Value. The scientific basis underlying the protective values of dunes and beaches is that they are extremely efficient land features in terms of their singular or combined capacities to dissipate and absorb wave energy. On the other hand, under the assault of storm-tides and attendant wave action, the high performance of these features in dissipating wave energy comes at the expense of their own erosion and degradation. However, if the sediment supply to the beach and dune system is adequate, the system will recover from storm effects in the interim periods between major storm events.

3. Natural Storm-Recovery of Beach/Dune Systems.

a. The natural process of beach recovery usually occurs in a matter of days or weeks following a storm and often begins in the waning hours of the damaging storm. On the other hand, the recovery or restorative process for dunes and the upper level of the beach strand takes months and involves the reestablishment of stabilizing vegetation as well as the re-accumulation of the sediment volume lost to erosion.

b. The sediment supply for general beach recovery is provided by the adjacent shorelines and immediate offshore areas and is transported to the beach by post-storm wave action having restorative hydraulic characteristics. Indeed, a large proportion of the sediment supply involved in beach recovery comes from the pre-storm beach sediments which were displaced to the nearshore zone during the subsequent course of storm-tide and wave attack. The supply of sediment for natural dune development and storm recovery comes from the finer-grain fraction of both the beach and upland areas and is transported to the dunes by wind action. As noted above, the restorative process pertaining to natural dunes takes place over a considerably longer time span than the post-storm recovery of the frontal beach strand.

c. The simple but fundamental portrayal of beach/dune system behavior given above underscores the dynamic nature of these common physical features. In brief, beaches and dunes are characterized by periodic cycles of damage and restoration, largely controlled by the regional storm-tide and wave climatology, i.e., the occurrence frequencies and intensities of storm events.

4. Long-Term Erosion Processes.

a. When the sediment supply to the beach is inadequate, for whatever reason, erosion of the beach will be a persistent, rather than an intermittent, phenomenon. In that situation, the original beach will progressively narrow in width and the frontal dunes, being increasingly exposed to more frequent and intense wave attack, will eventually be lost to erosive processes.

b. In a completely natural setting, an erosive condition is usually of little concern as the beach and dune system is simply reestablished in a more landward position. Exceptions in the natural case, as regards coastal management concerns, might arise if an erosive condition eventually threatens some particularly valuable natural resource existing in upland or bay areas. On the other hand, where substantial reaches of shoreline have been developed to any significant level, progressive erosion will almost always lead to a call for protective measures if relocations of endangered developmental features are functionally or economically infeasible, or socially unacceptable. Such problems were often addressed by construction of groins and seawalls, and now more recently, by placement of sand to restore the beach and dune to some previous condition.

5. Behavior of Artificial Beaches and Dunes.

a. Artificial dune and/or beach restoration measures are simply replications of the comparable natural features and rely on the high wave-energy dissipation characteristics of such features as the means of protecting coastal developments. By comparison to other shore protection measures, restored beaches and dunes have the added advantage of possessing essentially the same aesthetic and environmental qualities as their natural counterparts. Additionally, a restored beach provides a highly valued recreational land area. Though this particular aspect of beaches is incidental to the quality of their protective value from an engineering perspective, potential recreational use in combination with aesthetic and environmental considerations have contributed much in making beach restoration the method of choice for shore protection.

b. Since artificial beaches and dunes are, in most cases, placed along shoreline reaches with a history of severe episodic and/or progressive long-term erosion, the formulation and implementation of a beach/dune project requires a commitment to, and a plan for, a systematic sand replenishment or "nourishment" program to account for the sediment deficit which was manifested in the erosion history of the project site. Hence, restored beaches and dunes are recurrent-cost intensive and should not be undertaken without the commitment and wherewithal to perform replenishment operations as needed. Also, in this regard, it should be appreciated that the shore and nearshore environments are characterized by large variations in the intensities of storm tides and waves. Further, where significant erosion exists, it is almost always not a uniform process. Rather, the condition will, more likely than not, be strongly linked to episodic storm events of varying durations and intensities with accompanying variations in the severity of beach and dune response.

c. Though analyses of storm-tide/wave intensities and frequencies can usually establish reasonable values of expected return periods for these events and the associated beach/dune nourishment demands, the actual occurrences of the events, over time periods of several years, may be considerably more frequent than the very best analytical/statistical prediction of expected values would indicate. The converse is also true, i.e., there may occur extended storm-free periods in which nourishment applications are far below the expected amounts. Therefore, over periods of several years, some beach and dune nourishment projects require more replenishment than the estimated expected average annual amount; some require far less; and others receive more-or-less the expected long-term average nourishment volume. On balance, however, beach and dune nourishment projects perform well throughout the world and are usually the method of choice in shore protection as previously noted. This is particularly true in defending long reaches of shoreline.

6. Construction of Beach/Dune Projects.

a. Beach and dune fills are most frequently constructed by hydraulic dredging methods. Borrow areas for projects are usually submerged sources of sediments and are normally located in estuaries, inlets or offshore areas. In this regard, there is increasing reliance on offshore sources to insure adequate long-term supply of material, to obtain appropriate sediment quality and to avoid destruction of valuable benthic organisms in estuaries. Material is conveyed to the beach and immediate nearshore zone by pipeline from the dredging site, and the onshore depositions are distributed and configured by earth-moving equipment into a typical beach/dune profile shape. The initial or construction template over-builds the dry beach strand in order to provide sufficient material volume to be subsequently displaced, by wave action, to the submerged portions of the active beach profile. In relatively rare cases, the construction operation briefly described above is performed entirely through the use of a land source of material, road haul and earth-moving equipment. Following material placement, the dune feature is usually stabilized by an appropriate type of beach grass. Sand-fencing of various types can also be used for dune stabilization, but aesthetic value is lost by comparison to use of beach grasses.

b. In some cases, it is only necessary to develop or reinforce a dune line or a series of parallel dune ridges to provide an adequate level of protection. These situations require an adequate frontal beach width to permit the dune(s) to stand without exposure to normal surf conditions or even minor storm-tide/wave action expected at very frequent intervals. The objective is to reserve the dune(s) as a sacrificial defense line for major storm events. Dunes can be constructed quickly by direct placement of sand with hydraulic or mechanical means followed by stabilization by vegetation or sand-fences. Alternatively, dunes can be entirely developed over progressively longer time periods, through use of sand-fences and vegetation, respectively. When dunes have been developed by use of sand-fences, vegetation can be applied at the final stage to provide for a natural appearance as well as added stability against the effects of wind.

c. Improvements in Methodology.

(1). The first standardized guidance on coastal structure design was produced by the Corps of Engineers "Beach Erosion Board" in 1954 as "Shore Protection Planning and Design," also known as TR-4. This was the fore-runner of the "Shore Protection Manual," (SPM) which was first published in 1973, and revised in 1975, 1977, and 1984. These documents presented the methodologies applied in the coastal structure and beach fill designs for most of the projects presented in this report.

(2). The methodologies in TR-4 emphasized designing coastal structures for stability against wave forces. The technology available at that time provided insufficient means to address the functional performance of structures, nor was any guidance available for predicting the performance or stability of a beach fill. Beach and dune design was only qualitatively addressed. Simple linear wave theory, static terrestrial structural engineering principles, and trial-and-error experiential data were used to develop the empirical relationships and rules-of-thumb presented in TR-4. Beach fills of that era were typically placed as an added feature to increase the sediment supply in the area of interest and to the reduce wave energy striking the protective structures.

(3). The SPM was a significant advancement over TR-4 in that it used the results of physical model tests to develop principles of wave-structure interaction, advancements in wave theory, and statistics and other data from various projects. The SPM provided significantly more guidance in the positioning and intent of groins and breakwaters, predicting the flood control benefits of seawalls, and predicting the stability of beach fills. The SPM and beach fill projects of the 1970s and early 1980s were designed around the intent of beach erosion control and recreational use. The quantity of material to be placed was computed based on the long-term recession rates and the amount of surface area desired to support recreational needs. Guidance was presented in the SPM to assist in predicting maintenance renourishment quantities based on the grain size of the placed fill and its projected stability relative to the native material grain size. Neither the SPM or the projects constructed during this time period concerned themselves with the performance of the beach fill template during a particular storm. Beach fills were not usually designed with a primary purpose of providing flood control benefits.

(4). The advent of numerical models, reliable field instrumentation techniques, and improved understandings of the physical relationships which influence coastal processes, led to more sophisticated approaches to shore protection design in the later 1980s. Numerous guidance and analytical tools have been developed over the last ten years to assist the coastal engineer in predicting not only the stability of a beach fill, but also its performance during extreme events. Cross-shore and longshore change models, hydrodynamic hindcast data bases, and stochastic statistical approaches have been developed to provide the practicing coastal engineer with procedures for quantifying the flood control and storm damage reduction benefits of a proposed design. The functional interaction of beach erosion control structures (i.e., groins and breakwaters) can be analyzed with numerical simulation. Seawalls can be designed not only for stability, but also physically modeled to predict various elements of the wave-structure interaction including scour and overtopping. A central guidance reference for much of this new technology is currently being summarized by the Coastal Engineering Research Center during the development of the "Coastal Engineering Manual", which will supersede the SPM. The current schedule for completion of the new manual is for Fiscal Year 1998.

H. PLANNING FOR CLIMATE CHANGE AND SEA LEVEL RISE

1. Potential Impacts. Long-term climate change impacts are likely to exacerbate existing problems associated with living in the coastal zone. Sea level rise is a potential climate change impact unique to coastal areas and one that could lead to increased flooding and erosion in areas already vulnerable to the dynamic forces of wind, waves, currents, and tides. Climate change could also lead to more frequent and/or severe hurricanes and other coastal storms. Scientists are less confident about this possibility than they are about sea level rise, but even if coastal storms are unaffected by climate change, their impact on the coast will increase as the sea rises[3]. The attitudes of most water resource planners and managers concerning climate change and its potential adverse consequences are, by and large, very cautious. While concern is expressed, the climate change predictions have a high degree of uncertainty and the possible impacts are too far in the future for managers to commit their limited resources to solving highly uncertain future problems today.

2. Department of Army Sea Level Rise Policy. Substantial progress has been made in dealing with the highly variable existing hazards and problems similar to those that may be encountered under even the worst-case climate change scenarios. This is accomplished through the Corps normal approach of comprehensive planning studies and resolution of complex institutional issues relying on the P&G for water resources planning (see Paragraph D of this chapter). In addition, the 1987 report by the National Research Council NRC[14] presents a practical and rational review of data on relative sea level changes and the resulting impact on engineering structures. The study results have been incorporated in policy guidance published by the Corps for incorporation of the effects of possible changes in relative sea level in Corps feasibility studies is contained in Engineer Regulation 1105-2-100, 1990 [15]. A summary of the recommendations contained in this guidance is presented below.

a. Potential relative sea level change should be considered in every coastal and estuarine feasibility study that the Corps undertakes. The degree of consideration that the possible change receives will depend upon the historical record for the study site. Areas which are already experiencing relative sea level rise, or where increases are predicted, should undertake an analysis as part of the study. Plans should be formulated using accepted design criteria.

b. A sensitivity analysis should be conducted to determine what effect (if any) changes in the sea level would have on plan evaluation and selection. This analysis should be based on two scenarios as a minimum. The first scenario is the extrapolation of the local, historical record of relative sea level rise (low level). The second scenario is Curve III from the NRC[14] report (high level). Curve III was used as a "high" estimate since it represents a substantial eustatic sea level rise within the range of upper limits established in other studies.

c. If the plan selection is sensitive to sea level rise, then design considerations could allow for future modification when the impacts of future sea level rise can be confirmed. It may be appropriate to consider plans that are designed for today's conditions but that incorporate features to facilitate future changes, or plans designed for future conditions. In these cases, an evaluation of the timing (or inclusion at all) and the cost of potential changes should be conducted during the plan selection process.

3. Practical Experience.

a. The technical analytical procedures for factoring in the physical characteristics and consequences of climate change can be and have been progressively incorporated into planning evaluation and design, largely in the form of a longer statistical record and risk analysis techniques which allow for detailed risk-cost analyses of alternative scenarios. These are being incorporated continuously through the Corps' multifaceted research programs in hydrology/hydraulics, coastal engineering, reservoir operations, and water resources risk analysis. What is inflexible are the economic decision rules which are the primary determinants of the size and scope of a project. Although the Corps generally plans for a 50-year project life, the effective economic return on a water resources project is highly influenced by the discount rate. The Federal water resource discount rate for project economic analysis is fixed by law. When the rate is approximately eight percent, most project benefits are realized within 10 years and the Corps' effective project evaluation and decision horizon is less than 15 years. Thus, the discount rate has a far greater bearing on the choice and scale of an alternative water resources development project than does the supply and demand forecasts arising from potential climate change impacts of uncertain magnitude some 35 to 100 years or more in the future.

b. It is also important to realize that all estimates of sea-level rise predict the rise will be exponential with much of the rise occurring in the second half of the period between now and the year 2100. So for example, if the National Research Council (1990) best estimate of eustatic sea level rise of 20 inches by the year 2100 is used, the National Research Council (1987) predicts that less than two inches (i.e., about one tenth) of the rise will occur in the next 25 years and five inches (about one quarter) in the next 50 years. These rises are not significantly above the current trend [16].

c. The National Research Council (1987) notes, that for coastal structures and facilities, "Sea-level change during the design service life should be considered along with other factors, but it does not present such essentially new problems as to require new techniques of analysis. The effects of sea- level rise can be accommodated during maintenance periods or upon redesign and replacement of most existing structures and facilities." They recommend that feasibility studies consider which designs are most appropriate for a range of possible future sea-level rise. Further, they recommend that strategies appropriate for the entire range of uncertainty receive preference over those that would be optimal for a particular rise, but unsuccessful for other possible outcomes [16].

d. Renourishment intervals for beach fill projects typically are short compared to the time of significant sea-level rise even for the upper range of rise predictions. The Corps often considers beach nourishment feasibility for a 50-year interval of renourishments. However, feasibility is reevaluated prior to each renourishment, so cost increases due to sea-level rise or other factors can be considered and used to evaluate the economics of future renourishment. Therefore, uncertainty in future sea-level rise can be accommodated by reevaluating project feasibility as the future unfolds [16].

4. Measures to Counteract Sea Level Rise. It is more likely that effects of sea-level rise in the coastal zone will be met with measures such as set back requirements, vertical safety requirements and in some cases, relocation. Shore protection measures against sea level rise will be limited to high value urban development. The final choice will be based on a combination of economic, environmental and social concerns. A detailed analysis of climate change can be found in the October 1993 report Preparing for an Uncertain Climate, prepared by the United States Congress, Office of Technology Assessment[3].

I. SUMMARY

1. Overview. Eleven percent of the Nation's area (excluding Alaska), accommodates almost half of the Nation's population. This densely settled area is along the Nation's coastal and Great Lakes shorelines. With population growth has come development and a corresponding increase in vulnerability to coastal hazards, storms and hurricanes. Major Federal programs to deal with this risk date back to 1930, when Congress authorized the Corps to research and investigate problems concerning the effects of erosion and storms on developed coastal areas. Additional Federal programs to deal with this risk in the coastal zone were put in place in 1968 (the National Flood Insurance Program, administered by the Federal Emergency Management Agency), in 1972 (the Coastal Zone Management Act, administered by the National Oceanic and Atmospheric Administration), in 1982 (the Coastal Barrier Resources Act, administered by the Fish and Wild Life Service), and in 1990 (the National Coastal Geology Program, administered by the U.S. Geologic Survey). The mission of the Corps and role in the coastal zone is very different from that of the other Federal agencies. The Corps is the only agency at the Federal level with authority to construct shore protection measures.

2. Planning Guidance. The basic planning principles of the Corps are to contribute to national economic development consistent with protection of the nation's environmental resources. The planning process used by the Corps is systemic, and consists of six major steps: (1) identifying problems and opportunities, and developing objectives; (2) establishing the base condition; (3) formulating plans; (4) evaluating their effects; (5) comparing them; and, (6) recommending the best plan to alleviate problems and realize opportunities. This systematic approach is dynamic and reiterative and enables the public and decision makers to be involved and fully aware of the rationale employed throughout the planning process. As additional projects or periodic nourishments are accomplished, the design of the project is updated to current technical and planning guidance.

3. Level of Protection. The term "level of protection" is generally accepted by the public because of the longstanding usage by the Corps and other water resource agencies for flood damage reduction projects and because it is a simple way of describing a flood event. However, the use of a specific level of protection for shore protection is extremely difficult to estimate since recurrence intervals are assigned to each measurable characteristic of a storm. The current practice of the Corps is to utilize a set of design storm events to evaluate the cost effectiveness of design alternatives. These defined events are chosen to reflect realistic combinations of the various parameters which are descriptive of historic storm events which have impacted the location of interest. For tropical events; the storm should define the range of durations, maximum winds, radius of maximum winds, pressure deficits, track, etc., which have impacted that area. For extratropical events (northeasters), duration, shape, and maximum wind speeds are appropriate descriptors. Frequency relationships are then assigned to the set of storms and/or their damages.

4. Engineering Considerations. The primary purpose of the shore protection program is to reduce the impacts of waves, inundation, beach erosion and hurricanes on developed shorelines. In most cases, construction of a dune and/or beach, together with periodic nourishment, is the primary engineering solution to provide hurricane and storm damage reduction benefits. Artificial dune and/or beach protection measures are simply replications of the comparable natural features and rely on the high wave-energy dissipation characteristics of such features as the means of protecting coastal developments. In addition, restored beaches and dunes have the added advantage of possessing essentially the same aesthetic and environmental qualities as their natural counterparts. The impacts of potential sea level rise on shore protection projects, at this time, is minimal.

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A. INTRODUCTION

1. Overview. This chapter presents a compilation and evaluation of the cost and quantities of sand used in Federally authorized and constructed projects. Project data was gathered from the districts through a questionnaire and was the basis for developing a national perspective of the overall shore protection program. The data represents the Federal shore protection program as of 1 July 1993. As previously noted, there are 82 specifically authorized and constructed Federal projects and/or project segments that combine to span a distance of approximately 226 miles. While the 82 projects average 2.75 miles in length, 26 of these projects are very small in scope and only average 0.6 miles in length. These 26 projects account for only 16 of the 226 protected miles and cost a total of $4.56 million at the time of construction (an average of $175,400 per project). This total cost is small when compared to the average cost of $12 million for each of the remaining 56 projects. Also, these 26 projects were built in the 1950s and 60s and had limited historical data. Finally, the small size of these projects made it difficult to make meaningful comparisons with the other 56 projects. Therefore, the small projects were not included in the following detailed analysis. Locations of the remaining 56 large Congressionally authorized Federal shore protection projects East of the Mississippe are shown on Figure 4-1(A) and those West of the Mississippi are shown on Figure 4-1(B). Most coastal projects of the Corps are concentrated along the Atlantic Coast (36), followed by nine on the Gulf Coast, six on the Great Lakes and five in California.

2. Focus of the Chapter. This chapter focuses on the discussion associated with the answers to the following questions:

- How much money has been spent to date on Federal shore protection projects?
- How much sand has been placed to date on Federally supported shore protection projects?
- How do actual expenditures compare with original estimates for individual projects?
- How do actual quantities of sand used compare with original estimates for individual projects?
- What future financial commitments are associated with the beach nourishment projects already constructed, and those in the planning stages?

Figure 4-1 (A) Location of the Large Congressionally Authorized Projects East of the Mississippi

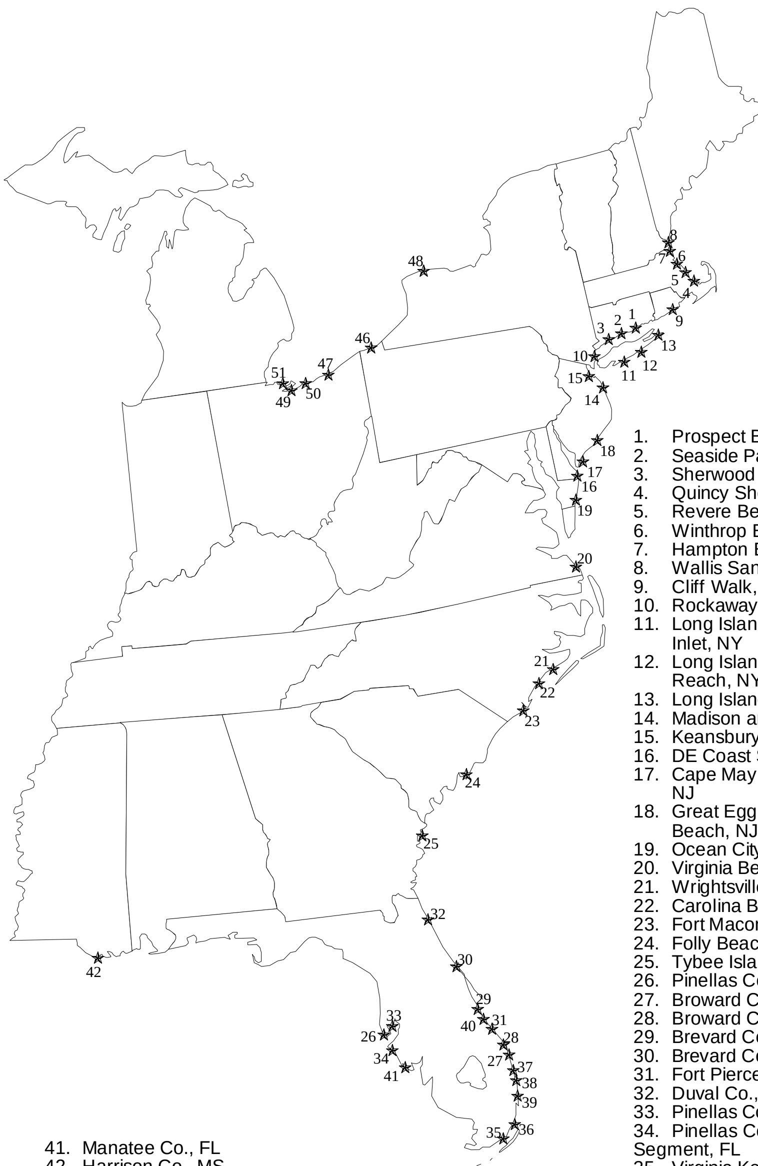


Figure 4-1 (B) Location of Large Congressionally Authorized Projects West of the Mississippi

B. COSTS OF THE FEDERAL SHORE PROTECTION PROGRAM

1. Program Overview. Actual expenditures on the 56 large authorized and constructed shore protection projects are summarized in Table 4-1. These figures are cumulative for the period 1950 to 1993 and are posted in actual dollars. Total expenditures were calculated at $670.2 million, with $403.2 million or 60 percent contributed by the Federal government. The major proportion (80.4 percent) of these expenditures was for beach restoration and periodic nourishment measures, with initial beach restoration accounting for 45 percent of the total costs, and periodic nourishment accounting for 35 percent of the total expenditures. Structural measures accounted for 17 percent of the costs, while only 2 percent of the costs were for emergency measures (percentages may not add due to rounding).

Table 4-1 Total Actual Expenditures, Shore Protection Program 1950-1993

Type of Measure	Federal Costs ($ million)	Total Costs ($ million)
Initial Restoration	180.7	303.3
Periodic Nourishment	147.2	235.4
Structures	59.4	115.6
Emergency Measures	15.9	15.9
Total	403.2	670.2

2. Individual Projects. Actual expenditures are displayed by individual project and project elements in Table 4-2. The largest expenditure for a project occurred in Dade County, Florida (Miami Beach). This project's initial construction cost was $72.2 million, and subsequent nourishments have totaled $10.7 million. Total expenditures for the project are $82.9 million. Other expensive projects include: Presque Isle, Pennsylvania - $50.1 million; the Atlantic Coast of New York City at Rockaway - $47.1 million; and, Channel Islands Harbor, California - $40.3 million. These four projects account for $220.4 million, or 32% of the $670.2 million total.

Table 4-2 Actual Expenditures by Project ($000s)

(continued on next page)

	Project	Year Constructed	Initial Beach Restoration	Periodic Nourishment	Structures	Emergency Costs	Total Costs
	NEW ENGLAND DIVISION						
1.	Prospect Beach, CT	1957	283	(1)	62	0	345
2.	Seaside Park, CT	1958	480	(1)	0	0	480
3.	Sherwood Island State Park, CT	1983	1119	(1)	107	0	1226
4.	Quincy Shore Beach, MA	1950	1305	(1)	559	0	1864
5.	Revere Beach, MA	1992	3015	0	0	0	3015
6.	Winthrop Beach, MA	1956	344	(1)	186	0	530
7.	Hampton Beach, NH	1966	515	(1)	130	0	645
8.	Wallis Sands State Beach, NH	1983	441	0	60	0	501
9.	Cliff Walk, RI	1975	0	0	1361	0	1361
	DIVISION TOTALS - CENED		**7502**	**0**	**2465**	**0**	**9967**
	NORTH ATLANTIC DIVISION						
10.	Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	1975	12825	30829	1682	1750	47086
11.	Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY	1974	13150	22557	0	0	35707
12.	S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach, NY	1965	3900	0	4400	0	8300
13.	S. Shore of Long Is. Fire Is. to Montauk Pt. Southampton to Beach Hampton, NY	1965	0	0	560	0	560
14.	Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	1965	1156	0	158	0	1314
15.	Raritan Bay and Sandy Hook Bay, Keansburg and E. Keansburg, NJ	1968	0	0	19081	0	19081
16.	DE Coast Sand Bypass - Indian River	1986	0	813	1876	88	2777
17.	Cape May Inlet to Lower Township, NJ	1989	8441	4561	3368	0	16370
18.	Great Egg Harbor Inlet and Peck Bch, NJ	1992	27184	0	2253	0	29437
19.	Atlantic Coast of MD-Ocean City, MD	1990	23290	685	5919	2335	32229
20.	Virginia Beach , VA	1964	0	12800	0	560	13360
	DIVISION TOTALS - CENAD		**89946**	**72245**	**39297**	**4733**	**206221**
	SOUTH ATLANTIC DIVISION						
21.	Wrightsville Beach, NC	1965	577	5470	0	760	6807
22.	Carolina Beach and Vicinity, NC	1965	983	16881	42	1769	19675
23.	Fort Macon, NC	1961	46	0	906	0	952
24.	Folly Beach, SC	1993	7184	0	1609	0	8793
25.	Tybee Island, GA	1975	2628	1989	1483	289	6389
26.	Pinellas Co.-Sand Key Segment, FL	1985	30430	0	1200	0	31630
27.	Broward Co.-Segment 2, FL	1970	1759	9988	0	0	11747
28.	Broward Co. -Segment 3, FL	1978	10982	15892	0	0	26874

Table 4-2 Actual Expenditures by Project ($000s) (Continued)

Project	Year Constructed	Initial Beach Restoration	Periodic Nourishment	Structures	Emergency Costs	Total Costs
SOUTH ATLANTIC DIVISION						
29. Brevard Co.-Indialantic/Melbourne, FL	1981	3552	0	0	0	3552
30. Brevard Co.-Cape Canaveral, FL	1975	1026	0	0	0	1026
31. Fort Pierce Beach, FL	1971	621	1428	0	0	2049
32. Duval Co., FL	1978	9579	15763	0	0	25342
33. Pinellas Co.-Long Key Segment, FL	1980	803	1752	935	0	3490
34. Pinellas Co.-Treasure Is. Segment, FL	1969	595	1776	851	3217	6439
35. Virginia Key and Key Biscayne, FL	1969	602	438	1367	0	2407
36. Dade Co., FL	1975	67281	10711	4867	0	82859
37. Lee Co.-Captiva Island Segment, FL	1989	6418	0	0	0	6418
38. Palm Beach Co.-Boca Raton Segment, FL	1988	3547	0	0	0	3547
39. Palm Beach Co.-Delray Beach Segment, FL	1973	2119	10525	0	0	12644
40. Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet, FL	1958	0	0	577	0	577
41. Manatee Co., FL	1992	8450	0	0	0	8450
42. Harrison Co., MS	1952	856	(1)	736	0	1592
DIVISION TOTALS - CESAD		**160038**	**92613**	**14573**	**6035**	**273259**
OTHER COASTAL DIVISIONS						
43. Grand Isle and Vicinity, LA	1985	10534	7571	284	4688	23077
44. Corpus Christi Beach, TX	1978	2078	1408	301	0	3787
45. Galveston Seawall, TX	1963	0	0	9335	0	9335
46. Presque Isle, PA	1956	5692	24637	19723	0	50052
47. Lakeview Park Cooperative, OH	1977	834	159	840	0	1833
48. Hamlin Beach State Park, NY	1974	1178	0	1200	0	2378
49. Point Place, OH	1983	0	0	14122	0	14122
50. Reno Beach, OH	1992	0	0	6554	0	6554
51. Maumee Bay, OH	1991	1517	0	785	0	2302
52. Surfside/Sunset, CA	1964	17712	0	1266	0	18978
53. Oceanside, CA	1961	1153	2608	195	0	3956
54. Channel Islands Harbor, CA	1959	2642	34205	3436	0	40283
55. Coast of CA, Point Mugu to San Pedro, CA	1968	1800	0	648	0	2448
56. Ventura-Pierpont Area, CA	1962	635	0	599	473	1707
DIVISION TOTALS - OTHER COASTAL		**45775**	**70588**	**59288**	**5161**	**180812**
TOTAL PROGRAM		**303261**	**235446**	**115623**	**15929**	**670259**

(1). Periodic nourishment costs for these projects were not available. Periodic nourishment was the responsibility of the local sponsors and the appropriate Corps office does not have records on actual expenditures.

C. COST ADJUSTED TO 1993 DOLLAR LEVEL

1. Methodology for Adjusting Costs.

a. Costs were converted to a common price level in order to make a meaningful comparison of actual and estimated costs and to analyze changes in spending over time. The method adopted converted the various price levels to 1993 price levels. For structural components of shore protection projects, costs were adjusted by applying the Engineering News Record (ENR) Construction Cost Index.

b. The Task Force, however, felt that the traditional (ENR price/cost index) method of adjustment to 1993 dollars does not adequately represent the cost changes in the dredging industry for beach nourishment projects. The gradual, steady, upward pattern of cost indices does not reflect the history of cost data related to the dredging industry and beach nourishment costs. In addition, the cost of placing sand on beaches varies regionally and through time in response to numerous factors such as: location and wave exposure of the sand source area; accessibility; the quantity and quality of material; environmental constraints; special handling requirements and pumping distances. Costs of sand for a particular project may be greater or less from year to year and may deviate significantly from the values given in original authorizing documents. In addition, sand costs in some areas of the country and for some specific projects are significantly higher than for others. Therefore, beach nourishment costs were adjusted on a project-specific basis in accordance with the prevailing 1993 cost of sand at the general project site. These 1993 costs of sand were submitted for each project by the appropriate Corps of Engineers office.

2. Variations in the Cost of Sand by Project.

a. General. The cost of sand is largely the cost of moving the material from the borrow area to the project area. Some of the factors which affect this cost are described in the paragraph above. In Table 4-3, the adjusted initial beach restoration and periodic nourishment costs were divided by the cubic yardage for each project, yielding the 1993 unit cost of sand for both actuals and estimates. A striking aspect of this table is the variability from one project to another. The 1993 unit cost of initial beach restoration sand ranged from less than $2.00 per cubic yard in Harrison County, Mississippi to over $18.00 per cubic yard in Broward County - Segment II, Florida. Periodic nourishment sand costs varied even more widely, from less than $2.00 per cubic yard at Wrightsville Beach, North Carolina to over $25.00 at Virginia Key and Key Biscayne, Florida.

Generally, sand is most expensive in Florida, moderately expensive in the North Atlantic, New England, and Great Lakes regions, and least expensive in the California region.

Table 4-3 1993 Unit Cost of Sand by Project For Initial Beach Restoration and Periodic Nourishment (continued next page)

Project	District	Beach Restoration: Unit Costs for Actuals	Beach Restoration: Unit Costs for Estimates	Periodic Nourishment: Unit Costs for Actuals	Periodic Nourishment: Unit Costs for Estimates
1. Prospect Beach, CT	**CENED**		9.00		9.00
2. Seaside Park, CT			9.00		9.00
3. Sherwood Island State Park, CT		9.00	9.00		9.00
4. Quincy Shore Beach, MA			9.00		
5. Revere Beach, MA		9.00	9.00		9.00
6. Winthrop Beach, MA			9.00		9.00
7. Hampton Beach, NH		9.00	9.00		9.00
8. Wallis Sands State Beach, NH			9.00		
9. Cliff Walk, RI			9.00		
10. Atlantic Coast of NYC. E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	**CENAN**	4.96	4.97	4.97	4.97
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY		5.93	5.93	5.93	
12. S. Shore of Long Is. Fire Is. to Montauk Point Moriches to Shinnecock Reach, NY		5.00	5.00		5.00
13. S. Shore of Long Is. Fire Is. to Montauk Point Southampton to Beach Hampton, NY					
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ			6.25		6.27
15. Raritan Bay and Sandy Hook Bay, Keansburg and E. Keansburg, NJ			6.25		6.32
16. DE Coast Sand Bypass - Indian River	**CENAP**		1.66	3.00	3.02
17. Cape May Inlet to Lower Township, NJ		7.17	7.17	6.42	7.17
18. Great Egg Harbor Inlet and Peck Beach, NJ		4.50	4.50		4.50
19. Atlantic Coast of MD - Ocean City, MD	**CENAB**	6.50	6.50	6.50	
20. Virginia Beach, VA	**CENAO**			6.10	8.28
21. Wrightsville Beach, NC	**CESAW**	3.09	3.08	1.65	5.86
22. Carolina Beach and Vicinity, NC		2.48	2.75	3.08	5.22
23. Fort Macon, NC		3.00	3.00		3.00
24. Folly Beach, SC	**CESAC**	2.32	4.52		
25. Tybee Island, GA	**CESAS**	6.88	6.88	5.70	6.00
26. Pinellas Co. - Sand Key Segment, FL	**CESAJ**	14.98	13.94		14.20
27. Broward Co. - Segment 2, FL		18.27	8.35	11.84	13.02
28. Broward Co. - Segment 3, FL		16.15	14.00	14.37	15.19
29. Brevard Co. - Indialantic/Melbourne, FL		11.32	10.50		10.50
30. Brevard Co. - Cape Canaveral, FL		3.82	9.00		
31. Fort Pierce Beach, FL		6.47	6.34	8.35	7.65
32. Duval Co., FL		15.12	15.12	17.07	13.83
33. Pinellas Co. - Long Key Segment, FL		7.42	7.45	7.12	6.72
34. Pinellas Co. - Treasure Is. Segment, FL		10.28	10.54	10.89	9.15

Table 4-3 Unit Cost of Sand by Project
For Initial Beach Restoration and Periodic Nourishment
(Continued)

Project	District	Beach Restoration		Periodic Nourishment	
		Unit Costs for Actuals	Unit Costs for Estimates	Unit Costs for Actuals	Unit Costs for Estimates
35. Virginia Key and Key Biscayne, FL		17.19	17.22	25.45	25.46
36. Dade Co., FL		9.93	9.03	17.50	11.13
37. Lee Co. - Captiva island Segment, FL	CESAJ	8.09	8.34		
38. Palm Beach Co.- Boca Raton Segment, FL		5.11	8.54		
39. Palm Beach Co. - Delray Beach Segment, FL		6.44	6.44	6.89	24.96
40. Palm Beach Co. (58) Lake Worth Inlet to South Lake Worth Inlet, FL					
41. Manatee Co., FL		3.88	7.03		
42. Harrison Co., MS	CESAM	1.75	1.75	3.24	
43. Grand Isle and Vicinity, LA	CELMN	7.38	7.39	6.95	6.45
44. Corpus Christi Beach, TX	CESWG	6.21	6.37	22.07	11.05
45. Galveston Seawall, TX					
46. Presque Isle, PA	CENCB	8.74	8.30	11.72	11.68
47. Lakeview Park Cooperative, OH		8.49	8.52	8.31	8.53
48. Hamlin Beach State Park, NY		9.11	15.30		15.43
49. Point Place, OH					
50. Reno Beach, OH					
51. Maumee Bay, OH		11.24	11.25		11.00
52. Surfside/Sunset, CA	CESPL	4.82	4.82		
53. Oceanside, CA		4.54	4.54	4.54	
54. Channel Islands Harbor, CA		3.01	3.01	3.01	3.01
55. Coast of CA, Point Mugu to San Pedro, CA		3.54	3.54		
56. Ventura-Pierpont Area, CA		3.01	3.01		

b. Projects with Large Differences - Initial Beach Restoration. Brief explanations are provided below for projects that had large differences in the unit cost of initial beach restoration sand between the estimates and the actuals.

(1). Folly Beach, South Carolina. The principal reason for the actual cost being lower than the estimated cost for this project was that the bidding environment was ideal at the time of construction. There were a number of large dredging contractors with idle equipment interested in this large project. The bidding environment was such that the low bidder was approximately one million dollars below the second low bidder and three million below the next bidder. Additional sand was required prior to completion of the project because three major storms (northeasters) occurred during the construction phase, plus the "Storm of the Century" adversely affected the entire eastern coast of the nation in March 1993. Additional sand was placed to put the project back to its design template and provide the protection intended prior to turnover to the non-Federal sponsor.

(2). Brevard County - Cape Canaveral, Florida. The estimated costs for initial beach restoration were based on the costs of constructing the project utilizing offshore borrow material independent of the navigation project. At the time of beach construction, however, Canaveral Harbor was deepened for use by Trident submarines. This work was coordinated with the construction of the beach project. This cooperative effort of sharing the equipment, and mobilization and demobilization costs, permitted economical use of the material from the navigation deepening for placement on the beach, resulting in lower than anticipated costs. The cubic yardage placed on the beach was also greater than anticipated since the adopted plan was to place all suitable material available from the deepening of the navigation channel on the beach. By placing more cubic yardage than anticipated, since it was readily available, the fixed costs were spread over more yardage, further reducing the unit cost of material. The strategy was always to take advantage of the economies of scale of the two projects. However, at the time the projects were formulated, there was no guarantee that the work would be combined, therefore, the feasibility of each project had to be analyzed on its own merits as an individual project during the study and authorization process.

(3). Dade County, Florida. This project is the largest beach nourishment project constructed by the Corps in terms of costs updated to 1993 dollars. The estimated costs of this project were based on the project being constructed in one large contract. This was certainly possible and rational from an engineering perspective. However, when construction was initiated, the non-Federal sponsor, due to financial constraints, preferred to construct the project through six incremental contracts rather than a single large one. This raised the cost of the project over what was initially estimated due to the additional mobilizations and demobilizations of the dredging equipment. Counteracting the cost increase was the fact that slightly less cubic yardage was actually placed than was anticipated. This is reflective of the general lack of storm activity in Dade County since construction was completed in 1982.

(4). Palm Beach County - Boca Raton, Florida and Manatee County, Florida. The estimated costs of these projects were based on the use of 18-inch dredges which are the predominant size dredge available and typically utilized for this type of project. At the time of construction, 30-inch dredges were available in the area. This more cost efficient equipment significantly lowered the actual cost per cubic yard versus the estimated cost per cubic yard. When the cost estimates were made, there was no way of knowing that there would be a 30-inch dredge in the area at the time the project was initiated. These two projects demonstrate that cost savings opportunities do arise occasionally, as a result of the competitive bidding process, and are taken advantage of to lower actual project costs.

(5). Hamlin Beach State Park, New York. For this project, actual unit cost was significantly less than estimated since the estimated cost was based on the assumption that processed sand from a land source would be used as a borrow source. Upon construction, value engineering studies found the source to be clean enough to use without processing except for a small quantity which was processed for use as a cover layer.

c. Projects with Large Differences - Periodic Nourishment. Some projects had special circumstances that influenced the unit cost of sand for periodic nourishment (contained in Table 4-3), and these are described below.

(1). Wrightsville Beach, North Carolina and Carolina Beach, North Carolina. The unit cost of the actual periodic nourishment was lower due to fewer mobilizations and demobilizations than had originally been anticipated. More sand was actually placed in periodic nourishment of these projects, but the unit cost was significantly lower than expected.

(2). Duval County, Florida. The actual cost per cubic yard is higher than the estimated cost per cubic yard since the window for hopper dredging in that area is now limited to the 1 November to 30 April time frame in order to avoid adverse impacts on sea turtles. This restriction was not anticipated when this project was initially estimated. Compounding this restriction is the fact that periodic nourishment was estimated for the entire 10-mile project in one contract. However, due to the location of the borrow site (approximately four to five miles from the project), and the limited dredging window, actual periodic nourishments are now done in two or three smaller contracts

(3). Dade County, Florida. The actual cost per cubic yard was higher than the estimated cost per cubic yard since the actual cubic yardage was less than what was estimated, and fixed costs such as mobilization and demobilization were divided by a smaller total cubic yardage to arrive at the unit cost. Limited sand availability from suitable offshore borrow sources has also raised the cost of periodic nourishment for this project. These costs will rise in the future as borrow sources become even more limited. Both upland sources and arragonite from the Bahamas are being considered as future borrow sites for this project. However, the project has been relatively stable since it was constructed and actual nourishment quantities are significantly less than anticipated. This helps to compensate for the higher unit costs.

(4). Palm Beach County - Delray Beach, Florida. The estimated costs per cubic yard for periodic nourishment are significantly higher than the actual costs. The original plan was to nourish with a relatively small quantity of sand (108,000 cubic yards) every three years, whereas actual nourishments have been done on a seven year cycle. The erosion at this project has been higher than predicted. The actual yardage placed is 2,577,000 cubic yards for the 20 year period between 1973 and 1993, or 128,850 cubic yards per year. About 36,000 cubic yards per year was estimated for the project, assuming that no overfill was needed. One reason for the higher erosion rate is that nourishments have utilized available offshore borrow areas with granular sizes less than the native coarser beach sand. The current offshore borrow areas have a median diameter of 0.26 mm. The original borrow source had sand ranging from 0.27 to 0.41 mm. median diameter. The native beach material has a mean diameter of 0.34 mm. The native beach consists of 0.5 mm. sand in the backshore and 0.1 mm. diameter sand in the foreshore. The larger quantities of actual nourishment and the less frequent nourishment cycle make the actual costs per cubic yard less than the estimated costs, because the fixed costs are spread over more yardage and total fixed costs for the period of record are lower with fewer actual nourishments. Actual costs in the future may be impacted by the acceptable window for hopper dredging in the area from 1 November to 31 March in order to avoid adverse impacts on sea turtles.

3. Adjusted Costs, Entire Program.

a. Figure 4-2 shows the adjusted costs of the entire program from 1950 to 1993. Because these costs are at a common price level, relative changes in spending over time can be observed. Although there is significant variability from year-to-year, the general trend has been one of rising costs. This is a natural expectation as more projects are constructed. Overall, Federal shore protection program costs have increased from $5 million in 1950 to about $60 million in 1990.

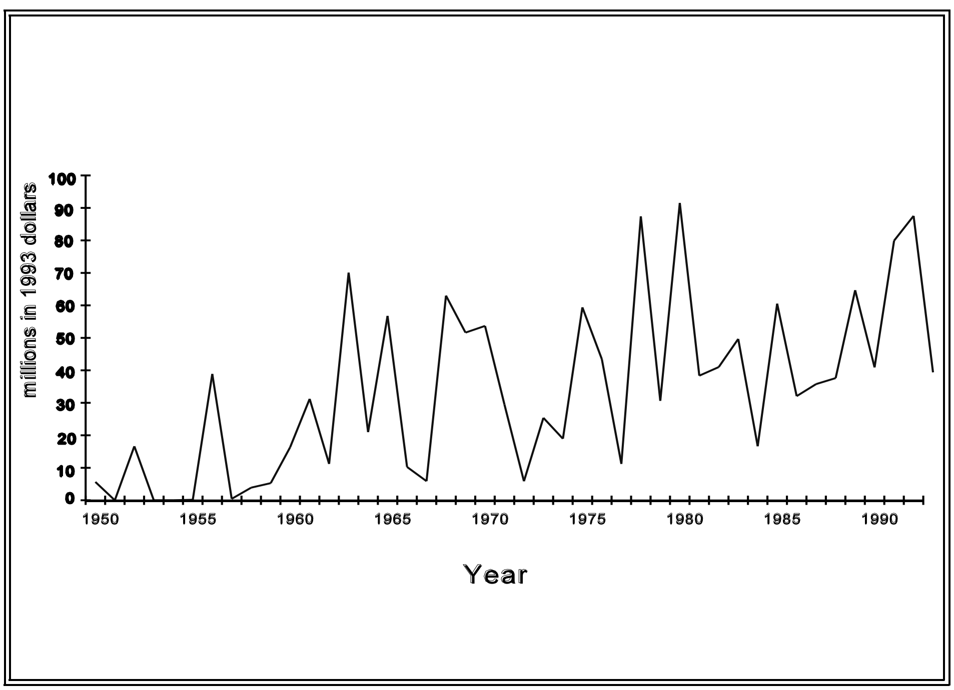


Figure 4-2 - Shore Protection Program Costs 1950-1993

b. The expenditures for the 56 projects were totaled for each project element and are presented in Table 4-4. Total cumulative costs in 1993 dollars are $1,489.5 million. If all project costs were adjusted using only the ENR index, the total cost in 1993 dollars would be $1,177.3 million.

Table 4-4 Adjusted Costs, Shore Protection Program, 1950-1993

Types of Measures	Federal Costs ($ million 1993)	Total Costs ($ million 1993)
Initial Restoration	426.0	730.4
Periodic Nourishment	270.9	420.4
Structures	153.9	308.5
Emergency Measures	30.2	30.2
Total	881.0	1,489.5

4. Adjusted Costs by Project.

a. General. This section analyzes and describes adjusted costs for particular projects. Table 4-5 contains individual project costs adjusted to 1993 dollars and listed by project elements. This table summarizes total project costs to date, including initial construction, periodic nourishment, structures, and emergency costs. The adjusted cost data is categorized under the Corps office that oversees each project.

b. Brief Descriptions. Brief descriptions of the Corps offices and their projects are provided in the following paragraphs.

(1). New England Division (CENED). Most New England Division's (Maine through Connecticut) projects were built in the 1950s and 1960s and were typically designed for the protection of small pocket-beaches. In 1992, New England's largest shore protection project was completed at Revere Beach, MA at a cost of 6 million 1993 dollars.

(2). New York District (CENAN). All of the New York District (Atlantic coast of New York and northern New Jersey) shore protection projects were constructed in the 1960's and 1970's. The projects in Rockaway, NY, Fire Island, NY, and Keansburg, NJ each cost over 40 million 1993 dollars. The most expensive, Keansburg (80 million 1993 dollars), was a hurricane dune, levee and tide gate project. The other two were primarily beach nourishment projects.

(3). Philadelphia District (CENAP). Philadelphia District (Southern New Jersey and Delaware) has beach nourishment projects at Cape May (Cape May Inlet to Lower Township, NJ)

Table 4-5 Adjusted Costs by Project and Project Element

(Thousands in 1993 Dollars) **(Continued on Next Page)**

	Project Name	District	Initial Beach Restoration	Periodic Nourishment	Structures	Emergency Costs	Total Costs
1.	Prospect Beach, CT	**CENED**	(1)	(2)	441		441
2.	Seaside Park, CT		(1)	(2)	0		0
3.	Sherwood Island State Park, CT		1017	(2)	135		1152
4.	Quincy Shore Beach, MA		(1)	(2)	5646		5646
5.	Revere Beach, MA		6030	0	0		6030
6.	Winthrop Beach, MA		(1)	(2)	1382		1382
7.	Hampton Beach, NH		1525	(2)	707		2232
8.	Wallis Sands State Beach, NH		(1)	0	302		302
9.	Cliff Walk, RI		0	0	1715		1715
	DIVISION TOTALS - CENED		**8572**	**0**	**10328**	**0**	**18900**
10.	Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	**CENAN**	31565	26490	2439	3399	63893
11.	Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY		24449	19616	0		44065
12.	S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to ShinnecockReach, NY		9000	0	20136		29136
13.	S. Shore of Long Is. Fire Is. to Montauk Pt. Southampton to Beach Hampton, NY		0	0	2962		2962
14.	Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ		5944	0	812		6756
15.	Raritan Bay and Sandy Hook Bay, Keansburg and E. Keansburg, NJ		0	0	80231		80231
16.	DE Coast Sand Bypass - Indian River	**CENAP**	0	719	2069	109	2897
17.	Cape May Inlet to Lower Township, NJ		9787	4561	3618		17966
18.	Great Egg Harbor Inlet and Peck Bch, NJ		27316	0	2287		29603
19.	Atlantic Coast of MD-Ocean City, MD	**CENAB**	32117	1196	6280	1950	41543
20.	Virginia Beach , VA	**CENAO**	0	27287	0	2169	29456
	DIVISION TOTALS - CENAD		**140178**	**79869**	**120834**	**7627**	**348508**
21.	Wrightsville Beach, NC	**CESAW**	9245	9087	0	2755	21087
22.	Carolina Beach and Vicinity, NC		8910	23129	194	5209	37442
23.	Fort Macon, NC		279	0	3852		4131
24.	Folly Beach, SC	**CESAC**	7184	0	1609		8793
25.	Tybee Island, GA	**CESAS**	15597	7410	2681	355	26043

(1) Costs could not be adjusted because cubic yardages of material placed were not available.
(2) Periodic nourishment was the responsibility of local sponsors and information is not available

Table 4-5 Adjusted Costs by Project and Project Element

(Thousands in 1993 Dollars) (Continued)

	Project Name	District	Initial Beach Restoration	Periodic Nourishment	Structure	Emergency Costs	Total Costs
26.	Pinellas Co.-Sand Key Segment, FL	**CESAJ**	40563	0	1443		42006
27.	Broward Co.-Segment 2, FL		18818	20716	0		39534
28.	Broward Co. -Segment 3, FL		49585	24599	0		74184
29.	Brevard Co.-Indialantic/Melbourne, FL		6111	0	0		6111
30.	Brevard Co.-Cape Canaveral, FL		4781	0	0		4781
31.	Fort Pierce Beach, FL		4646	3555	0		8201
32.	Duval Co., FL		37583	44196	0		81779
33.	Pinellas Co.-Long Key Segment, FL		1877	3273	1139		6289
34.	Pinellas Co.-Treasure Is. Segment, FL		6167	9450	1429	8518	25564
35.	Virginia Key and Key Biscayne, FL		6016	2545	3472		12033
36.	Dade Co., FL		144969	10939	7402		163310
37.	Lee Co.-Captiva Island Segment, FL		11477	0	0		11477
38.	Palm Beach Co.-Boca Raton Segment, FL		4471	0	0		4471
39.	Palm Beach Co.-Delray Beach Segment, FL		8630	17752	0		26382
40.	Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet, FL		0	0	3906		3906
41.	Manatee Co., FL		8534	0	0		8534
42.	Harrison Co., MS	**CESAM**	9975	10851	6646		27472
	DIVISION TOTALS - CESAD		**405418**	**187502**	**33773**	**16837**	**643530**
43.	Grand Isle and Vicinity, LA	**CELMN**	21170	8869	2300	5014	37353
44.	Corpus Christi Beach, TX	**CESWG**	4608	3686	361		8655
45.	Galveston Seawall, TX		0	0	53210		53210
46.	Presque Isle, PA	**CENCB**	38684	47199	23983		109866
47.	Lakeview Park Cooperative, OH		1061	133	1680		2874
48.	Hamlin Beach State Park, NY		2887	0	2964		5851
49.	Point Place, OH		0	0	17794		17794
50.	Reno Beach, OH		0	0	6750		6750
51.	Maumee Bay, OH		1608	0	832		2440
52.	Surfside/Sunset, CA	**CESPL**	68971	0	4481		73452
53.	Oceanside, CA		10892	2482	1181		14555
54.	Channel Islands Harbor, CA		18760	90624	21613		130997
55.	Coast of CA, Point Mugu to San Pedro, CA		4968	0	3261		8229
56.	Ventura-Pierpont Area, CA		2659	0	3163	682	6504
	DIVISION TOTALS - OTHER COASTAL		**176268**	**152993**	**143573**	**5696**	**478530**
	TOTAL PROGRAM		**730436**	**420364**	**308508**	**30160**	**1489468**

and at Ocean City, New Jersey (Great Egg Harbor Inlet and Peck Beach, NJ). This district also has a sand bypassing plant at Indian River in Delaware.

(4). Baltimore District (CENAB). Baltimore District (Maryland and the northern Virginia peninsula) contains one of the best known projects, Ocean City, Maryland. Seventy seven percent of the 41.5 million 1993 dollar total cost was attributed to the 8.4 mile long berm, in the initial beach restoration. Structural costs were incurred for the construction of a 1.8 mile long bulkhead. This fairly recent project (construction began in 1990) has been hit by severe storms in both 1991 and 1992, attracting much media attention.

(5). Norfolk District (CENAO). Norfolk District (Southern Virginia) has had a beach nourishment project at Virginia Beach, VA since the early 1960s. About 2.1 million 1993 dollars has been spent for emergency costs. The remaining costs of 27.3 million 1993 dollars have been for periodic beach nourishment.

(6). Wilmington District (CESAW). Wilmington District (North Carolina) has three projects in North Carolina, all built in the 1960s. Two projects, Wrightsville and Carolina Beach, cost between 20 and 40 million 1993 dollars. While Fort Macon cost only 4 million 1993 dollars.

(7). Charleston District (CESAC). Charleston District (South Carolina) has just one project, at Folly Beach, South Carolina. The project was authorized in 1986 and construction began in 1993. The majority of the project cost was initial beach restoration of a 5 mile long protective sand berm. Structural costs were incurred for the construction of nine groins, placed every 600 feet along the coast.

(8). Savannah District (CESAS). Savannah District (Georgia) has the Tybee Island project, located at the northern most barrier island of Georgia. The project has been in place for twenty years. Initial beach restoration increased the usable beach from 500 feet in length to 15,000 feet. The structural costs were for building a concrete seawall the length of the beach and a rock groin at each end.

(9). Jacksonville District (CESAJ). Jacksonville District (covering the peninsular Florida coastline, Puerto Rico, and the U.S. Virgin Islands) has more shore protection projects (16) than any other district . The majority of these were built in the 1970s and 1980s. They run the gamut in terms of cost, from 3.9 million 1993 dollars for the sand transfer plant in Palm Beach County to 163.3 million in 1993 dollars for the Dade County project. The average cost per project in Jacksonville district is 32.4 million in 1993 dollars. The most recent project in Florida was the Manatee County project, constructed in 1993 and costing $8.5 million.

(10). Mobile District (CESAM). Mobile District (Western part of Florida, Alabama and Mississippi) has one of the first beach nourishment shore protection projects. This project was constructed in Harrison County, Mississippi in 1952. Previous to the 1952 project, Harrison County had built a seawall to protect U.S. 90, a major transit corridor between Florida and Louisiana. By 1952, the beach fronting the seawall had disappeared and waves were pounding at the base of the structure. The 1952 project called for initial beach restoration, some periodic nourishment, and repairs to the existing seawall.

(11). New Orleans District (CELMN). New Orleans District (Louisiana) contains the Grand Isle, Louisiana project. Prior to the Corps involvement in 1970, various state agencies attempted to protect the shoreline with groins and beach nourishment. In 1970, the Corps constructed a revetment to tie 1,400 feet of shoreline into the existing eastern groin. Later, a groin at the western end of the island was completed. The initial restoration and periodic nourishment costs were incurred during the completion of a seven mile beach and dune between the east and west groins. The small structural costs were incurred for the extension of both groins 500 feet. Additional, emergency funding was necessary to restore the project after several devastating storms.

(12). Galveston District (CESWG). Galveston District's (Texas) shore protection program consists of the Galveston Seawall and the nourishment project at Corpus Christi Beach. Galveston's seawall was originally built after the devastating 1900 hurricane and was extended in 1960. The 1960 seawall extension is 17 feet tall, 3 miles long and made of concrete. Galveston's project is typical of the older structural projects, with no money spent on beach restoration or nourishment. In contrast, most of the cost of the 1978 Corpus Christi project was for the restoration and nourishment of the beach.

(13). Buffalo District (CENCB). Buffalo District (Lake Ontario and eastern Lake Erie) contains one of the Nation's most expensive projects, Presque Isle, Pennsylvania on Lake Erie. Since 1956, 110 million in 1993 dollars has been spent to curb erosion of the Presque Isle peninsula. Buffalo District has four other relatively small projects along Ohio's Lake Erie shoreline, and one on the shoreline of Lake Ontario in New York State.

(14). Los Angeles District (CESPL). All of the Corps shore protection projects on the west coast are in the Los Angeles District (Southern coast of California). Two of these are quite large in terms of total cost: Channel Islands Harbor (131 million in 1993 dollars); and Surfside/Sunset (73.5 million in 1993 dollars).

D. PROJECT PERFORMANCE COST

1. Introduction.

a. Changing Conditions. The time between authorization and construction of Federal shore protection projects in most cases is many years. During the course of these years, physical land conditions, Federal cost sharing and design requirements, and non-Federal needs and concerns change. For example, approximately half of all the beach erosion control and storm damage reduction projects were first authorized by the mid-1960's. Most of these early beach projects planned to utilize borrow areas located in inland waterways, rivers, estuaries, or dry land quarries due to limited offshore dredging technology. Because of uncertainties involved, Federal participation in periodic nourishment was limited to ten years from completion of construction. The Coastal Engineering Research Center (CERC), which was established in 1963, was just starting to develop the technology that is now available to all the Corps districts. In addition, studies were initiated to locate offshore sources of sand in 1964 (Intercontinental Shelf Sediment Study by CERC) to avoid the environmental impacts associated with inland water and estuary use. See Chapter 2, paragraph D, of this report for additional background information in this area. For these and other reasons, cost estimates for the early Corps projects contained in the Congressional documents did not always accurately reflect what was finally constructed.

b. Defining Estimated Costs. Comparison of an "authorized" fixed structure to a soft beach nourishment project, or of a 20-mile-long project to a five-mile-long project would be meaningless. This report attempts to compare "actual/estimated" for like projects rather than "actual/authorized" for projects which changed drastically from authorization to construction. To measure performance, this report uses the preconstruction cost estimates available when the local cooperation (the project) agreement is signed by the Corps and the non-Federal sponsor. Agreements are normally signed after preconstruction documents are completed. The execution of the agreement and project funding by the local, state, and Federal interests is, in reality, the legal commitment by all parties to fund and construct the project. As projects change over time, Congress is made aware of these changes during the yearly budget testimony and the non-Federal sponsor through refinements to the project cooperation agreements.

c. Review of Selected Projects. It was beyond the scope of this report to track all changes for all projects. However, six projects were randomly selected for a thorough historical review. Of these projects, three are on the Atlantic coast (Ocean City, MD; Carolina Beach, NC; and, Tybee Island, GA); one is on the Gulf Coast (Grand Isle, LA); one is on the Great Lakes (Presque Isle, PA); and one is on the Pacific coast (Surfside/Sunset, CA). Appendix E contains a detailed description of these six projects. This description includes; project location; storm history; problem statement; study authority; project authorization; information at time of project authorization; project

Box 4-1

Brief Authorization Summary of Six Projects

Project	Study Authority	Project Authorization	Project Modification	Construction Complete
Ocean City, Maryland	H Res. Jun 1963 S Res. Feb 1967	1986 WRDA	1989 GDM	October 1991
Carolina Beach, North Carolina	PL 71-84, 1955	1962 FCA	1967 Em. Meas. 1970 Em. Meas. 1973 Em. Meas. 1981 Em. Meas.	July 1982
Tybee Island, Georgia	H Res. Jun 1963 S Res. Apr 1963	1971 H&S Res.	1974 GDM	March 1976
Grand Isle, Louisiana	H Res. Sep 1963 S Res. May 1966	1976 H&S Res.	1980 GDM 1988 Em. Meas. 1990 Em. Meas.	September 1991
Presque Isle, Pennsylvania	H Doc. 83-231	1954 R&H Act	1960 R&H Act 1974 WRDA 1980 GDM 1981 COE Rpt. 1986 GDM 1986 WRDA	November 1992
Surside/Sunset, California	Sec. 2, 1930 R&H Act 1958 R&H Act	1962 R&H Act	1963 COE Rpt. 1976 WRDA 1986 WRDA	Stage 1; 6/64 Stage 2; 11/68 Stage 3; 2/70 Stage 4A; 5/71 Stage 4B; 3/73 Stage 5; 3/73 Stage 6; Def. Stage 7; 6/79 Stage 8; /85 Stage 9; /90

modifications; project nourishment and maintenance program; and a history of the project's costs and benefits. A very brief authorization summary of the six projects is contained in Box 4-1. As shown in the table, the average time between project authorization and completion of construction is almost 20 years.

2. Performance at the Program Level, Costs.

a. Total for Program. This section compares actual costs to the re-construction estimates for each element of the program: initial beach restoration; periodic nourishment; and structures. Certain projects were excluded from this analysis due to incomplete data, or because the constructed project differed significantly from that envisioned at the time of the preconstruction estimate. For example, one project was deleted from this comparison because the estimates were for a 15-mile-long project but only 2 miles of the project were actually constructed. Table 4-6 summarizes and compares the actual and estimated costs for each project element (initial beach restoration, periodic nourishment, and structures) as well as providing totals for the entire program. Analyzing the projects with sufficient data indicates that the overall program's actual and estimated costs, in 1993 dollars, are $1,340.9 million and $1,403.0 million, respectively. This is a difference of 4 percent, with the actual costs being less than the estimated. However, these findings must be qualified by the fact that only about 82 to 83 percent of each category's total number of projects are being represented in the total actual and estimated costs, as explained above.

Table 4-6 Comparison of Actual to Estimated Costs at the Program Level

Type of Measure	Number of Projects	Actual Costs ($ million 1993)	Estimated Costs ($ million 1993)
Initial Restoration	40 of 49	652.4	660.0
Periodic Nourishment	33 of 40	389.9	431.6
Structures	35 of 42	298.6	311.4
Totals		1,340.9	1,403.0

b. Initial Beach Restoration. In the initial beach restoration category, 49 projects had either planned or actual beach restoration. However, after careful review of the data, nine of these projects were excluded from the overall program cost performance analysis. The specific projects, and their reasons for exclusion, are listed below:

(1). Five New England Division projects (Prospect Beach, CT; Seaside Park, CT; Quincy Shore Beach, MA; Winthrop Beach, MA; and, Wallis Sands State Beach, NH) were excluded because beach restoration was done by non-Federal sponsors and later reimbursed by the Corps. Quantities of sand were not available for these projects and, therefore, costs could not be updated to 1993 dollars with the study methodology (see "methodology for adjusting costs" above).

(2). The South Shore of Long Island, Fire Island to Montauk Point, Moriches to Shinnecock Reach project was excluded because the estimates were for a 15.5 mile reach, only a small portion (about 2 miles) of which was actually constructed.

(3). For the Delaware Coast Sand Bypass - Indian River, DE and Raritan and Sandy Hook Bay, Keansburg and E. Keansburg, NJ projects, beach restoration was planned, but no actual costs were provided by the districts.

(4). Surfside/Sunset, CA cost estimates provided by the district were partial figures; no estimates were available for two stages of project construction.

c. Periodic Nourishment. There were 40 projects that involved periodic nourishment, but seven of these were eliminated from the overall program comparison. Specific projects and reasons are listed below.

(1). Five New England Division projects (Prospect Beach, CT; Seaside Park, CT; Quincy Shore Beach, MA; Winthrop Beach, MA; and, Wallis Sands State Beach, NH) and the Harrison County, MS project, were excluded because information is missing on periodic nourishment as periodic nourishment was the responsibility of the non-Federal sponsors and the Corps does not have any records.

(2) The project for the Atlantic Coast of Long Island, Fire Island Inlet and Shore Westerly to Jones Inlet was excluded because estimates were not available for periodic nourishment for this project. Any sand removed from the navigation channel is placed on the beach to serve as a feeder beach.

d. Structures. There were 42 projects that incorporated structural components. Seven of these were excluded from the overall program comparison of actual and estimated structural costs. Specific projects and reasons are given below.

(1). For the five projects listed below, estimates were not available for structures because they were not part of the original project.

(a). Atlantic Coast of New York City, East Rockaway Inlet\ Jamaica Bay
(b). Carolina Beach, NC
(c). Pinellas County, FL - Sand Key Segment
(d). Pinellas County, FL - Long Key Segment
(e). Pinellas County, FL - Treasure Island Segment

(2). For the Broward County, FL - Segment III project, actual costs for structural elements were not available. This is a reimbursable project, with the work being performed by Broward County. The structural work involved includes some derelict groin removals and sand tightening of structures at inlets, both relatively minor in cost. The structural work was not part of the original project.

(3). For the Coast of CA, Point Mugu to San Pedro project, the estimates for structures are only partial figures; they do not include all of the structures that were actually constructed.

3. Performance at the Project Level, Costs. Table 4-7 lists the differences between actual and estimated costs for individual projects, expressed as a percentage of the estimate. In order to maximize use of the available data, percentage differences were calculated for each project element (initial beach restoration, periodic nourishment, and structures). This allowed the inclusion of some projects that had missing data on nourishment, for example, but complete data for structures. Positive numbers indicate cost overrun; negative numbers indicate savings. For example, a 10 in Table 4-7 means that actual costs were 10 percent higher than the estimated costs. Similarly, a -10 in Table 4-7 means that actual costs were 10 percent less than estimated costs. A zero in Table 4-7 means the actual cost was equal to the estimated cost.

4. Statistical Analysis at the Program Level.

a. Introduction. The following section of the report examines the percentage differences between actual and estimated costs, by project and project element (presented in Table 4-7), in a quantitative fashion, through the use of statistical analysis.

b. Inititial Beach Restoration. There are 40 cases of initial beach restoration cost differences that range from -73 to + 85 percent. The mean, or arithmetic average, of these 40 cases is 0.3 percent. This means that the average difference between actual initial beach restoration costs and estimated initial beach restoration costs is less than one percent; actual costs were less than one percent higher than estimated costs. The median, or middle point, of this distribution is 2, indicating a 2 percent cost overrun. The relative closeness of these two measures of central tendency to zero indicates that the magnitude of the cost overruns of the group is about equal to the magnitude of the cost underruns. These percentage differences were also converted to standardized scores. Standard scores are the difference between the score and the mean, divided by the standard deviation. Standardizing the scores allows one to determine the exact percentile for each score. In the case of initial beach restoration, 76 percent of the cases fell below a 25 percent cost overrun.

c. Periodic Nourishment. There are 30 periodic nourishment cost differences in Table 4-7 that range from -100 to +95. A "-100" in Table 4-7 means that the project included planned periodic nourishment that was never done. This does not necessarily indicate that low rates of erosion left nourishment unwarranted. Nourishment was not carried out as planned for several reasons. In some cases, the non-Federal sponsor withdrew from the project agreement. In some recently constructed projects, the schedule had slipped so that nourishment was really not due yet. In only two of the nine projects with -100's (Hamlin Beach State Park, NY, and Maumee Bay, OH) was the lack of nourishment an indicator of less-than-expected erosion rates. Therefore, the remaining seven were eliminated from the statistical analysis, so as not to inappropriately skew the

Table 4-7 Differences Between Actual and Estimated Costs Expressed as a Percentage of the Estimate (Continued on Next Page)

	Project Name	Initial Beach Restoration Costs (%)	Periodic Nourishment Costs (%)	Structures Costs (%)
1.	Prospect Beach, CT			32
2.	Seaside Park, CT			
3.	Sherwood Island State Park, CT	-73		-93
4.	Quincy Shore Beach, MA			117
5.	Revere Beach, MA	-13	-100	
6.	Winthrop Beach, MA			-51
7.	Hampton Beach, NH	-50		359
8.	Wallis Sands State Beach, NH			-23
9.	Cliff Walk, RI			-74
10.	Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	-22	-1	
11.	Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY	-51		
12.	S. Shore of Long Is. Fire Is. to Montauk Point Moriches to Shinnecock Reach, NY			
13	S. Shore of Long Is. Fire Is. to Montauk Point Southampton to Beach Hampton, NY			-21
14.	Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	13	-100	-9
15.	Raritan Bay and Sandy Hook Bay, Keansbury and E. Keansburg, NJ		-100	235
16.	DE Coast Sand Bypass - Indian River		-66	83
17.	Cape May Inlet to Lower Township, NJ	-6	-12	13
18.	Great Egg Harbor Inlet and Peck Beach, NJ	47	-100	128
19.	Atlantic Coast of MD - Ocean City, MD	29		-23
20.	Virginia Beach, VA		76	
21.	Wrightsville Beach, NC	20	10	
22.	Carolina Beach and Vicinity, NC	61	-13	
23.	Fort Macon, NC	-31	-100	27
24.	Folly Beach, SC	-36		-45
25.	Tybee Island, GA	17	-22	20
26.	Pinellas Co, Sand Key Segement, FL	9	-100	
27.	Broward Co, Segment 2, FL	47	-46	
28.	Broward Co, Segment 3, FL	17	18	
29.	Brevard Co, Indialantic/Melbourne, FL	-11	-100	
30.	Brevard Co, Cape Caneveral, FL	-40		
31.	Fort Pierce Beach, FL	-23	-61	
32.	Duval Co, FL	-24	-23	
33.	Pinellas Co, Long Key Segment, FL	4	95	

Table 4-7 Differences Between Actual and Estimated Costs Expressed as a Percentage of the Estimate (Continued)

Project Name	Initial Beach Restoration Costs (%)	Periodic Nourishment Costs (%)	Structures Costs (%)
34. Pinellas Co, Treasure Is. Segment, \fl	13	3	
35. Virginia Key and Key Biscayne, FL	0	-48	-39
36. Dade Co, FL	4	-53	100
37. Lee Co, Captiva Island Segment, FL	32		
38. Palm Beach Co, Boca Raton Segment, FL	-17		
39. Palm Beach Co, Delray Beach Segment, FL	0	10	
40. Palm Beach Co, Lake Worth Inlet to South Lake Worth Inlet, FL			12
41. Manatee Co, FL	-45		
42. Harrison Co, MS	0		0
43. Grand Isle and Vicinity, LA	13	-10	23
44. Corpus Christi Beach, TX	0	10	-28
45. Galveston Seawall, TX			-50
46. Presque Isle, PA	6	1	-13
47. Lakeview Park Cooperative, OH	13	-80	-43
48. Hamlin Beach State Park, NY	-23	-100	-11
49. Point Place, OH			28
50. Reno Beach, OH			-20
51. Maumee Bay, OH	-12	-100	-34
52. Surfside/Sunset, CA			-13
53. Oceanside, CA	85		30
54. Channel Islands Harbor, CA	22	18	-26
55. Coast of CA, Point Mugu to San Pedro	0		
56. Ventura-Pierpont Area, CA	37		-15

analysis. The Fort Pierce Beach, FL and the Virginia Key and Key Biscayne projects were also eliminated from the statistical analysis because their cost underruns in periodic nourishment were not indicative of a lack of erosion. Statistics were calculated for periodic nourishment cost performance in 21 projects. The mean of this group was -14 and the median was -10, indicating that the average project underspent on periodic nourishment by 14 percent. The standard deviation of this distribution was 48. Compared to the initial beach restoration cost differences examined above, the periodic nourishment cost differences had a higher standard deviation (more variation), but also had more incidence of cost underruns.

d. Structures. Finally, there are 34 structure cost differences that range from -93 to +359. The mean of the distribution is 17 and the median is -12. The negative median suggests that there are more projects where structural costs were less than estimated, but that there are a few large cost overruns that have pulled the mean upward. The large standard deviation of 87 indicates that there is a high variability. It can be noted that the structural components had larger overruns than both of the beach nourishment project components.

5. Performance by Project Size, Cost.

a. Comparison by Size. Projects were grouped by size in order to further explore the question of cost performance. Categories were based on the aggregate cost of the project, and were as follows: Small (under $10 million); medium ($10 to $50 million); and, large (over $50 million). Percentage differences between actual and estimated total project costs were analyzed within each group. As can be seen in Table 4-8, cost performance varied substantially from one project to another. Of the 46 projects which were analyzed, 22 had cost overruns, 23 had cost underruns, and 1 had actual costs equal to the estimated costs. Statistical analysis by project size showed that, on average; small projects cost 16 percent less than estimated; medium projects cost 16 percent more than estimated; and large projects cost 4 percent more than estimated. Standard deviations were similar for all three groups.

b. Comparison by Size by Year. In order to see whether cost performance has changed over time, the percentage differences were plotted according to the year of the project construction cost estimates. These scatter graphs are included as Figures 4-3, 4-4, and 4-5, which show small, medium, and large projects, respectively. Examination of these figures reveals that for medium and large projects, cost performance has improved significantly since the 1960s. These figures also show the absence of a bias toward either cost overruns or cost underruns.

c. Comparison by Size, Including Emergency Costs. Some projects experienced severe storms and required emergency repairs and nourishment. Table 4-9 displays a similar analysis of actual/estimated cost differences as was done above, but in this case emergency costs are included with the actual costs. No estimates are done for emergency costs. The results of this analysis are almost the same as Table 4-8 for small and large projects. For medium projects, the inclusion of emergency costs brings the mean percentage cost overrun up from 16 to 24 percent. Standard deviations for all three groups remain in the range of 34 to 39.

Table 4-8 Percentage Differences Between Actual and Estimated Costs By Project and Project Size

PROJECTS COSTING <$10 MILLION	%	PROJECTS COSTING $10 - 50 MILLION	%	PROJECTS COSTING OVER $50 MILLION	%
Seaside Park, CT	N/A	Harrison CO., Mississippi	N/A	Surfside/Sunset, CA	N/A
Wallis Sands Beach, NH	N/A	S. Shore of Long Is. Fire Is. to Montauk Pnt. Moriches to Shinnecock Reach, NY	N/A	Galveston Seawall, TX	-50
Prospect Beach, CT	N/A	Point Place, OH	28	Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	-10
Sherwood Island State Park, CT	N/A	Oceanside, CA	114	Broward Co, Segment3, FL	16
Winthrop Beach, MA	N/A	Cape May, NJ	-4	Keansburg, NJ	95
Quincy Shore Beach, MA	N/A	Wrightsville Beach, NC	15	Duval CO, FL	-24
Hampton Beach, NH	N/A	Pinellas Co, Treasure Is., FL	17	Presque Isle, PA	-1
Revere Beach, MA	-21	Tybee Is. GA	3	Channel Islands Harbor, CA	8
Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	8	Palm Beach Co, Delray Beach, FL	6	Dade Co., FL	-2
Palm Beach Co., Lake Worth Inlet to South Lake Worth Inlet, Fl	12	Lee Co., Captiva Island, FL	32	**N**	8
S. Shore of Long Is. Fire Is. to Montauk Pt. Southampton to Beach Hampton	-21	Virginia Key and Key Biscayne, FL	-27	**MEAN**	4.00
Reno Beach, OH	-20	Virginia Beach, VA	76	**STANDARD DEVIATION**	39.37
Cliff Walk, RI	-74	Great Egg Harbor, NJ	22		
Palm Beach Co., Boca Raton, FL	-17	Grand Isle, LA	6		
Brevard, Cape Canaveral, FL	-40	Carolina Beach, NC	0		
Maumee Bay, OH	-26	Broward Co., Segment 2, FL	-23		
Hamlin Beach State Park, NY	-28	Ocean City, MD	20		
Lakeview Park Coop, OH	-37	Pinellas Co, Sand Key, FL	2		
Brevard Co, Indialantic/Melbourne, FL	-53	Atlantic Coast of Long Is. Fire Is. Inlet and Shore Westerly to Jones Inlet, NY	-11		
Pinellas Co, Long Key, FL	80	**N**	17		
Ventura Pierpont, CA	3	**MEAN**	16.24		
Delaware Coast Sand Bypass, DE	-17	**STANDARD DEVIATION**	33.41		
Fort Macon, NC	6				
Fort Pierce Beach, FL	-46				
Coast of CA, Point Mugu to San Pedro	34				
Manatee CO, FL	-45				
Corpus Christi, TX	2				
Folly Beach, SC	-38				
N	21				
MEAN	-16.10				
STANDARD DEVIATION	32.76				

Figure 4-3 Small Projects - Comparison of Cost Differences
Between Actual and Estimated, Expressed as a Percentage of the Estimate

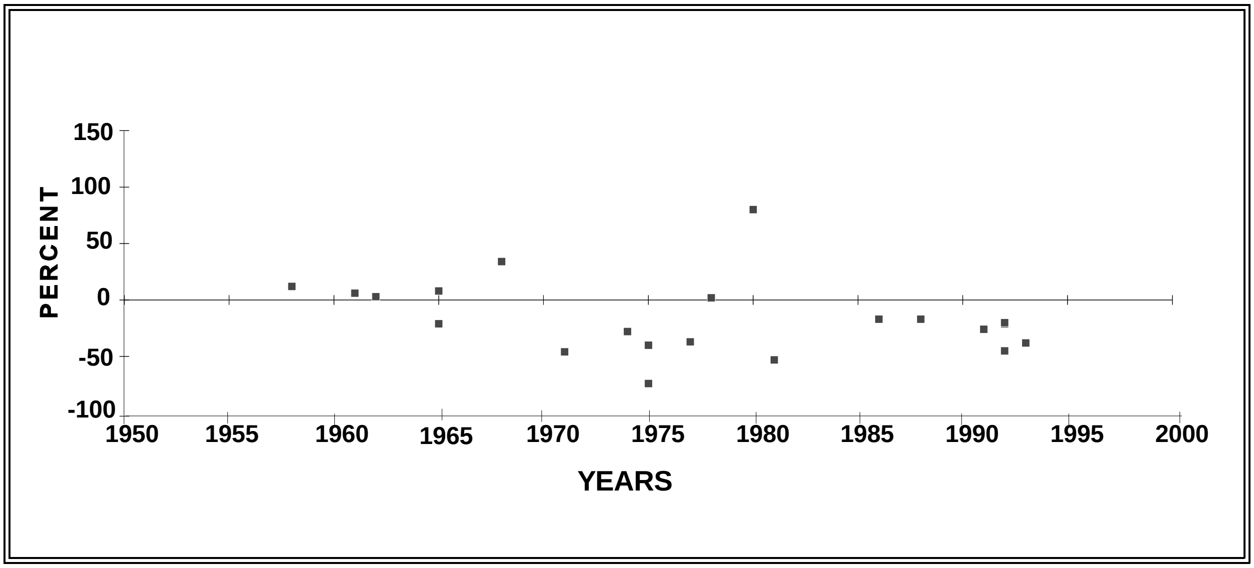


Figure 4-4 Medium Projects - Comparison of Cost Differences
Between Actual and Estimated, Expressed as a Percentage of the Estimate

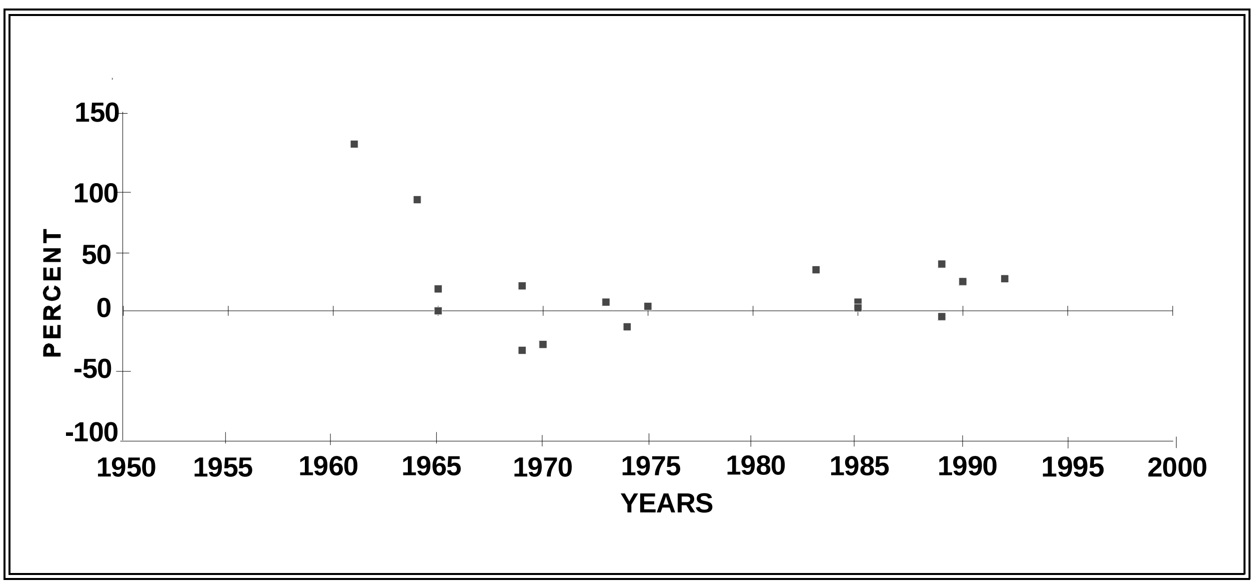


Figure 4-5 Large Projects - Comparison of Cost Differences Between Actual and Estimated, Expressed as a Percentage of the Estimate

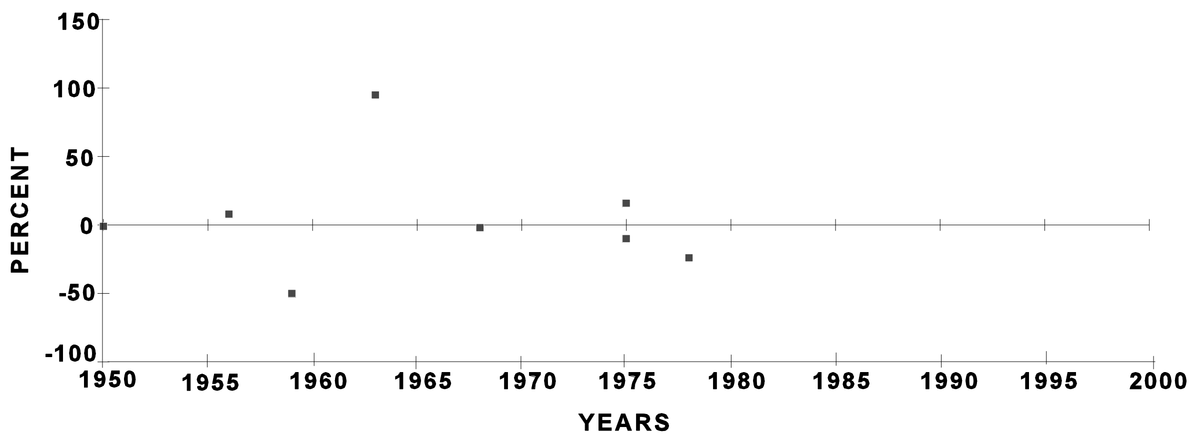


Table 4-9 Differences Between Actual and Estimated Costs (Including Emergency Costs)

PROJECTS COSTING (WITH EMERGENCY COSTS) < $10 MILLION	%
Seaside Park, CT	N/A
Wallis Sands Beach, NH	N/A
Prospect Beach, CT	N/A
Sherwood Island State Park, CT	N/A
Winthrop Beach, MA	N/A
Quincy Shores Beach, MA	N/A
Hampton Beach, NH	N/A
Revere Beach, MA	-21
Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	8
Palm Beach Co., Lake Worth Inlet to South Lake Worth Inlet, FL	12
S Shore of Long Is. Fire Is. to Montauk Pnt. Southampton to Beach Hampton	-21
Reno Beach, OH	-20
Cliff Walk, RI	-74
Palm Beach Co., Boca Raton, FL	-17
Brevard, Cape Canaveral, FL	-40
Maumee Bay, OH	-26
Hamlin Beach State Park, NY	-28
Lakeview Park Coop, OH	-37
Brevard Co, Indialantic/Melbourne, FL	-53
Pinellas Co, Long Key, FL	80
Ventura Pierpont, CA	15
Delaware Coast Sand Bypass, DE	-14
Fort Macon, NC	6
Fort Pierce Beach, FL	-46
Coast of CA, Sand Mugu to Sad Pedro	34
Manatee CO, FL	-45
Corpus Christi, TX	2
Folly Beach, SC	-38
N	21
MEAN	-15.10
STANDARD DEVIATION	33.98

PROJECTS COSTING (WITH EMERGENCY COSTS) $10 - $50 MILLION	%
Harrison CO., Mississippi	N/A
S. Shore of Long Is. Fire Is. to Montauk Pnt. Moriches to Shinnecock Reach, NY	N/A
Point Place, OH	28
Oceanside, CA	114
Cape May, NJ	-4
Wrightsville Beach, NC	32
Pinellas Co, Treasure Is., FL	75
Tybee Is. GA	4
Palm Beach Co, Delray Beach, FL	6
Lee Co., Captiva Island, FL	32
Virginia Key & Key Biscayne, FL	-27
Virginia Beach, VA	90
Great Egg Harbor, NJ	22
Grand Isle, LA	23
Carolina Beach, NC	17
Broward Co., Segment 2, FL	-23
Ocean City, MD	26
Pinellas Co, Sand Key, FL	2
Atlantic Coast of Long Is. Fire Is. Inlet and Shore Westerly to Jones Inlet, NY	-11
N	17
MEAN	23.88
STANDARD DEVIATION	37.01

PROJECTS COSTING (WITH EMERGENCY COSTS) OVER 50 MILLION	%
Surfside/Sunset, CA	N/A
Galveston Seawall, TX	-50
Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	-5
Broward Co, Segment 3, FL	16
Raritan and Sandy Hook Bay, Keansburg	95
Duval CO, FL	-24
Presque Isle, PA	-1
Channel Islands Harbor, CA	8
Dade Co., FL	-2
N	8
MEAN	4.63
STANDARD DEVIATION	39.18

E. QUANTITIES OF SAND PLACED IN BEACH NOURISHMENT PROJECTS

1. Program Overview. In addition to project costs, information was also collected on the quantities of sand placed during initial restoration and periodic nourishment. The survey data revealed that 49 of the 56 projects involved initial beach restoration. The total volume of sand placed was 110.6 million cubic yards, distributed among the regions of the country as follows: 22 percent in the North Atlantic Division; 46 percent in the South Atlantic Division; and 32 percent in the other coastal divisions. Based on the collected data, 40 of the 56 projects involved periodic nourishment. The total volume placed was 79.1 million cubic yards, distributed among the regions as follows: 18 percent in North Atlantic Division; 36 percent in South Atlantic Division; and 46 percent in other coastal divisions.

2. Individual Projects. The quantities of sand used for beach restoration and periodic nourishment are shown by project in Table 4-10. The 36.3 million cubic yards of sand used in California's Channel Islands Harbor is the largest quantity of sand that has been placed. The second largest quantity of sand was used in Dade County (Miami Beach), Florida (15.2 million cubic yards), followed by Surfside/Sunset, California (14.3 million cubic yards); the Atlantic coast of New York City at Rockaway (11.7 million cubic yards); and, Carolina Beach, North Carolina (11.1 million cubic yards). These projects' cumulative sand records are a result of periodic activity throughout their 20 or more years of existence.

Table 4-10 Quantities of Sand By Project (Continued on Next Page)

	Project Name	Year of Construction	Initial Beach Restoration Cubic Yards (000s)	Periodic Nourishment Cubic Yards (000s)	Total Sand Placed Cubic Yards (000s)
1.	Prospect Beach, CT	1957	N/A	N/A	N/A
2.	Seaside Park, CT	1958	N/A	N/A	N/A
3.	Sherwood Island State Park, CT	1983	113	N/A	113
4.	Quincy Shore Beach, MA	1950	N/A	N/A	N/A
5.	Revere Beach, MA	1992	670	0	670
6.	Winthrop Beach, MA	1956	N/A	N/A	N/A
7.	Hampton Beach, NH	1966	169	N/A	169
8.	Wallis Sands State Beach, NH	1966	N/A	0	0
9.	Cliff Walk, RI	1983	0	0	0
10.	Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	1975	6364	5330	11694
11.	Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY	1974	4123	3308	7431
12.	S. Shore of Long Is. Fire Is. to Montauk Point, Moriches to Shinnecock Reach, NY	1965	1800	0	1800
13.	S. Shore of Long Is. Fire Is. to Montauk Point Southampton to Beach Hampton, NY	1965	0	0	0
14.	Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	1965	N/A	0	0
15.	Raritan Bay and Sandy Hook Bay, Keansburg and E. Keansburg, NJ	1968	0	0	0
16.	DE Coast Sand Bypass - Indian River	1986	0	240	240
17.	Cape May Inlet to Lower Township, NJ	1989	1365	710	2075
18.	Great Egg Harbor Inlet and Peck Bch, NJ	1992	6070	0	6070
19.	Atlantic Coast of MD-Ocean City, MD	1990	4941	184	5125
20.	Virginia Beach , VA	1962	0	4472	4472
21.	Wrightsville Beach, NC	1965	2993	5506	8499
22.	Carolina Beach and Vicinity, NC	1965	3597	7510	11107
23.	Fort Macon, NC	1961	93	0	93
24.	Folly Beach, SC	1993	3100	0	3100
25.	Tybee Island, GA	1975	2267	1300	3567
26.	Pinellas Co.-Sand Key Segment, FL	1985	2707	0	2707
27.	Broward Co.-Segment 2, FL	1970	1030	1750	2780
28.	Broward Co. Segment 3, FL	1978	3070	1712	4782
29.	Brevard Co.-Indialantic/Melbourne, FL	1981	540	0	540
30.	Brevard Co.-Cape Canaveral, FL	1975	1250	0	1250
31.	Fort Pierce Beach, FL	1971	718	426	1144
32.	Duval Co., FL	1978	2486	2589	5075
33.	Pinellas Co.-Long Key Segment, FL	1980	253	460	713

Table 4-10 Quantities of Sand by Project (Continued)

	Project Name	Year of Construction	Initial Beach Restoration Cubic Yards (000s)	Periodic Nourishment Cubic Yards (000s)	Total Sand Placed Cubic Yards (000s)
34.	Pinellas Co.-Treasure Is. Segment, FL	1969	600	868	1468
35.	Virginia Key and Key Biscayne, FL	1969	350	100	450
36.	Dade Co., FL	1975	14601	625	15226
37.	Lee Co.-Captiva Island Segment, FL	1989	1418	0	1418
38.	Palm Beach Co.-Boca Raton Segment, FL	1988	875	0	875
39.	Palm Beach Co.-Delray Beach Segment, FL	1973	1340	2577	3917
40.	Palm Beach Co.-(58) Lake Worth Inlet to South Lake Worth Inlet, FL	1958	0	0	0
41.	Manatee Co., FL	1992	2200	0	2200
42.	Harrison Co., MS	1952	5700	3350	9050
43.	Grand Isle and Vicinity, LA	1985	2870	1276	4146
44.	Corpus Christi Beach, TX	1978	742	167	909
45.	Galveston Seawall, TX	1963	0	0	0
46.	Presque Isle, PA	1956	4426	4028	8454
47.	Lakeview Park Cooperative , OH	1977	125	16	141
48.	Hamlin Beach State Park, NY	1974	317	0	317
49.	Point Place, OH	1983	0	0	0
50.	Reno Beach, OH	1992	0	0	0
51.	Maumee Bay State Park, OH	1991	143	0	143
52.	Surfside/Sunset , CA	1964	14303	0	14303
53.	Oceanside, CA	1961	2400	547	2947
54.	Channel Islands Harbor, CA	1959	6225	30071	36296
55.	Coast of CA, Point Mugu to San Pedro, CA	1968	1405	0	1405
56.	Ventura-Pierpont Area, CA	1962	883	0	883

F. PROJECT PERFORMANCE, SAND

1. Performance at the Program Level, Quantities of Sand

a. Introduction. In addition to cost performance, beach fill projects were also assessed in terms of the actual quantity of sand placed. This yardstick was independent of price levels, inflation, etc. The analysis was restricted to those projects having adequate detail on both the estimates and the actual quantity of sand used over time. Projects excluded were built primarily in the 1950s and 1960s, were generally limited to ten years of Federal participation, and did not include a prediction of future sand requirements as part of the design.

b. Initial Beach Restoration. A detailed summary of the overall program's quantities of sand for initial beach restoration is shown below. Thirty nine of the total 49 initial beach restoration projects had sufficient data for analysis. These 39 projects used a total of 94.5 million cubic yards of sand compared to an estimated quantity of 93.7 million cubic yards. The actual amount exceeded the estimate by one percent. This analysis is dependent on 80 percent of the projects' data on actual/estimated quantities of sand. It is unclear how the remaining 20 percent of the projects would affect the sand data results.

c. Exclusions from Initial Beach Restoration. The specific projects which were excluded from the actual/estimated comparison are listed below, along with the reasons.

(1). Five New England Division projects (Prospect Beach, CT; Seaside Park, CT; Quincy Shore Beach, MA; Winthrop Beach, MA; and, Wallis Sands State Beach, NH) were excluded because beach restoration was done by local sponsors and later reimbursed by the Corps of Engineers. Quantities of sand used were not available for these projects.

(2). South Shore of Long Island, Fire Island to Montauk Point, Moriches to Shinnecock Reach, NY. This project was excluded because the estimates were for a 15.5 mile reach, only a small portion (about two miles) of which was actually constructed.

(3). Raritan and Sandy Hook Bay, NJ, Madison and Matawan Townships and Raritan and Sandy Hook Bay, NJ, Keansburg and East Keansburg projects. Quantities of sand used in initial beach restoration were not available for these projects.

(4). The DE Coast Sand Bypass-Indian River project was excluded because the plan estimated the project would use sand, but no sand was used for initial beach restoration.

(5). Surfside/Sunset in California. This project was excluded because the initial beach restoration figures only included partial figures. The construction of this project was done in stages and there was no record of estimates for two of the stages.

d. Periodic Nourishment. Of the 40 periodic nourishment projects only 33 had sufficient data on both actual and estimated quantities of sand to be included in this performance analysis. These 33 projects' historical record indicates an actual placement of 72.5 million cubic yards of sand compared to an estimated quantity of 64.7 million cubic yards. Considering the program as a whole, the actual periodic nourishment sand exceeded the estimates by 12 percent. A summary is presented below.

e. Exclusions from Periodic Nourishment. The specific projects which were excluded form the actual/estimated comparison are listed below, along with the reasons for their exclusion.

(1). Six of the periodic nourishment projects (Prospect Beach, CT; Seaside Park, CT; Sherwood Island, State Park; CT, Quincy Shore Beach, MA; Winthrop Beach, MA; and, Hampton Beach, NH) were excluded because the information on actual periodic nourishment, and in some cases estimated periodic nourishment, was not available. Periodic nourishment for these projects was the responsibility of the local sponsors, and the NED office does not have any records indicating whether or not it was done.

(2). Atlantic Coast of Long Island, Fire Island Inlet & Shore Westerly to Jones Inlet, NY was excluded because estimates were not available for this project. This project uses the amount of sand that is removed from the navigation channel and places it on this shore to serve as a feeder beach.

2. Performance at the Project Level, Quantities of Sand. Table 4-11 shows the differences between actual and estimated quantities of sand for individual projects, expressed as a percentage of the estimate. Positive numbers indicate cubic yardage overruns; negative numbers indicate cubic yardage underruns. For example, a "10" in Table 4-11 means that actual cubic yardage of sand placed was 10 percent more than the amount estimated. A "-10" in Table 4-11 means that the actual amount of sand placed was 10 percent less than the estimate. A zero in Table 4-11 means that there was no difference between the actual and the estimate; the actual volume of sand was equal to the estimated volume of sand.

3. Statistical Analysis.

a. Initial Beach Restoration. There are 39 projects with percentage differences between actuals and estimates for quantities of sand used for initial beach restoration (listed in Table 4-12). The values range from -73 to +85. The mean is 5 and the median is 1. The mean of 5 indicates that the average project placed 5 percent more sand than was estimated for initial beach restoration. The median of 1 indicates that about half of the projects had sand overruns while the other half had sand underruns. The fact that the mean is higher than the median suggests that the sand overruns are slightly larger than the sand underruns, even though they are equal in number.

Table 4-11 Difference Between Actual and Estimated Sand Volume Expressed as a Percentage of the Estimate (Continued on Next Page)

Project Name	Initial Beach Restoration Cubic Yards Percent	Periodic Nourishment Cubic Yards Percent
1. Prospect Beach, CT		
2. Seaside Park, CT		
3. Sherwood Island State Park, CT	-73	
4. Quincy Shore Beach, MA		
5. Revere Beach, MA	-13	-100
6. Winthrop Beach, MA		
7. Hampton Beach, NH	-50	
8. Wallis Sands State Beach, NH		
9. Cliff Walk, RI		
10. Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	-22	-1
11. Atlantic Coast of Long Is. Fire Is. Inlet & Shore Westerly to Jones Inlet, NY	-51	
12. S. Shore of Long Is. Fire Is. to Montauk Point Moriches to Shinnecock Reach, NY		-100
13 S. Shore of Long Is. Fire Is. to Montauk Point Southampton to Beach Hampton, NY		
14. Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ		-100
15. Raritan Bay and Sandy Hook Bay, Keansburg and E. Keansburg, NJ		-100
16. DE Coast Sand Bypass - Indian River		-66
17. Cape May Inlet to Lower Township, NJ	-6	-1
18. Great Egg Harbor Inlet and Peck Beach, NJ	47	-100
19. Atlantic Coast of MD - Ocean City, MD	29	
20. Virginia Beach, VA		139
21. Wrightsville Beach, NC	20	289
23. Fort Macon, NC	-31	-100
22. Carolina Beach and Vicinity, NC	78	48
24. Folly Beach, SC	24	
25. Tybee Island, GA	17	-18
26. Pinellas Co, Sand Key Segement, FL	1	-100
27. Broward Co, Segment 2, FL	-33	-41
28. Broward Co, Hillsboro Inlet, Segment 3, FL	1	25
29. Brevard Co, Indialantic/Melbourne, FL	-18	-100
30. Brevard Co, Cape Canaveral, FL	40	
31. Fort Pierce Beach, FL	-24	-64
32. Duval Co, FL	-24	-38
33. Pinellas Co, Long Key Segment, FL	4	84
34. Pinellas Co, Treasure Is. Segment, FL	16	-13
35. Virginia Key and Key Biscayne, FL	1	-48
36. Dade Co, FL	-5	-70
37. Lee Co, Captiva Island Segment, FL	36	

Table 4-11 Differences Between Actual and Estimated Sand Volume Expressed as a Percentage of the Estimate (Continued)

Project Name	Initial Beach Restoration Cubic Yards Percent	Periodic Nourishment Cubic Yards Percent
38. Palm Beach Co, Boca Raton Section, FL	38	
39. Palm Beach Co, Delray Beach Segment, FL	0	298
40. Palm Beach Co, Lake Worth Inlet to South Lake Worth Inlet, FL		
41. Manatee Co, FL	0	
42. Harrison Co, MS	0	
43. Grand Isle and Vicinity, LA	13	-16
44. Corpus Christi Beach, TX	3	-45
45. Galveston Seawall, TX		
46. Presque Isle, PA	1	0
47. Lakeview Park Cooperative, OH	14	-80
48. Hamlin Beach State Park, NY	30	-100
49. Point Place, OH		
50. Reno Beach, OH		
51. Maumee Bay, OH	-12	-100
52. Surfside/Sunset, CA		
53. Oceanside, CA	85	
54. Channel Islands Harbor, CA	22	17
55. Coast of CA, Point Mugu to San Pedro, CA	0	
56. Ventura-Pierpont Area, CA	37	

b. Periodic Nourishment. There are 31 projects with percentage differences between actuals and estimates for the cubic yards of sand used for periodic nourishment (see Table 4-11). These values range from -100 to +298. A "-100" in Table 4-12 means that a certain amount of periodic nourishment was planned, but no periodic nourishment was done. Projects which had "-100's" were examined more closely, and it was discovered that, in several cases, the absence of periodic nourishment was not a true indicator of project performance with respect to erosion rates. Nourishment was not carried out as planned for several reasons. In some cases, the local sponsor withdrew from the project agreement. In some recently constructed projects, the schedule had slipped so that nourishment was really not due yet. In only two of the ten projects with "-100's" (Hamlin Beach State Park, NY and Maumee Bay, OH) was the lack of nourishment an indicator of less-than-expected erosion rates. Therefore, the remaining eight were eliminated from the statistical analysis, so as not to inappropriately skew it downwards. Fort Pierce Beach, FL and Virginia Key and Key Biscayne projects were also eliminated from the statistical analysis because their low nourishment rates were not related to low erosion rates. Statistics were calculated for periodic nourishment sand performance in 21 projects. The mean of this group was 15 and the median was

-13. This means that the average project used 15 percent more sand for periodic nourishment than expected. However, the median project (the one in the middle of the distribution) used 13 percent less sand than estimated. The mean was pulled up by a few projects which had very large sand overruns. The standard deviation was quite large, at 107.

4. Performance by Project Size, Quantities of Sand.

a. Comparison by Size.

(1). Table 4-12 shows the differences between actual and estimated quantities of sand for individual projects, expressed as a percentage of the estimate. Positive numbers indicate cubic yardage overruns, negative numbers indicate cubic yardage underruns, and a zero means that the estimate of sand equaled the actual amount of sand placed. Table 4-12 also groups the projects into three size categories based on total cumulative project costs in 1993 dollars: 1) small - projects costing less than $10 million; 2) medium - projects costing between $10 and $50 million; and, 3) large - projects costing more than $50 million.

(2). Of the 56 projects examined in this study, 38 had sufficient data on quantities of sand to be included in this performance analysis. Projects which were excluded either had no estimates for quantities of sand, were completely structural and therefore did not involve sand, or were only partly constructed.

(3). Table 4-12 reveals considerable variation in the percentage differences between actual and estimated quantities of sand at the project level, but no overall bias towards either underestimation or overestimation. In fact, the projects were almost evenly split between sand overruns (18 projects) and sand underruns (17 projects). Three projects placed exactly as much sand as had been estimated.

(4). Quantitative analysis of the percentage differences shows that small projects placed on average 8 percent less sand than estimated, medium projects placed on average 34 percent more sand than estimated, and large projects placed on average 4 percent less sand than estimated. All of the large sand overruns involved medium-sized projects.

b. Comparison by Size and Year of Estimation. The percentage differences between actual and estimated quantities of sand are plotted over time for small, medium, and large projects in Figures 4-6, 4-7, and 4-8, respectively. Of special note is Figure 4-7, which shows significant improvement in the estimates of quantities of sand over time for medium-sized projects. There were several large sand overruns in medium-sized projects built in the 1960s and early 1970s, but more recent projects have actual sand use much closer to the estimates. For small (Figure 4-6) and large (Figure 4-8) projects, there is not much change in sand performance over time.

Table 4-12 Percentage Differences Between Actual and Estimated Quantities of Sand by Project Size

PROJECTS COSTING < $10 MILLION	%
Seaside Park, CT	N/A
Wallis Sands Beach, NH	N/A
Prospect Beach, CT	N/A
Sherwood Island State Park, CT	N/A
Winthrop Beach, MA	N/A
Cliff Walk, RI	N/A
Hampton Beach, NH	N/A
Quincy Shore Beach, MA	N/A
Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	N/A
Palm Beach Co., Lake Worth Inlet to South Lake Worth Inlet, FL	N/A
S. Shore of Long Is. Fire Is. to Montauk Pt. Southampton to Beach Hampton, NY	N/A
Reno Beach, OH	N/A
Revere Beach, MA	-21
Palm Beach Co., Boca Raton, FL	38
Brevard, Cape Canaveral, FL	40
Maumee Bay, OH	-21
Hamlin Beach State Park, NY	1
Lakeview Park Coop, OH	-26
Brevard Co, Indialantic/Melbourne, FL	-56
Pinellas Co, Long Key, FL	45
Ventura Pierpont, CA	37
Delaware Coast Sand Bypass, DE	-69
Fort Macon, NC	-67
Fort Pierce Beach, FL	-46
Coast of CA, Point Mugu to San Pedro	0
Manatee CO, FL	0
Corpus Christi, TX	-11
Folly Beach, SC	24
N	16
MEAN	-8.25
STANDARD DEVIATION	37.17

PROJECTS COSTING $10 - $50 MILLION	%
Harrison CO., Mississippi	N/A
S. Shore Long Is. Fire Is. to Montauk Pnt. Moriches to Shinnecock Reach ,NY	N/A
Point Place, OH	N/A
Oceanside, CA	127
Cape May, NJ	-4
Wrightsville Beach, NC	117
Pinellas Co, Treasure Is., FL	-3
Tybee Is. GA	2
Palm Beach Co, Delray Beach, FL	97
Lee Co., Captiva Island, FL	36
Virginia Key and Key Biscayne, FL	-17
Virginia Beach, VA	139
Great Egg Harbor, NJ	17
Grand Isle, LA	2
Carolina Beach, NC	56
Broward Co., Segment 2, FL	-38
Ocean City, MD	34
Pinellas Co, Sand Key, FL	-8
Atlantic Coast of Long Is. Fire Is. Inlet and Shore Westerly to Jones Inlet, NY	-11
N	16
MEAN	34.13
STANDARD DEVIATION	54.63

PROJECTS COSTING > $50 MILLION	%
Surfside/Sunset, CA	N/A
Galveston Seawall, TX	N/A
Raritan and Sandy Hook Bay, Keansburg, NJ	N/A
Broward Co, Segment 3, FL	9
Atlantic Coast of NYC, E. Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY	-14
Duval CO, FL	-32
Presque Isle, PA	0
Channel Islands Harbor, CA	18
Dade Co., FL	-13
N	6
MEAN	-4.00
STANDARD DEVIATION	14.43

Figure 4-6 Small Projects - Sand Quantities: Differences Between Actual and Estimated, Expressed as a Percentage of the Estimate

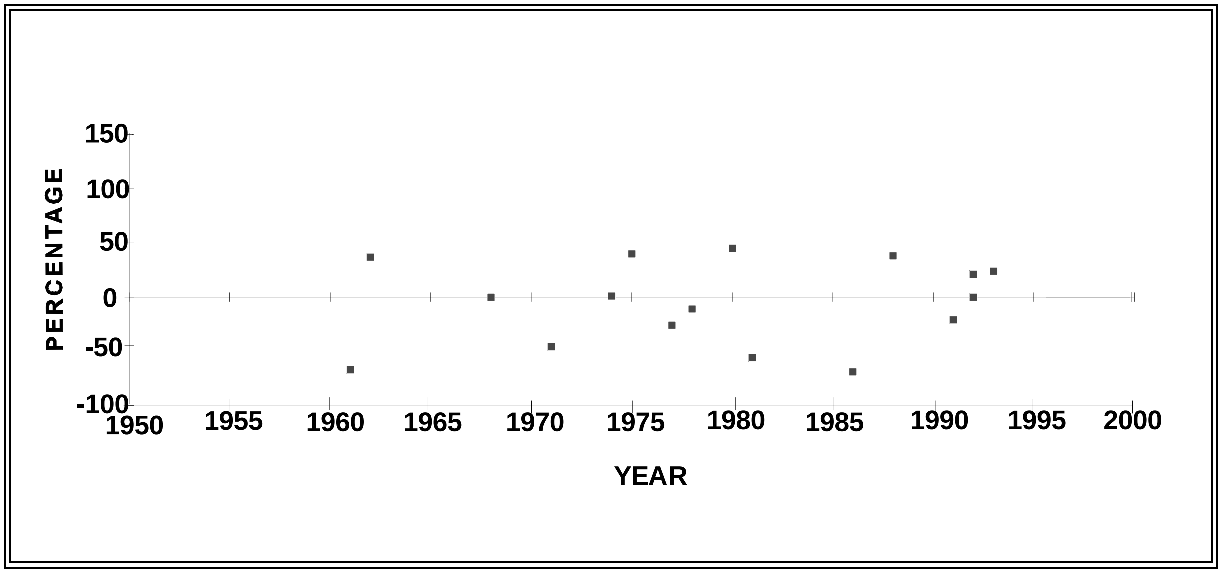


Figure 4-7 Medium Projects - Sand Quantities: Differences Between Actual and Estimated, Expressed as a Percentage of the Estimate

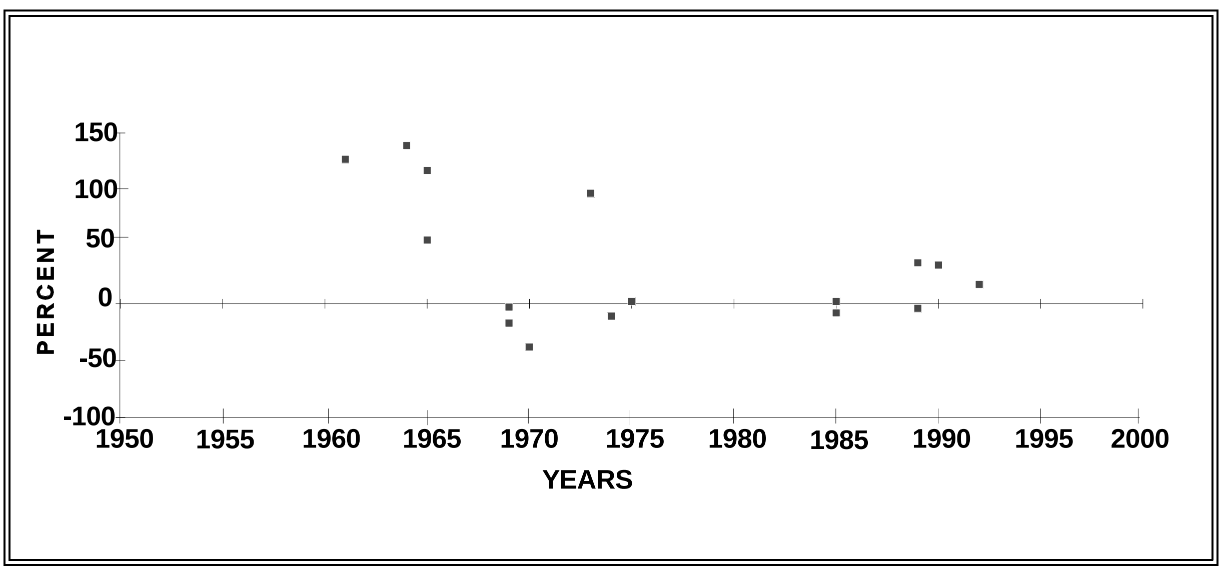
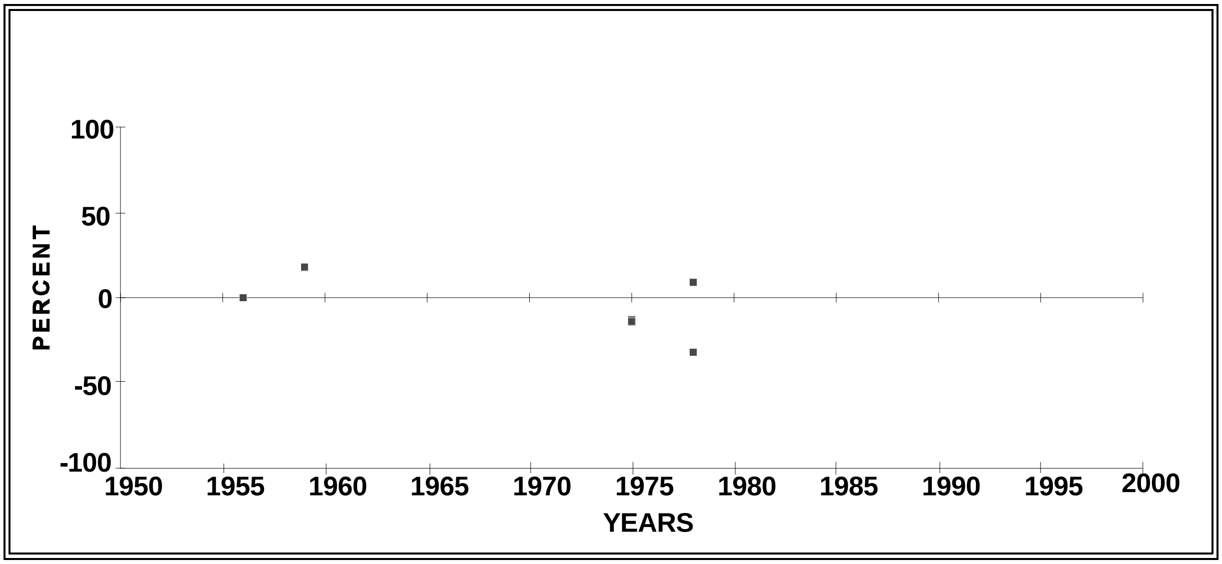


Figure 4-8 Large Projects - Quantities of Sand: Differences Between Actual and Estimated, Expressed as a Percentage of the Estimate



5. Navigation Disposal Material. In some cases, material dredged from navigation channels has been placed on beach nourishment projects. If this is the least-cost disposal alternative, the cost is attributed to the navigation project. Therefore, the cost to the beach nourishment project may be zero. This was the case in Cape Canaveral (Canaveral Harbor), Fort Pierce Beach, FL (Fort Pierce Harbor), and Duval Co., FL (St. Johns River). If it is not the least-cost disposal alternative, it may still be more economical than obtaining beach nourishment sand from elsewhere, and it may still be done. In these cases, costs are shared between the navigation project, the beach nourishment project, and the non-Federal sponsors. According to the survey done for this study, seven of the 56 large projects received some navigation disposal sand. The quantities of sand and costs to the beach nourishment project are listed in Table 4-13 for each of these projects. This material is typically a finer-grained material than would be obtained from an offshore borrow source, and is therefore not reflective of either a background erosion rate or a loss rate for the artificially-nourished project beach.

G. FUTURE COSTS OF THE SHORE PROTECTION PROGRAM

1. Costs of Already Constructed Projects. Figure 4-9 shows the future yearly expenditures of the 210 miles of already-constructed Federal shore protection projects (averaged over five year periods), assuming that all planned and currently authorized nourishments are carried out, but that no projects are extended beyond their currently authorized period. As expected, these yearly expenditures

gradually decline over the next 50 years as project authorizations expire. Total Federal expenditures over this future time period, in 1993 dollars, are estimated to be $505.3 million. The expected distribution of Federal funds among the types of shoreline measures is shown in Table 4-14. These projections assume that there will be no additional Congressional authorizations to extend Federal involvement in these projects.

Table 4-13 Navigation Disposal Material Placed on Beach Nourishment Projects

Project	Navigation Disposal Material- thousands of cubic yards	Cost of Navigation Disposal Material Placed (in thousands of 1993 dollars)
Virginia Beach, VA	1190	8870
Wrightsville Beach, NC	N/A	6486
Carolina Beach, NC	61	66
Brevard Co, FL - Cape Canaveral	1517	15,919
Fort Pierce Beach, FL	164	0
Duval Co, FL	1383	0
Dade Co., FL	5508	6940

Figure 4-9 Expected, Future Annual Expenditures of Already-Constructed Projects (Assuming no Extensions) in 1993 Dollars, Averaged Over Five Year Periods

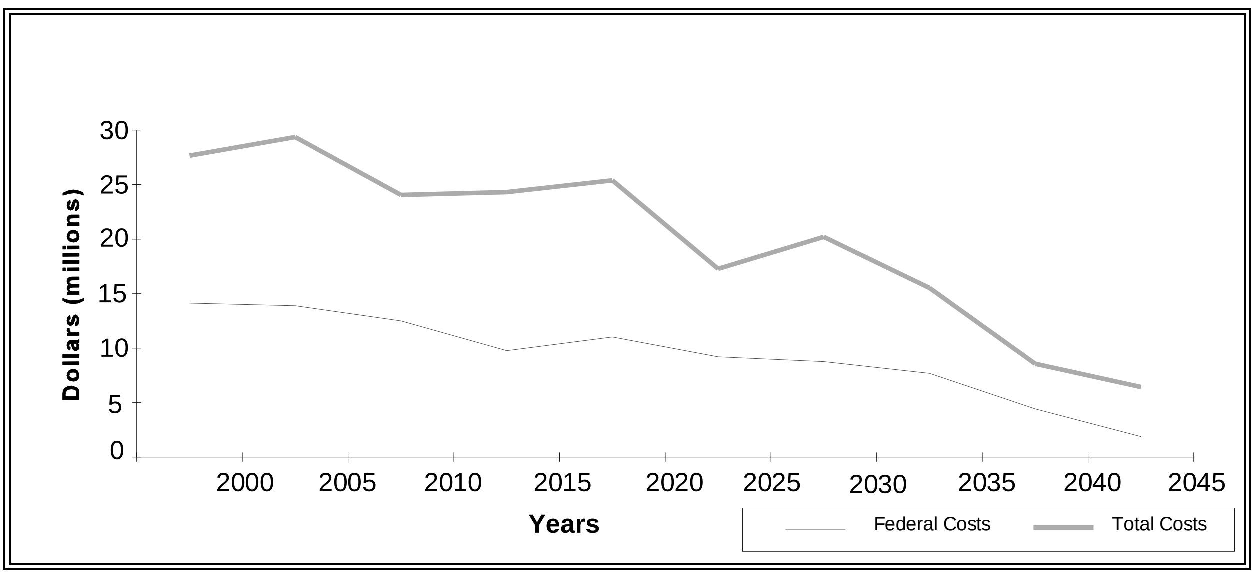


Table 4-14 - Future Federal Expenditures Associated with Already-Constructed Projects

Type of Measure	Remaining Federal Expenditures ($ million 1993)
Initial Restoration	12.3
Periodic Nourishment	477.4
Sand Bypassing Systems	15.6
Total	505.3

2. Possible Future Costs of Planned Projects. The data from the Districts revealed that there are presently 26 projects, covering 150.7 miles, that are far enough along in the planning process to have cost estimates. The total costs over the next 50 years for these 26 projects is estimated to be $2,055.3 million in 1993 dollars. Federal costs for these projects are projected to be $1,259.2 million. Table 4-15 divides these projects by construction status and then lists the Federal cost and total cost. The four largest projects account for half of the total cost: the Atlantic Coast of New Jersey at Seabright - $424.1 million; Atlantic Coast of New Jersey at Asbury Park - $263.5 million; Panama City Beaches, Florida - $218.2 million; and, Myrtle Beach, South Carolina - $134.3 million.

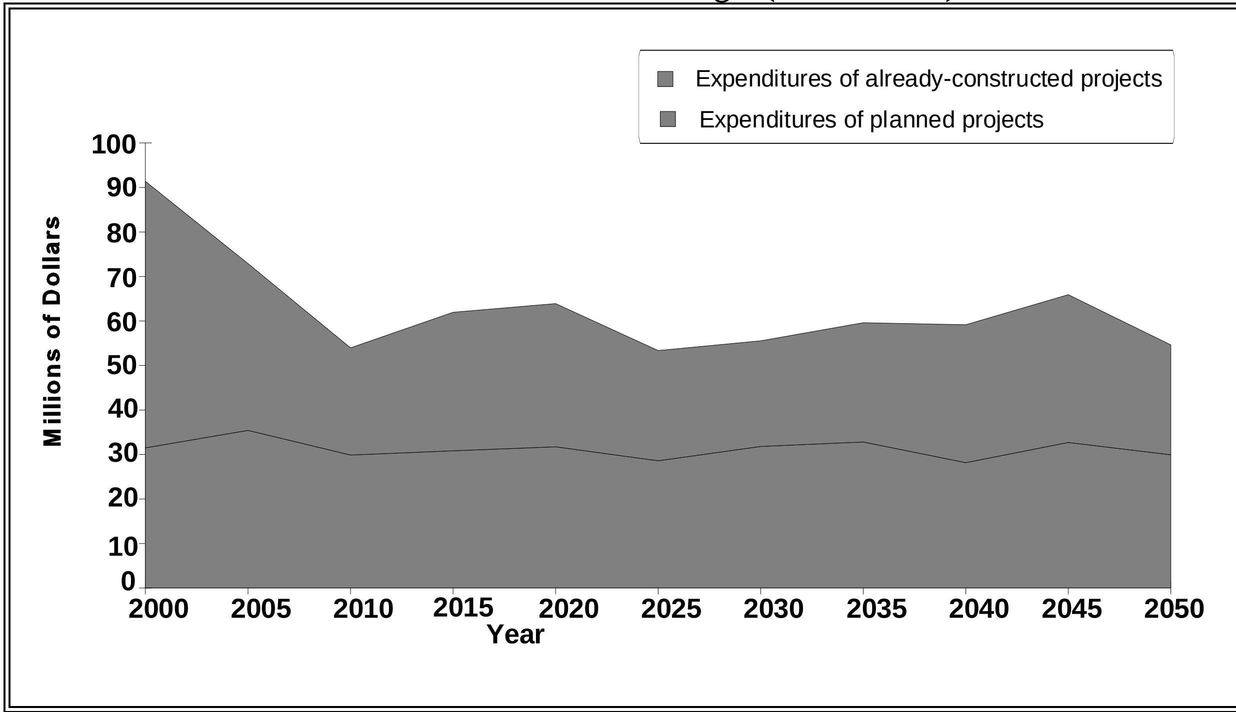
Table 4-15 Estimated Costs of Planned Projects Based on 1993 Conditions

Status	Number of Projects	Estimated Federal Cost ($ million 1993)	Estimated Total Cost ($ million 1993)
Under Construction	1	9.9	15.2
Authorized/Waiting Initiation of Construction	10	491.3	879.1
Preconstruction Engineering and Design	15	758.0	1161.0
Total	26	1259.2	2055.3

3. Future Costs if the Existing 56 Projects are Extended Until the Year 2050 and if all 26 Planned Projects are Constructed. Figure 4-10 shows the projected yearly expenditures (calculated as five-year averages) of both existing and planned shore protection projects in 1993 dollars. This scenario assumes that all existing projects will continue to be nourished and maintained, and that all 26 planned projects will be constructed and nourished until 2050. Under these assumptions, the yearly expenditures of existing projects remains fairly steady at $30 million. After a surge of initial beach

construction, the yearly expenditure of planned projects remains in the $25 to $30 million dollar range. Total yearly shore protection program expenditures are projected to be in the $55 to $60 million range. The Federal share of these expenditures is expected to be approximately 65 percent, based on current cost sharing policies.

Figure 4-10 Projected Yearly Expenditure of Existing and Planned Projects, Calculated as Five Year Averages (1993 Dollars)



H. SUMMARY

1. Total Sand. The Federal government, through the Corps, has sponsored a total of 82 specifically authorized shore protection projects since 1950. Of these projects, 56 were of large enough scale to be considered in a detailed assessment. A total of 110.6 million cubic yards of sand were placed for initial beach restoration, and 79.1 million cubic yards for periodic nourishment, yielding a total quantity of sand placed of 189.7 million cubic yards.

2. Total Expenditures and Future Costs for Existing Projects. Total expenditures to date on these projects have been $670.2 million, with a Federal share of $403.2 million. If these expenditures are

adjusted to 1993 dollars, the figures become $1,489.5 million total with the Federal contribution at $881 million. Expected Federal expenditures associated with the 56 already-constructed projects are $505.3 million in 1993 dollars, and these will be spread over approximately the next 50 years and until their individual project authorization expires. If it is assumed that all authorizations are extended until the year 2050, the future Federal expenditure would be $883.5 million.

3. Future Expenditures for Planned Projects. Total expenditures over a 50 year period for the 26 projects which are currently under construction, authorized/awaiting initiation of construction, or in the preconstruction engineering design (PED) stage are estimated at $2,055.3 million in 1993 dollars. The Federal share of this is expected to be $1,259.2 million.

4. Project Performance.

a. General. Project performance was measured in terms of cost and, for beach nourishment projects, in terms of quantities of sand as well. Comparisons between actual and estimated costs and quantities were made for the program as a whole as well as for individual projects. Differences between actual and estimated costs (and quantities of sand) were expressed as a percentage of the estimate.

b. Program Level. When summed across the Federal Shore Protection Program, actual costs were four percent less than estimated costs. Quantities of sand, when viewed at the program level, were five percent more than estimated.

c. Project Level. There was considerably more variation between actuals and estimates at the individual project level, but the data revealed no bias toward either underestimation or overestimation of either costs or quantities of sand. Nearly equal numbers of projects had cost and sand overruns as had cost and sand underruns.

d. Project Size. Project performance was better for large projects (projects with costs greater than $50 million) than for small and medium projects. Performance was also generally better for more recent projects than for those designed and constructed 20 or more years ago.

I. ADDENDUM

1. Introduction. As explained earlier, this report is based on data current as of July 1993. In late 1995, certain of the data were updated to reflect costs and conditions as of October 1995. This data is as follows:

a. total actual expenditures for the 82 projects based on 1993 conditions;

b. total expenditures updated to 1995 prices based on 1993 conditions;

c. estimated costs of planned projects based on 1995 conditions; and

d. list of Congressionally authorized projects and studies based on 1995 conditions.

2. Total Actual Expenditures. As developed in paragraph B1 of this chapter, the total actual expenditures for the 56 large projects from 1950 to 1993 was $670.2 million. In addition, the 26 small specifically authorized projects were shown to cost $4.6 million (see Table 2-14). This combined actual cost for the 82 projects from 1950 to 1993 is $674.8 million. To arrive at a price for these 82 projects through 1995, it was assumed an average yearly cost of $27 million in the current time frame for the remaining expenditures associated with the already constructed projects (see Figure 4-9). This calculation asssumes that all planned and currently authorized nourishments are carried out, but that no projects are extended beyond their currently authorized period. Since the $27 million was an estimated cost based on 1993 dollars, an inflation factor of three percent per year was assumed for both 1994 and l995. This results in a total actual cost for the 82 projects (assuming no extensions of authorization) of $731.2 million. This updating is displayed in Table 4-16.

Table 4-16 Total Actual Expenditures for 82 Projects
1950-1995 Based on 1993 Conditions and Assuming No Extensions

Item	1950-1993 $ million	Δ 94 [1] $ million	Δ 95 [1] $ million	Total 1995 $ million
82 large constructed projects	674.8	27.8	28.6	731.2

Footnote: [1] Assumes a yearly cost of $27 million in 1993 dollars and an inflation factor of 3 % per year for 1994 and 1995.

3. Total Expenditures Updated to 1995. As developed in paragraph C3 of this chapter, the adjusted cost for the shore protection to 1995 costs is $1,489.5 million of the 56 large projects. Assuming an inflation factor of three percent per year for 1994 and 1995, this cost becomes $1,580.2 million in 1995 dollars. Similarly, the 26 small specifically authorized projects cost $17.6 million in 1995 dollars (see Table 2-14) and assuming an inflation factor of three percent per year for 1994 and 1995, this cost becomes $18.7 million in 1995 dollars. Yearly expenditures of these already constructed projects (assuming full authorization) was projected to be approximately $30 million (see Figure 4-

10). Similarly, at the time of the report survey in July 1993, there were 26 projects in the advanced planning and design stage (see Table 4-15). As shown in Figure 4-10, the projected yearly expenditures for these projects in the current time frame, and assuming full authorization, was projected to be approximately $60 million. An inflation factor of three percent was applied to these values to arrive at total 1995 cost for the 82 existing projects and the 26 planned projects of $1,787.1 million in 1995 dollars. These costs are summarized in Table 4-17.

Table 4-17 Total Expenditures for 82 Projects and 26 Planned Projects Adjusted to 1995 Prices, Based on 1993 Conditions and Full Authorization

Item	Miles of Shoreline	1950-93 $ million	93 $ million	Δ 94 [1] $ million	Δ 95 [1] $ million	Total 1995 $ million
56 large constructed projects	210	670.2	1489.5	44.7	46.0	1580.2
26 small constructed projects	16	4.6	17.6	0.5	0.6	18.7
Sub total 82 constructed projects	**226**	**674.8**	**1507.1**	**45.2**	**46.6**	**1598.9**
Future costs of the 82 @ $30M/yr in $1993 [2]	0	0	0	30.9	31.8	62.7
26 planned projects @ $60M/yr in $1993	151	0	0	61.8	63.7	125.5
Total	**377**	**674.8**	**1507.1**	**137.9**	**142.1**	**1787.1**

Footnotes:

[1] Assumes a 3 percent inflation factor per year for 1994 and 1995.

[2] Because of the limited data available and the small size of the projects, for the purposes of this study, it was assumed that there were no future costs associated with the 26 small scope specifically authorized projects. Based on project costs, this would impact the future costs by only about 1percent.

4. Estimated Costs of Planned Projects Based on 1995 Conditions. As shown in Table 4-15, at the time of the 1993 survey for the report, there were 26 projects in the advanced planning and design stage with an estimated Federal cost of $1,259.2 million and a total cost of $2,055.3 million. The 1995 updating produced a dramatic change, primarily in the category of "Under Construction." In this category, the number of projects increased from 1 to 12 and the total cost increased from $15.2 million to 1,695.0 million. Those projects in the "Authorized/Awaiting Initiation of Construction" stage reduced from 10 to 6 with an accompaning decrease in costs of about $750 million and the projects in the "Preconstruction Engineering and Design" stage decreased by two, but resulted in a

cost increase of about $330 million. The total planned projects now number 31 with a estimated Federal cost of $2,195.5 million and a total cost of $3,316.1 million. These costs are summarized in Table 4-18.

Table 4-18 Estimated Costs of Planned Projects Based on 1995 Conditions (1995 Dollars)

Status	Number of Projects	Estimated Federal Cost ($ millions)	Estimated Total Cost ($millions)
Under Construction	12	1,168.8	1,695.0
Authorized/Awaiting Initiation of Construction	6	65.1	131.6
Preconstruction Engineering & Design	13	961.6	1,489.5
Total	31	2,195.5	3,316.1

For each of the three categories of "Under Construction", Authorized/Awaiting Imitation of Construction" and "Preconstruction Engineering and Design", costs are show, respectively, in Tables 4-19, -20, and -21, by project, district and construction measure.

5. <u>List of Congressionally Authorized Projects and Studies Based on 1995 Conditions</u>. At the time of the initial survey for this report (July 1993) there were a total of 149 projects and studies (see Table 2-3). This list is provided in Appendix D "Congressionally Authorized Projects and Studies - 1993." As a result of the 1995 update, this list has been modified and is provided as Appendix D Modified "Congressionally Authorized Projects and Studies - 1995." There is currently a total of 159 projects and studies on this list as summarized in Table 4-22.

Table 4-19 Projects Under Construction Based on 1995 Conditions (1995 Dollars)

Corps Office	Project	Initial Construction ($000)	Periodic Nourishment ($000)	Structures ($000)	Total ($000)	Federal Share of Total (%)
NED	Roughans Point, Revere, MA [1]	0	0	12,200	12,200	65
NAN	Fire Island Inlet to Montack Point Long Island, NY (Westhampton Beach)	33,400	101,600	0	135,000	70
NAN	Atlantic Coast of New York City from Rockaway Inlet to Norton Point (Coney Island Area), NY	9,500	7,650	0	17,150	65
NAN	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, (Reach 1 Sea Bright to Ocean Township), NJ	189,500	327,000	0	516,500	65
NAO	Virginia Beach, VA - [2]	57,065	277,835	45,100	380,000	65
SAW	South of Carolina Beach, Kure Beach, NC	19,400	96,900	0	116,300	65
SAW	Fort Fisher & Vicinity, NC	0	0	1,800	1,800	50
SAC	Myrtle Beach, SC	54,135	162,072	0	216,207	65
SAJ	Martin County, FL	11,418	44,482	0	55,900	47
SAJ	Sarasota County, FL - Venice Segment	19,084	21,472	0	40,556	73
NCC	Casino Beach, IL	0	0	7,420	7,420	49
NCC	Indiana Shoreline Erosion, IN [3]	21,800	174,200	0	196,000	100
	TOTAL	415,302	1,213,211	66,520	1,695,033	[4]

Footnotes:

[1] FY 96 Congressional add for a new start. Project authorized as flood control (WRDA '86), cost shared as shoreline protection.

[2] FY 96 Congressional add for a new start.

[3] FY 96 Congressional add for a new start. The 100% Federal cost is based on this project being a Federal park. The distribution between initial construction and periodic nourishment is approximate, based on a 1986 total project cost estimate of $67,536,000.

[4] The total Federal cost is $1,168,848,000 and the average Federal share is 69%.

Table 4-20
Projects Authorized/Awaiting Initiation of Construction
Based on 1995 Conditions
(1995 Dollars)

Corps Office	Project	Initial Construction ($000)	Periodic Nourishment ($000)	Structures ($000)	Total ($000)	Federal Share of Total (%)
SAJ	Broward County and Hillsboro Inlet, FL - Segment I, North County Line to Hillsboro Inlet	9,461	2,086	0	11,547	58
SAJ	Pinellas County, FL - Clearwater Beach Island Segment	3,245	20,455	0	23,700	61
SAJ	Palm Beach County, FL (62) - South Lake Worth Inlet to Boca Raton Inlet (except Boca Raton, Jupiter/Carlin, and Delray Beach)	5,315	1,868	1,576	8,759	63
SAJ	Charlotte County, FL	7,919	51,231	0	59,150	51
SAJ	Indian River County, FL - Sebastian Segment	0	18,238	0	18,238	37
SAJ	Sarasota County, FL - Longboat Key Segment	5,146	5,109	0	10,255	15
	TOTAL	31,086	98,987	1,576	131,649	[1]

Footnote:

[1] The total Federal cost is $65,126,000 and the average Federal share is 49%.

Table 4-21
Projects in Preconstruction, Engineering and Design
Based on 1995 Conditions
(1995 Dollars)

Corps Office	Project	Initial Construction ($000)	Periodic Nourishment ($000)	Structures ($000)	Total ($000)	Federal Share of Total (%)
NAN	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Reach 2 (Asbury Park to Manasquan), NJ	49,000	233,500	0	282,500	65
NAN	Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, NY	72,000	126,700	0	198,700	65
NAO	Sandbridge, VA	13,870	302,800	0	316,670	65
SAW	Brunswick County Beaches, Ocean Isle, NC	8,234	40,069	0	48,303	65
SAJ	Monroe County, FL	6,644	3,056	0	9,700	50
SAJ	Nassau County, FL	15,200	0	0	15,200	80
SAJ	St. Johns County, FL	16,769	175,631	0	192,400	84
SAJ	Indian River County, FL - Vero Beach Segment	13,034	77,233	0	90,267	57
SAJ	Lee County, FL - Estero Island Segment	3,869	7,631	0	11,500	13
SAJ	Lee County, FL - Gasparilla Island Segment	9,321	4,079	0	13,400	34
SAM	Panama City Beaches, FL	37,000	67,000	0	104,000	60
NCC	Chicago Shoreline, IL	0	2,200	201,800	204,000	54
NPA	Dillingham Snag Point, AK [1]	0	0	2,906	2,906	100
	TOTAL	244,941	1,039,899	204,706	1,489,546	[2]

Footnotes:

[1] Congressional Add in FY 95. Authorized in Section 116 of PL 99-190 to be 100 percent Federal, to correct severe shoreline erosion problems adjacent to the City of Dillingham AK.

[2] Total Federal cost is $961,608,000 and the average Federal share is 65%.

Table 4-22
Program Status 1995

Shore Protection Project Status	Number of Projects/Studies
Large Constructed Projects	57
Small Specifically Authorized Projects	26
Subtotal Constructed	**83**
Under Construction	12
Authorized\Awaiting Imitation of Construction	6
Preconstruction Engineering and Design	13
Subtotal Authorized/PED but Unconstructed Projects	**31**
Feasibility Phase (GI Study)	14
Reconnaissance Phase (GI Study)	16
Subtotal General Investigation Studies	**30**
TOTAL PROJECTS AND STUDIES	**144**
Inactive Studies	2
Deauthorized Projects	10
Authorized but Unfunded Studies	3
Subtotal in Active and Deauthorized	**15**
TOTAL AUTHORIZED AND DEAUTHORIZED	**159**

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CHAPTER 5 - BENEFITS OF SHORE PROTECTION PROJECTS

A. INTRODUCTION

1. Theory. The actual benefits of shore protection projects are much more difficult to measure than the actual costs. The basic approach is to develop two scenarios for the proposed project area: 1) with the project, and 2) without the project. The difference between these two situations is the impact of the project, the net project benefits. Neither situation can be measured directly, because at the time of project evaluation both are in the future. Therefore, projections into the future are an integral part of the development and measurement of the benefits of shore protection projects.

2. Types of Benefits. According to the most recent National Economic Development (NED) Procedures Manual on Coastal Storm Damage and Erosion [1][1], the major categories of benefits for shore protection projects are hurricane and storm damage reduction, erosion protection, and recreation. Since a project may protect against both storm damage from flooding and wave attack as well as erosion, it is necessary to be able to evaluate the benefits of each type of protection, and to avoid double counting of benefits. Other benefit categories include reduced maintenance of existing coastal protection structures, and enhancement of property values.

3. Project Formulation. Alternative plans are formulated in a systematic manner to ensure that all reasonable alternative solutions are evaluated. Usually, a number of alternative plans are identified early in the planning process and are refined in subsequent iterations. However, additional alternative plans may be introduced at any time. The Water Resources Development Act of 1986 (WRDA '86) specified that shore protection projects must be formulated for one purpose, to provide for storm damage reduction. Any enhancement of recreation that may also result is considered incidental. Such recreation benefits are NED benefits, however, and are included in the economic analysis. Additional beach fill, beyond that needed to achieve the storm damage reduction purpose, to better satisfy recreation demand would be a separable recreation feature which is not an Administration budgetary priority. See Chapter 3 paragraph D for further discussion of the Corps planning process and a definition of "NED".

[1] Numbers in brackets "[ ]" refer to reference numbers. References for Chapter 5 are at the end of the chapter.

B. TYPES OF BENEFITS

1. Storm Damage Reduction Benefits.

a. Upland Development.

(1). Wave Damage Reduction Benefits. In many areas, the most significant damages are caused by wave action. This category of damage can also be extremely difficult to accurately estimate, particularly when damages are calculated on a structure-by-structure basis. Alternatively, an analyst familiar with the area may develop a matrix showing the percentage of the value of a particular structure type damaged by waves of a given magnitude.

(2). Inundation Reduction Benefits. Another significant benefit category is reduction of the inundation damages from coastal flooding. Inundation reduction benefits include the decrease of both physical and non-physical costs. These benefits include the saving of structures and contents from flood and salt water damage, and the alleviation of clean-up costs, flood fighting expenses, evacuation costs, emergency aid, and traffic rerouting.

(3). Erosion Reduction Benefits. Structures are often more severely damaged by erosion of the land under them in coastal storms than from flooding. In some cases, they are totally destroyed. In other cases, where structures are elevated above flood levels, erosion can render them inaccessible and uninhabitable.

b. Loss of Land. The area of land that would be lost in the absence of the project over the period of evaluation may be estimated based on the historical rate of shore erosion in cases of long-term erosion. In instances of erosion due to coastal storms, the area that would be lost may be estimated with coastal erosion models that predict rates of erosion for storms of various frequencies.

2. Recreation. Prior to the enactment of WRDA ‘86, projects were formulated for hurricane protection, beach erosion control, and recreation. For many projects, most of the benefits were associated with recreation. During the mid 80s, Army budgetary policy placed a lower priority on projects considered primarily recreation. This policy resulted in a shift to formulating projects for damage prevention, rather than for recreation. Following enactment of WRDA '86, Corps policy required that shore protection projects be formulated first for hurricane and storm damage reduction (HSDR). Additional beach fill beyond that required for the project formulated for HSDR, to satisfy recreation demand, is a separable recreation feature that is not supported for Federal participation under current budgetary policy. This policy is intended to focus Federal funds on the objective of reducing damages to coastal facilities. Recreation can still be used to partially justify projects. However, the extent to which recreation benefits can provide for economic justification is limited by current budgetary policy to 50 percent of benefits needed for project justification.

3. Other.

a. Reduced Maintenance of Existing Structures. Structures in the immediate vicinity of the shore may require more frequent maintenance because of recurring incidents of erosion. Benefits can be claimed to the extent that a project would reduce the extra maintenance. Reductions in the amount of beach nourishment required can also be claimed in this category.

b. Enhancement of Property Values. Location and intensification benefits attributable to an erosion control project result from increased use of land through either intensified activities or by changing to an economically higher-valued development than would occur in the absence of the project. Such benefits result because of the higher utilization made feasible by increased safety of investments in improvements. Land enhancement benefits are over and above benefits received from damage reduction. These benefits apply only to land values and not to the value of future improvements.

c. Navigation, Recreational Boating, and Area Redevelopment. A few older projects cited navigation and recreational boating benefits in their project evaluations. Reduced siltation of navigation and recreational boating facilities lowered navigation project costs by reducing maintenance in the navigation channels, as the channels were used as borrow areas for the shore protection projects. Area redevelopment benefits were also claimed for a few projects.

C. BENEFIT ESTIMATION PROCEDURE

1. Storm Damage Reduction. The National Economic Development (NED) Procedures Manual for Coastal Storm Damage and Erosion [1] recommends an eleven-step procedure for estimating storm damage reduction benefits. The steps are discussed below.

a. Step One, Delineate the Study Area. The study area is that area which is immediately or indirectly affected by the perceived problem, and thus by any resulting project. Geographically, it includes the storm inundation area and the area that will be affected by erosion, including downdrift, over the project evaluation period. It also includes an area sufficiently inland to describe the impacts of the storm erosion events and any protective measures.

b. Step Two, Define the Problem. The existing without-project condition must be properly identified since it is the basis for comparison with conditions projected with all alternative plans. The description of the existing conditions should include a history of the economic and social effects of storm damage and erosion problems in the area. Dates, storm intensities, wave heights, shoreline erosion, sediment movements, and peak stages of major storm events should be gathered. Existing and anticipated without-project man-made alterations to the shore should be taken into account, especially the degree of protection which existing facilities can be expected to provide.

c. Step Three, Select Planning Shoreline Reaches. Reaches are sections of shoreline with similar geomorphic conditions, and are the primary geographic unit for planning. Plans are formulated with components that may cover a series of reaches. The hydraulic and hydrologic effects and subsequent benefits of a project are calculated for each reach.

d. Step Four, Establish Frequency Relationships. A frequency is the number of times a specified phenomenon occurs in a given interval. For example, the water level may reach a height of 10 feet at a particular site 10 times in 100 years; or 20 feet or more of a beach is lost to a single storm once every 10 years. These frequencies can also be expressed as an exceedance probability of 0.1, or an event with a 10 percent chance of being exceeded in any particular year. Elevation-frequency relationships delineate the relationship between wave and water levels and the frequency of occurrence, while erosion-frequency relationships delineate the relationship between periodic erosion (or accretion) and frequency of occurrence.

e. Step Five, Outline Area Affected. This is the part of the study area most directly affected by storm damage or long-term erosion. The geographic area would be bounded by the shoreline and the immediately adjacent inland areas subject to damage. Upcoast and downcoast boundaries would be limited by natural features such as headlands or inlets in most cases. The primary purpose of this step is to allow an accurate inventory of existing conditions, and to identify areas which may be protected by erosion/storm damage prevention measures.

f. Step Six, Inventory Existing Conditions. This inventory should include a survey of affected area properties, including land, to assist in predicting potential damage. Types of information needed to evaluate properties in the affected area include susceptibility classification (including such factors as distance from the water, the existence of natural barriers, and construction materials), value, use, ground floor area, number of stories, and elevation. This information is then used as a basic step in the computation of storm and/or erosion damages and damage reduction benefits.

g. Step Seven, Determining Most Likely With- and Without-Project Conditions.

(1). The purpose of forecasting conditions expected to exist with and without each plan under consideration is to isolate the changes that are expected to occur as a result of implementation of the plan from those that would occur if the plan were not implemented. Without-plan conditions, therefore, are the conditions expected to prevail if no Federal action is taken, while with-plan conditions are those expected to prevail with implementation of a plan. The level of detail required in collecting data and forecasting future conditions depends on factors such as type of study (e.g., reconnaissance or feasibility), available time and money, sensitivity of project formulation and justification to changes in storm damage prevention benefits, and interests and concerns of the local sponsor, if applicable.

(2). Development of forecasts of future conditions requires consideration of human responses to long-term erosion and coastal storm damage. As long-term erosion occurs, individuals and communities will respond by taking action to protect, relocate, or abandon existing properties. Action may also be taken to limit future development. Individuals and communities may also respond to storm damage to property in a variety of ways, including relocation, abandonment, and repair or reconstruction. The economist must determine the most likely course of action which would be taken in the absence of a Corps shore protection project.

h. Step Eight, Develop Damage Relationships. This step consists of the process of developing and selecting appropriate damage functions to meet the requirements of a particular situation. Damage relationships describe the expected value of structural or content damages caused by various factors, such as depth of flooding, duration of flooding, sediment load, wave heights, amount of shoreline recession, and warning time. In some cases it is necessary to compute site-specific functions and in other cases generalized damage relationships may be used. The objective of this step is to determine how much damage occurs with various types of events. Basic estimates of losses for buildings, roads, protective works, and other development features should be prepared at current price levels for the existing state of development of the problem area.

i. Step Nine, Calculate Damage-Frequency Relationships.

(1). The damage-frequency relationship relates damage associated with a given event to the frequency of that event. Two alternative methodologies may be used for this step depending on the type and complexity of the erosion or storm damage situation.

(2). The traditional approach relies on the damage-frequency and erosion-frequency relationships to quantify probable damages and benefits in a given year. Damages are based on the probability of occurrence of each damaging event using the hydrologic and economic conditions that prevailed at that time. For example, the probable damages associated with a 100-year event and a 10-year event are, respectively, 0.01 and 0.1 times the damages estimated for each of these events in that year. The summation of all probable damages, over the range of events, defines expected damages for that year.

(3). Monte Carlo, or similar simulation models, are usually computer-based mathematical replications of the way the real world reacts to a series of unrelated random events and situations. Unlike the standard analytical methodology which develops damages and benefits based on probabilistic averages, simulation techniques use the randomness associated with the variables (in this case, erosion rates or severity and duration of storms, for example) to generate a number of life cycles (called games in simulation terminology). Use of the Monte Carlo method has not been widespread in shore protection studies.

j. Step Ten, Compute Expected Average Annual Damages. The expected annual damage is the expected value of erosion losses and storm damages in any given year. Calculation of expected annual damages does not mean that this amount of damage will occur in any particular year, but it is rather the actuarial value of the damage risk. Over a long period of time, the average amount of damage will tend to approach that value. Expected annual damages are the most tangible measure of the severity of the existing erosion and/or storm damage problem. Erosion damage is separated from inundation damage in order to avoid double counting benefits.

k. Step Eleven, Estimate Total Storm Damage Reduction and Erosion Prevention Benefits. The storm damage reduction and/or long term erosion reduction benefit calculation is the difference between expected annual damages determined in Steps One through Ten under the without-project conditions and the expected annual damages estimated in Steps Seven through Ten under the with-project conditions. All benefit estimates should be made for existing conditions (those existing at the time of the study), the base year (the first year in which the project is expected to become operational), and future conditions over the period of analysis. This period, usually 50 years, is defined as the time horizon, beginning with the base year, for which project benefits and operation, maintenance, and replacement costs are considered. Discounting procedures are then used to derive estimates of average annual equivalent benefits. Although all Corps district offices are required to evaluate project storm damage reduction benefits with this basic procedure, there is latitude for individual districts to develop techniques that are particularly suited to their areas.

2. Recreation.

a. Recreation benefits are those benefits derived from the availability of beach recreational area and the demand for use of that area by residents and tourists. ER 1105-2-100, Section VIII [2] provides specific detailed procedures for evaluation of recreation benefits. According to the guidance, an acceptable recreation evaluation has the following characteristics:

(1). The evaluation is based on an empirical estimate of demand applied to the particular project;

(2). Estimates of demand reflect the socioeconomic characteristics of market area populations, recreation resources under study, and alternative existing recreation opportunities;

(3). The evaluation accounts for the value of losses or gains to existing sites in the study area affected by the project; and

(4). Willingness to pay is evaluated by (1) travel cost method, (2) contingent valuation method, or (3) unit day value method.

b. The first step in the recreation evaluation procedure is to define the study area. Typically, feasibility studies and projects are authorized by county. Even when studies are for site specific areas, statistics for recreation demand are usually available on a county-wide basis.

c. The second step is to forecast the potential recreation use in the study area. Potential use is the expected visitation at prevailing prices unconstrained by supply. Forecasting existing and potential future participation in recreation activities for the study area involves (1) collection of any available recreation demand data, (2) relating or testing the data with actual usage, and (3) forecasting this demand over the economic period of analysis.

d. Some states periodically produce a report on the recreational needs of the state's residents and tourists, "State Comprehensive Outdoor Recreation Planning" (SCORP). SCORP data is comprised of information concerning outdoor recreation activities obtained from questionnaires and information selected from tourists to the state and state residents. Utilizing this data, the annual beach activity demand can be determined.

e. Assuming the earlier participation rates provided by the state hold true for future years, and using population projections from the nearest source, usually state statistical abstracts, the future recreation demand in the county can be determined.

f. Once the annual saltwater beach recreation demand for a study area has been determined for the economic analysis period, annual participation patterns within a given year need to be calculated. By examination of plots of daily beach attendance, it is obvious for areas such as south Florida and California that beach attendance occurs year round. In most other parts of the U.S., beach attendance follows a more distinct pattern of winter/summer weather-influenced attendance. These patterns must be taken into consideration in estimating annual recreational demand.

g. The next step in the process is to estimate/inventory the available recreation resource capacity within the study area. The demand that is developed is for saltwater beach usage, therefore, all beaches available for saltwater beach use are inventoried and tabulated. This usually involves an inventory of all access points, parks and public shorefront, and the associated parking. The existing beach capacity at each location is also determined. Recreation sites that are under development or likely to be developed are included.

h. Beach capacity in terms of people is calculated by dividing the available public beach area by 100 square feet, the area required by one beach visitor, and multiplying by 2, the daily turnover rate for beach visitors. This conversion is easily verified by counting the number of beach users within a specified area of beach. This calculation converts the surface area capacity to people capacity, to be applied against the daily demand developed earlier. By applying the historical erosion rate to the shoreline in the study area, beach capacity for future years can then be determined.

i. Using the annual beach activity demand and the existing and future beach capacity, with and without project beach attendance to the study area are then calculated. The second major step in the evaluation of recreation benefits is now completed. The saltwater beach activity demand reflecting the socio-economic characteristics of the market area population has been determined. All available recreation resources within the study area are summarized and inventoried, and these resources have been used as sinks which use or "soak up" the existing demand prior to crediting recreation usage to any considered projects.

j. The third and last step in the benefit evaluation procedure for recreation is to determine willingness to pay, or assign a value to the recreational usage generated by a proposed project. The three acceptable methods to determine value are discussed below.

(1). The Travel Cost Method. This method uses the variable costs of travel as a proxy for price in determining the net willingness-to-pay for consumption of recreational activities. According to this method, individuals have the option of enjoying a recreation day at many possible sites. Though the sites are similar, and can be considered substitutes, they each provide slightly different recreation opportunities. Individuals' recreation decisions reflect both the costs incurred and the benefits attained from a site visit. Costs include travel expenditures and the value of time spent traveling. These costs decrease with proximity to the site. Travel cost method equates the implicit price of each site characteristic with the additional benefits its usage provides. By observing the pattern of site usage by individuals located different distances from the site, the analyst estimates a demand curve for the site.

(2). The Contingent Value Method. This method differs from the travel cost method, in that it does not rely on observed behavior to estimate benefits. Instead, surveys are used to elicit information about either an individual's willingness-to-pay (WTP), or willingness-to-accept (WTA) payment for a change in some environmental characteristic. Careful survey design is crucial to the validity of results obtained by this method. The form of the questions should include specific information about the choice being evaluated, and should accurately reflect the decision facing the respondent. While either WTP or WTA can be used to measure benefits, there is a subtle, but important, difference between them. For an increase in either environmental quality or quantity, WTP answers the question, "Given the initial quality/quantity of an environmental attribute, how much would you be willing to pay to see a specific improvement?". The starting point for evaluation is the current level of quality/quantity. WTA answers the question, "An improvement in environmental quality is going to take place. How much would you be willing to accept in lieu of the improvement?". The initial evaluation point is the post-improvement level of quality/quantity.

Though estimated benefits are associated with the same environmental change, they can diverge significantly depending on which measure is used. The accuracy of the Contingent Value method (CV) relies heavily on survey respondents being well informed. They must understand and be familiar with the commodity being valued. Also, when the survey is administered, the environmental change being evaluated must be explicitly stated. If the respondent's level of uncertainty is limited, CV can generate accurate estimates.

(3). The Unit Day Value Method. This method applies a simulated market value to estimated annual use. The simulated value is judgmentally derived from a range of values agreed to by Federal water resources agencies (Principles and Guidelines, see Chapter 3, Paragraph D). These values are developed either using comparable market prices, or the point system. To generate market prices, prices are collected from at least ten private sector establishments with comparable facilities in the affected area. Under the point system, a planner categorizes the various recreation activities available at the site. Points are then distributed to each of these categories. Conversion of points into dollar values is based on guidance provided by the Principles and Guidelines. The unit day value method is intended to represent the users' average willingness-to-pay for a day of recreation activity at the site. When a properly formulated unit day value is applied to estimated use, an approximation of the area under the site demand curve is obtained, which is used in estimating recreation benefits. The method inherently relies on professional judgement to arrive at a project-specific unit day value. Consistent application of the procedure for each alternative being evaluated will produce meaningful estimates of value. When using the unit day value method, departure from the published range of values is not permissible.

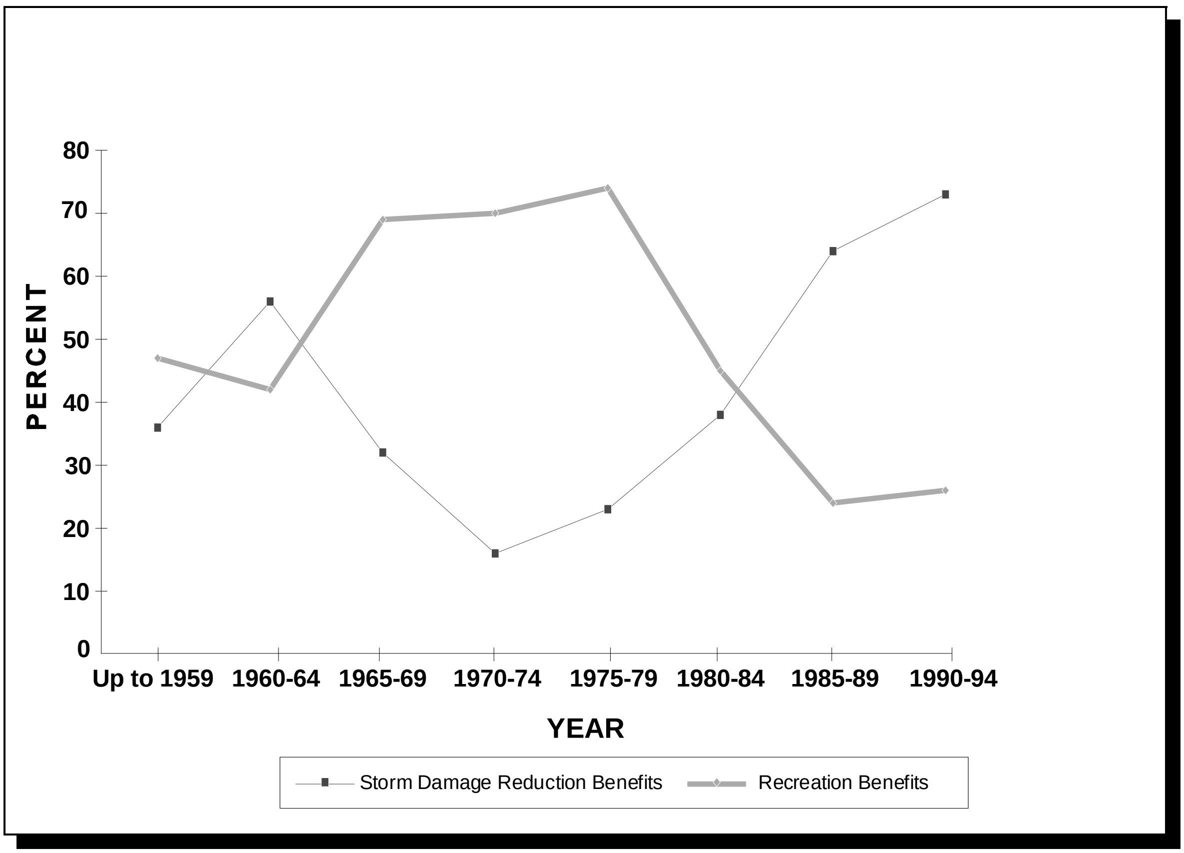
D. EXPECTED AVERAGE ANNUAL BENEFITS

1. Average Annual Benefits by Project. The expected average annual benefits of the 56 shore protection projects are listed by category in Table 5-1. This information was obtained from project evaluation reports prepared by the Corps district offices. The price level and interest rate used in each benefit evaluation are included in this table, as well as the expected average annual costs and the benefit/cost ratio. No attempt was made to adjust these figures to a common price level, and therefore no totals are presented. The project benefits have been arranged in chronological order based on the price level. Several projects appear more than once in the table, because they were evaluated more than once. Most of these reevaluations were done in the wake of the WRDA ‘86 and the consequent change in policy. It is evident that more recent evaluations of the same project report much higher storm damage reduction benefits than the earlier evaluations.

2. Comparison of Storm Damage Reduction and Recreation Benefits. When the storm damage reduction and recreation benefits in Table 5-1 are calculated as percentages of the total project benefits, and grouped by 5 year periods, the pattern illustrated in Figure 5-1 emerges. This figure

shows that the average project designed and evaluated prior to 1964 contained significant proportions of both storm damage reduction benefits and recreation benefits. From 1965 to 1979, projects were justified mainly with recreation benefits, while storm damage benefits assumed a minor role. During the 1980s and 1990s a reversal occurred, due to policy changes of the Department of the Army as well as those caused by WRDA '86. The typical 1990's shore protection project receives 73 percent of its benefits from storm damage reduction and only 26 percent from recreation.

Figure 5-1 Trends in the Percentages of Project Benefits of Storm Damage Reduction and Recreation



3. <u>Other</u>. In the "other" category of Table 5-1, most of the benefits (about 80 percent) are decreased maintenance of existing structures, including reduced beach nourishment. The remainder of the "other" benefits fall into the navigation category (10 percent), enhancement of property values (8 percent), and recreational boating and area redevelopment.

Table 5-1 Average Annual Benefits by Project (in Thousands) (Continued on Next Page)

Project Name	Price Level	Interest Rate	Storm Damage Reduction Upland Dev.	Storm Damage Reduction Land Loss	Recreation	Other	Total Average Annual Benefits	Average Annual Costs	B/C ratio
Galveston Seawall, TX	1947	3.000	360.0	0.0	0.0	195.0	555.0	358.0	1.6
Winthrop Beach, MA	1947	3.000	17.4	0.0	22.8	4.4	44.6	43.0	1.0
Harrison CO., MS (1)	1948	3.000				454.0	454.0		
Presque Isle, PA	1948	3.000	0.0	30.0	250.0	50.0	330.0	274.9	1.2
Quincy Shore Beach, MA	1950	3.000	20.9	0.0	56.9	15.3	93.1	43.7	2.1
Hampton Beach, NH	1953	2.500	5.8	0.0	22.0	36.1	63.9	38.1	1.7
Prospect Beach, CT	1953	3.000	3.2	0.0	20.0	0.7	23.9	8.3	2.8
Seaside Park, CT	1953	3.000	8.1	0.0	96.0	0.0	104.1	18.7	5.6
Channel Islands Harbor, CA	1957	2.500	276.0	0.0	50.0	68.0	394.0	328.0	1.2
Long Island, Fire Is. to Montauk Pnt, Southampton to Beach Hampton, NY	1958	2.500	1075.5	161.1	139.1	0.0	1375.7	543.6	2.5
Carolina Beach & Vicinity, NC	1960	2.625	213.5	0.0	133.9	28.3	375.7	123.1	3.1
Oceanside, CA	1960	2.625	0.0	55.1	35.9	0.0	91.0	42.2	2.2
Wallis Sands State Beach, NH	1960	2.500	0.0	0.0	18.0	0.0	18.0	18.4	0.9
Wrightsville Beach, NC	1960	2.625	95.4	38.6	45.9	16.6	196.5	45.4	4.3
Fort Macon, NC	1961	2.625	242.6	40.9	86.7	0.0	370.2	148.9	2.5
Ventura-Pierpont, CA	1962	5.000	125.3	0.0	60.0	0.0	185.3	82.8	2.2
Surfside/Sunset, CA	1962	5.000	1896.0	0.0	280.0	45.0	2221.0	613.0	3.6
Fort Pierce Beach, FL	1962	3.000	3.4	53.7	62.7	0.0	119.8	89.4	1.3
Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ	1963	3.000	14.5	3.6	92.8	2.5	113.4	58.9	1.9
Long Island, Fire Island to Montauk Pt.,Moriches to Shinnecock Reach,NY	1963	3.000	745.0	581.0	650.0	0.0	1976.0	1184.4	1.7
Raritan and Sandy Hook Bay, Keansburg and E. Keansburg, NJ	1964	2.625	430.9	4.5	187.5	3.8	626.7	359.5	1.7
Coast of CA, Point Mugu to San Pedro	1966	3.125	20.0	0.0	441.0	0.0	461.0	107.0	4.3
Pinellas Co, Treasure Is., FL	1968	3.250	60.2	0.0	0.0	73.4	133.6	96.0	1.4
Hamlin Beach State Park, NY	1969	3.250	0.0	0.0	220.9	0.0	220.9	116.3	1.9
Cliff Walk, RI	1969	3.250	16.9	0.0	97.2	6.3	120.4	62.5	1.9
Long Island, Fire Is. to Jones Inlet, NY	1970	3.250	0.0	2242.0	0.0	1949.0	4191.0	2788.1	1.5
Tybee Island, GA	1970	4.875	0.0	0.0	322.8	22.3	345.1	111.3	3.1
Brevard Co, Cape Canaveral, FL	1972	3.250	0.0	0.0	206.0	10.0	216.0	84.3	2.6
Palm Beach Co, Delray Beach, FL	1973	3.250	112.2	0.0	482.2	0.0	594.4	199.3	3.0
Sherwood Island State Park, CT	1974	5.875	1.0	0.0	1299.0	11.3	1311.3	286.7	4.6
Rockaway, NYC	1974	6.625	70.0 0	0.0	4611.6	338.8	5020.4	1860.6	2.7
Duval Co, FL	1974	3.250	340.2	11.4	1948.0	92.0	2392.0	1581.0	1.5
Dade Co, FL	1974	3.250	1448.0	0.0	14375.0	285.0	16108.0	2708.0	5.9
Pinellas Co, Treasure Is. FL	1974	3.250	151.0	0.0	0.0	196.0	347.0	181.0	1.9
Lakeview Park Coop, OH	1975	3.250	0.0	0.0	406.0	0.0	406.0	140.0	2.9
Broward Co., FL, Segment 3	1978	6.625	136.4	30.9	2382.3	9.8	2559.4	673.2	3.8
Point Place, OH	1978	6.625	556.7	0.0	21.1	68.2	646.0	538.3	1.2
Brevard Co, Indialantic/Melbourne, FL	1978	6.625	11.5	0.0	1154.0	0.0	1165.5	597.1	2.0
Grand Isle and Vicinity, LA	1978	6.875	659.0	429.0	605.0	195.0	1888.0	1249.0	1.5

(1) Complete information was not available for this project.

Table 5-1 Average Annual Benefits by Project (in Thousands) (Continued)

Project Name	Price Level	Interest Rate	Storm Damage Reduction Upland Dev.	Storm Damage Reduction Land Loss	Recreation	Other	Total Average Annual Benefits	Average Annual Costs	B/C ratio
Corpus Christi Beach, TX	1975	5.875	2.0	0.0	1002.0	0.0	1004.0	323.0	3.1
Pinellas Co, Long Key, FL	1978	6.625	22.0	0.0	302.0	0.0	324.0	116.0	2.8
Broward Co, Segment 2, FL	1980	7.375	1532.0	0.0	565.0	67.0	2164.0	1412.0	1.5
Sherwood Island State Park, CT	1981	7.375	0.0	21.6	713.2	0.0	734.8	94.9	7.8
Wrightsville Beach, NC	1981	7.375	414.1	225.7	270.5	0.0	910.3	668.0	1.4
Fort Pierce Beach, FL	1982	7.625	0.0	63.0	973.0	2.0	1038.0	226.0	4.6
DE Coast Sand Bypass	1984	8.375	0.0	412.5	0.0	8789.8	9202.3	383.0	24.0
Pinellas Co, Long Key, FL	1984	8.125	278.0	0.0	154.0	52.0	484.0	392.0	1.2
Pinellas Co, Sand Key, FL	1984	8.125	4912.0	0.0	4481.0	282.0	9675.0	2684.0	3.6
Dade Co., FL- Sunny Isles (N. Dade Co.)	1984	8.125	419.0	0.0	2185.0	10.0	2614.0	1850.0	1.4
Pinellas Co, Treasure Is., FL	1984	8.125	401.0	0.0	0.0	213.0	614.0	337.0	1.8
Revere Beach, MA	1985	8.375	868.0	0.0	65.0	0.0	933.0	724.6	1.3
Reno Beach, OH	1986	3.250	603.1	0.0	0.0	441.4	1044.5	338.0	3.1
Palm Beach Co, Boca Raton, FL	1986	8.875	1130.0	14.0	389.0	0.0	1533.0	745.0	2.0
Palm Beach Co, Lake Worth Inlet to South Lake Worth Inlet, FL	1986	8.875	4845.0	633.0	0.0	0.0	5478.0	3485.0	1.6
Presque Isle, PA	1986	8.625	0.0	21.0	0.0	2912.0	2933.0	2560.0	1.2
Cape May Inlet to Lower Twp, NJ	1987	8.625	2977.0	0.0	856.0	160.0	3993.0	2389.7	1.7
Virginia Beach, VA	1987	8.625	6611.0	0.0	6120.0	0.0	12731.0	2511.0	5.1
Maumee Bay, OH	1988	8.625	0.0	6.7	2540.6	0.0	2547.3	1061.4	2.4
Great Egg Harbor and Peck Beach, NJ	1988	8.875	25903.4	0.0	5699.3	232.0	31834.7	7051.2	4.5
Revere Beach, MA	1988	8.625	0.0	0.0	65.0	1308.6	1373.6	778.0	1.8
Lee Co, Captiva Island, FL	1988	8.625	783.3	93.8	540.0	0.0	1417.1	902.5	1.6
Prospect Beach, CT	1989	8.875	279.0	0.0	100.0	0.0	379.0	346.3	1.1
Ocean City, MD	1989	8.875	13453.1	0.0	534.0	0.0	13987.1	9510.0	1.5
Folly Beach, SC	1990	8.250	1865.0	0.0	1403.0	0.0	3268.0	2007.0	1.6
Duval Co, FL	1990	8.875	2188.0	377.3	2108.5	1207.2	5881.0	3434.0	1.7
Broward Co, Seg. 3, FL	1990	8.875	2013.0	434.0	1082.0	0.0	3529.0	2886.0	1.2
Manatee County, FL	1991	8.875	3765.7	91.6	321.0	0.0	4178.3	1856.5	2.3
Palm Beach Co, Delray Beach, FL	1991	8.875	1816.0	71.0	497.0	0.0	2384.0	981.0	2.4
Broward Co, Segment 2, FL	1992	8.250	8591.0	1193.0	632.0	0.0	10416.0	2152.0	4.8
Brevard Co, Indialantic/Melbourne, FL	1992	8.500	850.0	112.0	0.0	0.0	962.0	694.0	1.4
Carolina Beach & Vicinity, NC	1992	8.250	4094.3	989.3	228.3	0.0	5311.9	2686.8	2.0
Brevard Co, Cape Canaveral, FL	1992	8.500	739.0	631.0	0.0	0.0	1370.0	1856.0	0.7
Fort Pierce Beach, FL	1993	8.125	1694.0	40.0	20.0	0.0	1754.0	1148.0	1.5
Rockaway, NYC	1993	8.750	3400.0	0.0	6370.0	0.0	9770.0	5136.9	1.9
Tybee Island, GA	1994	8.000	569.0	0.0	7567.0	0.0	8136.0	975.0	8.3

E. "ACTUAL" BENEFITS

1. Introduction. In contrast to the actual costs of a project, the term "actual benefits" is somewhat conceptual. The "actual" benefits of a project are defined as the difference between: 1) what happened since the project's construction in terms of storm damages, recreation, or any other type of benefit claimed for the project; and 2) what would have happened during that time period if the project had not been constructed. Part 1, what actually happened, could be measured directly, although such measurements are not routinely done by Corps district offices. Part 2, however, is a hypothetical situation. This part attempts to determine what would have happened without the project, and can only be estimated through modeling. This hypothetical situation is similar to the type of analysis that is done prior to the construction of a project, except in the case of trying to determine "actual benefits", one is looking backward over the life of an actual project rather than forward into the future of a proposed project. Another major difference is that in estimating "actual benefits", the storm events are known, so that these values can be inserted into the models. The models are then run under with- and without-project conditions and, in the case of storm damages, the difference in damages is the "actual" damages prevented by the project. These "actual" damages prevented are then the "actual benefits" claimed. Most Corps districts do not run these calculations as they are a costly and time-consuming operation, and in most cases, are a "nice to know" item rather than a "need to know" item. This lack of follow up on "actual" project benefits, however, makes it difficult to tell if project benefits claimed prior to construction are matched by "actual benefit" outputs.

2. Subjective Evaluation of Erosion Rates and Project Benefits. District offices of the Corps were asked to submit subjective evaluations of both erosion rates and benefits for the projects in their districts. In response to this request, ratings were received for 26 of the 56 projects. These ratings are presented in Box 5-1. No conclusions can be drawn from this subjective analysis. However, the general trend for both erosion rates and benefits is that they are more likely to be under estimated than over estimated.

3. Actual Benefits for Selected Projects. The following 11 shore protection projects were selected for detailed analysis because sufficient data and models were available to generate estimates of "actual" benefits. In most cases, they are older projects which do have some history, but which have also been recently re-evaluated and have storm damage models. Condensed versions of the reports which were submitted by the district offices are presented in this section.

Box 5-1

Subjective Estimate of Project Erosion Rates and Benefits

Project (1)	Erosion Rates (2)			Benefits (2)		
	(+)	(-)	(AsEx)	(+)	(-)	(As Ex)
Atlantic Coast of NYC, Rockaway, NY (3)	x				x	
Long Island, Fire Island to Jones Inlet, NY	x			x		
Long Island, Fire Is. to Montauk Pt., Moriches to Shinnecock Reach, NY (4)	x			x		
Long Is., Fire Is. to Montauk Pt., Southhampton to Beach Hampton, NY (4)			x			x
Raritan Bay & Sandy Hook Bay, Madison & Matawan Townships, NJ			x			x
Raritan Bay & Sandy Hook Bay, Keansburg & East Keansburg, NJ			x	x		
Atlantic Coast of Maryland (Ocean City), MD	x			x		
Wrightsville Beach, NC	x			x		
Carolina Beach and Vicinity, NC	x					x
Fort Macon, NC		x				x
Duval County, FL			x	x		
Brevard County, Cape Canaveral, FL			x	x		
Brevard County, Indialantic/Melbourne, FL			x			x
Fort Pierce, FL	x				x	
Palm Beach County, Lake Worth Inlet, FL			x		x	
Palm Beach County, Delray Beach, FL	x			x		
Palm Beach County, Boca Raton, FL			x			x
Broward County, Segment II, FL			x	x		
Dade County, FL		x		x		
Dade County, Sunny Isles, FL	x					x
Virginia Key and Key Biscayne, FL		x		x		
Lee County, Captiva Island, FL			x			x
Manatee County, FL		x		x		
Pinellas County, Sand Key, FL		x				x
Pinellas County, Treasure Island, FL		x		x		
Pinellas County, Long Key, FL	x				x	

(1) Projects in the New England Division have all been turned over to local interests, no information available.
(2) (+) is more than expected; (-) is less than expected; (As Ex) is as expected.
(3) Project was originally justified on recreational benefits.
(4) Only a portion of the project completed.

a. Rockaway Beach, New York City.

(1). General Description.

(a). The Rockaway peninsula is located on Long Island in the Borough of Queens, New York. The peninsula is approximately 10 miles long with a varying width not exceeding one mile. To the west of Rockaway is Rockaway Inlet, to the east is East Rockaway Inlet, and to the south is the Atlantic Ocean. The area is generally flat with the elevation only rising to 10 feet (NGVD). The Rockaway beach nourishment project is 6.2 miles long (see Figure 5-2).

Figure 5-2 Rockaway Beach, NY

(b). The peninsula's development pattern is a mixture of high rise towers and single-family residences. The majority of the land is developed, with only a vacant Urban Renewal parcel that may be developed into residential units. Hugging the shorefront are a boardwalk and other recreation facilities. Even though the majority of the area is privately owned, there is still public access to the strip of sandy beach.

(c). This area of New York is subject to damages from the wave attack and runup created by hurricanes and northeasters. Early attempts to reduce storm-induced sand loss were through the construction of groins. By 1964, one year prior to the erosion control plan, there were 242 groins (primarily timber) located along the coast of the Rockaway peninsula. The 1965 plan that focused on protecting six miles of shoreline was reevaluated in 1974. Initial beach restoration began in 1975 and was completed in 1977, with periodic renourishment occurring five times between 1980 and 1988. There has been no additional renourishment since 1988. The analysis of benefits are related to the work that began in 1975.

(2). Analysis of Benefits. The benefits cited in the 1974 plan included: reduction in damages and maintenance for shorefront structures (buildings, boardwalk, etc), and recreation benefits from the additional width of the beach. In a recent Section 934 of WRDA '86 reevaluation study, the benefits of the project were reevaluated.

(a). Calculation. The storm damage reduction benefits were calculated using a storm damage model. The model determines damages to structures and infrastructure from inundation, storm recession, and wave attack. The analysis is based on current development within the area and current price levels. Data was collected for the square-footage of each structure and first floor elevation. The square-footage was the basis for determining construction cost replacement values and the elevation was used in determining the impact of flood inundation. The model was run using the characteristics of statistically significant storms and controlled for erosion by one-time counting of damages to buildings overtaken by the annual erosion rate. The model was run twice to determine damages for with- and without-project scenarios. The difference between the with and without scenarios is the estimated benefits.

(b). Estimated Storm Damage Reduction Benefits. In 1974, it was determined that the project would generate $408,800 in annual storm damage reduction benefits, $70,000 from the prevention of damages to shorefront structures and $338,800 from the reduction in beach maintenance. The Section 934 Reevaluation recalculated the damages prevented at $3.4 million in 1993 dollars.

(c). "Actual" Storm Damage Reduction Benefits. Since the project was constructed in 1974, there have been five significant storms. The damages prevented for each storm were based on the difference between the value of the damages with- and without-project. Without the project there would have been $124 million in damages and with the project there were 1.5 million in damages, for a difference of $122.5 million in damages prevented over the life of the project.

(d). Recreation Benefits Estimate. In 1974, the largest benefit category was recreational. These benefits were valued at $4,611,600 in 1974 dollars, or 96 percent of the total benefits. The recreational benefits were recalculated in the 1993 Section 934 Study and based on a unit value per day. An enhancement value was calculated by taking the difference between what a person is paying now to use the beach and what a person would pay if the beach was widened. It was determined that a person would pay $5.53 per day without the project, but would be willing to pay an additional 91 cents to use the enhanced beach. The enhancement value of 91 cents was then multiplied by the annual average visitor rate and resulted in $6,370,000 in average annual recreation benefits in 1993 dollars.

b. Ocean City, Maryland.

(1). General Description.

(a). Ocean City, Maryland is located on Fenwick Island, which is 10 miles south of the Maryland-Delaware border and just north of Assateague Island National Park. The island is highly developed, attracting vacationers from the metropolitan centers of Washington, D.C. and Baltimore, MD (see Figure 5-3). Over the last two decades, development has evolved from the wooden frame 4 unit structures of the 1970s, to the luxurious highrise motels and condominiums of the 80s and 90s. Since Ocean City has little oceanfront vacant land, most of the recent development has occurred on the bay side of the island. This renovation and new construction has resulted in development which exceeds $2 billion in value.

(b). While the newer structures are better designed, they are not isolated from risk. The shoreline running from the Delaware border to Assateague Island is subject to severe damage from high tides and wave attack during the storm season. The damages related to storms have been magnified with the growth in development. Damages to public and private property at Ocean City from Hurricane Gloria in September 1985 were estimated at $11.9 million. An additional $944,000 in erosion damages were the result of Hurricane Juan in November 1985. The 1989 hurricane protection project has widened the state-nourished 90 foot beach to 130 feet. Without any action, it is estimated that this beach would erode at a rate of 2.3 feet per year, returning back to the state-maintained 90 foot beach in the year 2010. The analysis that follows, relates to the benefits attributed to the hurricane protection plan.

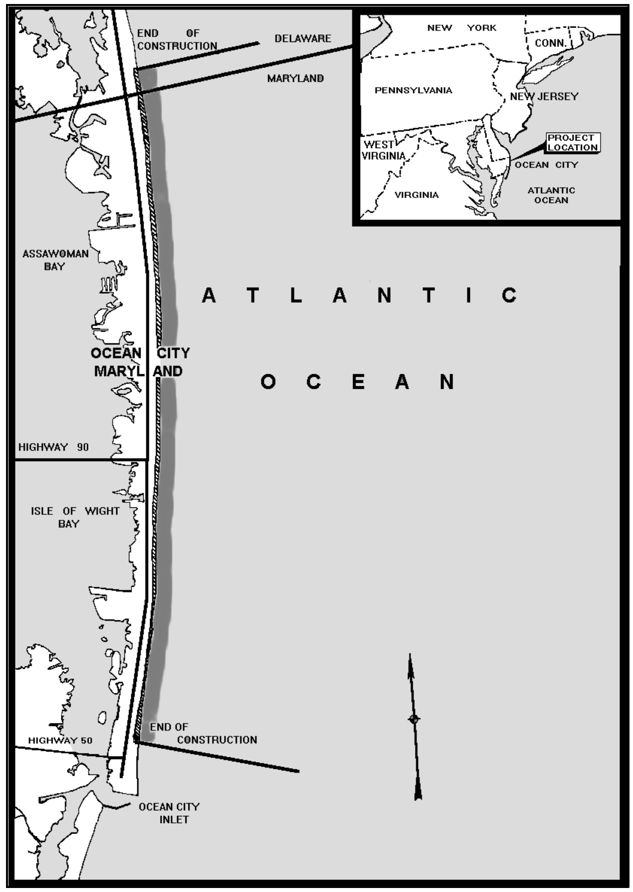


Figure 5-3 Ocean City, MD

(2). <u>Analysis of Benefits</u>.

(a). <u>Hurricane Protection</u>. The hurricane protection benefits were from both storm damage prevention and recreation. These benefits were based on the difference between the with- and without-project scenarios. The plan defined the "without" project scenario as the State-maintained 90 foot wide beach. It was assumed that without the project, State intervention would prevent further erosion. The "with" project scenario assumes that there will be a 130 foot beach with no loss to erosion.

(b). Storm Damage Prevention. Storm damage prevention was divided into two categories, wave/erosion and inundation. The wave/erosion damages are based on a survey of the existing buildings' elevations and specifications. Damage curves were designed to measure the wave force and erosion that could undermine the structures. Individual structure stage-damage curves were developed and compared with erosion and wave height modeled for various storm frequencies. The model accounted for the impact of long-term erosion by determining an annual erosion rate for each year of the 50 year project life. In year 20, the erosion rate reached the 90 foot State-maintained beach. For the remainder of the project years, the shoreline was held constant. The wave and erosion damages were compiled to yield an average annual wave/erosion damage benefit that was later combined with inundation damages.

(c). Estimated Storm Damage Reduction Benefits. To determine the inundation damages, a model was employed to estimate wave runup and overtopping rates associated with different storm frequencies. Damage data were associated with the various storm frequencies, producing stage damage curves. The stage damage curves identify the potential dollar value of damages related to a specific storm occurrence. Using a statistical sampling approach, damage curves for each land use type were modified to reflect current costs and development patterns. To reduce double counting in oceanfront areas where wave, erosion and inundation damages were calculated, only the category with the largest damages was documented. The total average annual estimated storm damage reduction benefits were $13,453,100 in 1993 dollars.

(d). "Actual" Storm Damage Reduction Benefits. Storm damages prevented based on actual storms were reported from the storms that occurred during the construction of the project. Actual benefits, as reported by the Baltimore District, have been $184 million to date. The dates of the storms and damages prevented are: October 1991 - $32 million; January 1992 - $52 million; December 1992 - $71 million; and March 1993 -$29 million. Damages prevented were computed by comparing the estimated frequency of the storm event and the measured wave runup to the stage damage and frequency curves described above and adjusting for current dollar values.

(e). Recreation Benefits Estimate: Without-Project. The without-project scenario recreational benefits are based on the 130 foot projected width of the beach to erode at 2.3 feet a year to the 90 foot beach. Since there has been a significant increase in development between the time of the 1980 study and the 1989 plan, it was considered appropriate to revise current estimates of visitation and beach use. Current estimates of beach use were adjusted using the change in wastewater volume over the past decades. This resulted in the 1989 peak visitation to be 92,900 for weekend days and 60,400 for weekdays. Not all of the visitation demand could be accommodated and had to be adjusted to reflect the beach capacity. Beach capacity was defined by the available acreage of the beach, a 100 square foot bather requirement, and a daily turnover rate of 2.7 bathers. Beach usage for a particular day is the lesser of the demand or capacity projection. The product of usage, the number of peak days and the unit day value became the peak day value. The sum of each year's peak day value for weekdays and weekends was adjusted to an October 1989 price level and discounted at 8.875 percent, to determine the present worth of $36,123,000 annual recreational benefits in 1989 dollars for the without-project scenario.

(f). Recreation Benefits Estimate: With-Project. The with-project scenario was based the recreational benefits on a maintained 130 foot beach, a dune and a bulkhead. The beach usage was recalculated using the wider beach, with no loss of beach width due to long-term erosion. As a result, the with-project plan provides a greater area for recreational activity from the year 2000 onward. The greater area is reflected in the increase in the peak day value. The sum of the peak day value for weekdays and weekends, adjusted to an October 1989 price level and discounted at 8.875 percent, results in the present worth of $36,657,000 in annual recreational benefits for the with-project scenario. The difference between the with-project recreational benefits of $36,657,000 and the without-project recreational benefits of $36,123,000 results in $534,000 in annual recreational benefits attributed to the hurricane protection project in 1989 dollars.

c. Virginia Beach, Virginia.

(1). General Description.

(a). The city of Virginia Beach is located in the southeastern part of the State of Virginia. The city is bordered by the Chesapeake Bay to the north, the city of Norfolk to the west, North Carolina to the south and the Atlantic ocean to the east. The city's oceanfront extends for 28 miles, with an additional 10 miles of bayfront (see Figure 5-4). A boardwalk runs along the beach and is the location of oceanfront shops and restaurants. The boardwalk was constructed between 1927 and 1983, with various sections being funded by city and private funds. In 1962, a northeaster devastated the boardwalk and the Corps was authorized to rehabilitate the structure.

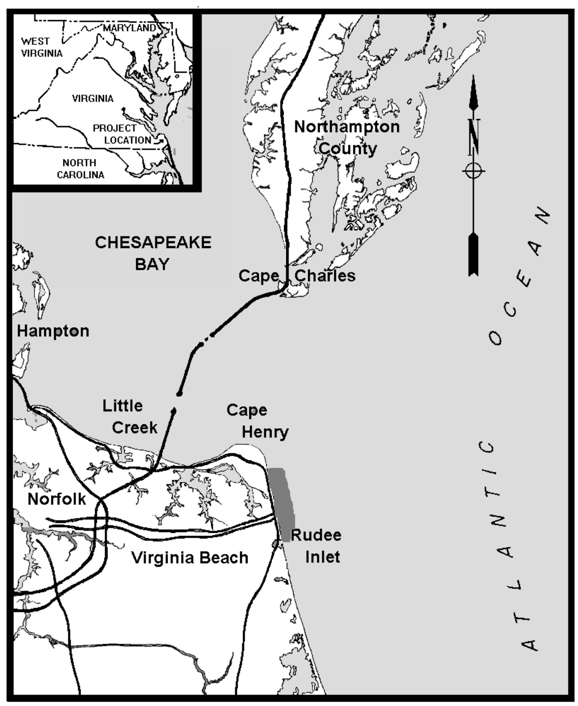


Figure 5-4 Virginia Beach, VA

(b). Nourishment procedures were first authorized in 1954. The original plan called for three and a half miles of beach nourishment, with an additional 21 groins constructed when deemed necessary. In order to expedite the work, local interests paid for the beach nourishment and provided maintenance over the next several years. The groins were never built and are no longer considered an appropriate protection measure for this area.

(c). Modifications to the project came in 1962, when the city took advantage of the Federal cost sharing program. The cost sharing ran for 25 years and expired in 1987. However, recalculations of benefits and costs under Section 934 of WRDA 86, determined that continued Federal participation was warranted. An agreement between the city and the Federal government has been signed for an additional ten years that will run until 1997. The benefits analyzed in this report are related to the nourishment activities that began in 1962 and have continued since.

(2). Analysis of Benefits. The project benefits included storm damage reduction and an increase in recreation. Storm damage reduction benefits are estimated through models. Historical storm data and stage damage curves are used to determine the damage in the with and without scenarios.

(a). Calculation. The model controls for successive storms to reduce the over counting of damages and long-term erosion rate. The storm control assures that a structure damaged in one storm would not be recounted if a successive storm hit within three months of the previous storm. The long-term erosion control assures that damages to structures lost to the long-term erosion rate are not double counted after the erosion rate overtakes the structure's location.

(b). Storm Damages Prevented. In the case of storm damage reduction, the estimated annual prevented damages were $6,611,000 and the "actual" damages prevented were $6,674,000. The actual storm damages were based on a 31 year period of analysis, where 58 storm events occurred with a frequency ranging from 1 to a 5 year event.

(c). Recreational Benefits. The recreational benefits are a secondary benefit. Without the project, the potential for recreation in this area would be negligible. Eventually, the beach would become so narrow that there would be no measurable benefits. Therefore, the without-project scenario considers that there will be no recreational benefits present. Therefore, any increase in the number of recreational visitors can be totally attributed to the project. Recreational benefits were based on a unit day value. It was estimated in 1951 that the unit day value was 25 cents, based on beach visitation numbers extrapolated from a city survey of the occupancy rate of area hotels and rental units. Based on the 25 cent unit day value, it was estimated that there were $22,500 recreational benefits in 1951. The $22,500 of recreational benefits were adjusted to 1993 dollars and yielded a projected $115,000 in estimated recreational benefits.

(d). Re-evaluation of Recreation Benefits Estimate. In order to determine recreational benefits for the 1993 Section 934 reevaluation, the recreational benefits in 1951 of $22,500 were used as the base year dollar value. In order to determine the realized recreational benefits for each successive year, the enhancement value was adjusted to reflect that year's dollar value. By 1993, the enhancement value was modified to $1.28 and the recreational benefits realized were $1,074,000. The study then took the actual annual recreational benefit and determined an average annual recreation benefit of $496,000, based on the 31 year life of the project and discounted at 8 percent. The Section 934 plan's annual recreation benefits of $496,000 are $381,000 more than those projected in the original plan.

d. Carolina Beach, North Carolina.

(1). General Description.

(a). Carolina Beach, North Carolina is on a barrier island, located southeast of Wilmington, south of the Carolina Inlet and north of Smith Island. The town is fronted by 2.6 miles of Atlantic ocean shoreline (see Figure 5-5).

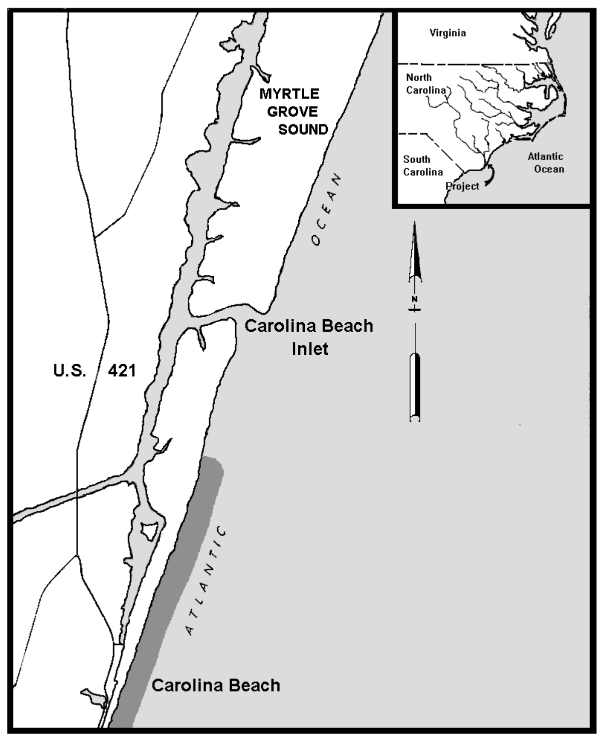


Figure 5-5 Carolina Beach, NC

(b). The Carolina Beach project was authorized in 1962, but it was not until December 1964 that initial placement of fill began. Severe erosion occurred immediately after the initial placement and prompted emergency action in 1967 and again in 1970. In the 1967 emergency nourishment, a temporary wood groin was constructed to the north to reduce the amount of sand lost. In 1970, emergency action included the initial construction of a rock revetment. The next year, the entire project was renourished but accelerated erosion persisted in the north. Later, it was determined that the Carolina Inlet, located north of the project site, was prohibiting littoral drift and starving the beach of sand.

(c). A full comprehensive plan was delayed until a study determined what navigation improvements to the Inlet could be done in conjunction with eliminating the negative impacts. With the completion of the navigation report in 1981, a final solution for Carolina Beach was adopted that included the excavation of a sediment trap in the throat of the Carolina Beach Inlet and the bypassing of this sediment to the project shoreline. The sediment trap area serves as a renewable source of beach quality sand for nourishing the storm damage reduction project at Carolina Beach.

(2). Analysis of Benefits.

(a). Calculation. A model was used to determine the storm damage reduction benefits and recreational benefits of this project. The model superimposes 1993 development on the 1964 shoreline and provides damages in 1993 dollars. Damages caused by long-term erosion were based on the pre-project shoreline recession rate. Potential storm damages for the without-project condition were determined in yearly increments by moving the shoreline position landward a distance equal to the annual long-term erosion, pre-project rate. At each new shoreline position, an assessment was made of the damage potential to the existing development associated with a representative number of storms ranging from 5 to 500 years. Damage potential for each storm was based on the storm shoreline recession, inundation, and wave impacts. Only the category with the largest damages was documented for a specific storm, so as not to over count.
The damage assessment analysis was repeated for the with-project scenario. It was assumed that with the project in place, long-term erosion would not occur. The project maintains the shoreline in a position somewhat seaward of its pre-project position, and generally reduces damages associated with storms. However, it is a paradox of the model that when a large storm occurs, the storm damages can actually exceed without-project damages for that storm. This apparent anomaly is the result of all the structures remaining in the data base rather than some being lost to the long-term erosion. This is rather rare and overall the total damages with the project are less than without the project in place.

(b). Estimated Storm Damage Reduction Benefits. In addition to the model accounting for erosion it also controls for storms that occur in rapid succession. The model controls for successive storms to reduce the over counting of damages. The storm control assures that a structure damaged in one storm would not be recounted if a second storm hit within three months of the previous storm. Once these factors were accounted for, the model determined that the annual storm damages prevented were $6,398,000.

(c). Actual Storm Damage Reduction Benefits. To determine the annual storm damages prevented based on actual storms, the model was run again using the characteristics of historical storm events. The procedure gives an approximation of the dollars in damage that actually would have occurred with and without the project. It was determined by running the model that the annual estimated damages prevented based on actual storms was $8,186,000. However, these annual prevented damages are inflated by the fact that the character and intensity of Carolina Beach's development has increased over time. Remember that these calculations were based on taking the 1993 development and overlaying it on the 1964 shoreline. Since the actual development in 1964 was not so intense and expensive as the 1993 development, the actual damages would have been less.

Therefore, the total annual estimated damages prevented were calculated by multiplying the total annual estimated damages by the ratio of the town's tax base in a given year and dividing by the value of the 1993 tax base. This procedure adjusted the annual damages prevented from the previously stated $8,186,000 to $1,921,000.

(d). Difference Between Actual and Estimated Storm Damages Prevented. The difference between the estimated storm damages prevented of $6,398,000 and the estimated damages prevented based on actual storms of $1,921,000 can be explained by the project area not being directly affected by a major hurricane since its initial construction in 1965. If the area experiences a major hurricane, the damages prevented by the project for this singular event could greatly increase the total dollar value of the damages prevented, and thus increase the actual benefit to cost ratio for the project.

(e). Estimated Recreational Benefits. Recreational benefits were based on an increase in the value of the recreational experience resulting from the improved beach. A with- and without-project recreational value was determined and the difference of 53 cents was considered to be the enhancement value of the project. Estimates of the existing annual visitation to Carolina Beach were based on average occupancy rates in the town's motels, cottages, condominiums, and duplexes and adjusted by the number of days in the beach season and the number of parking spaces available for public use. The product of the estimated visitation to Carolina Beach of 430,723 and the 53 cent enhancement value results in a projection of $228,300 in recreational benefits for 1993. A similar value was projected for each year of the project, with the total recreational benefits being $2,705,000 in 1993 dollars.

(f). "Actual" Recreational Benefits. The Wilmington District based the actual recreational benefits on the town's historical visitation record for the years the project was in place. The original feasibility study for Carolina Beach estimated that visitation to the beach would be 147,000. The difference between the visitation estimated in the 1964 study and the visitation presented in the 1993 study is closely linked to the increase in available units and an increase in the number of public parking spaces, as a result of the state's public beach access program. The product of the 1964 visitation count and the 53 cent enhancement value reveals that there were $77,000 in actual recreational benefits, one year prior to the project. It was further assumed that recreational benefits paralleled the growth in the town's tax base. Therefore, in order to reflect a realistic recreational value for each year since 1964, the recreational benefits had to be adjusted by the tax base ratio for that given year. This computation takes the 1964 base year recreational benefits and adds the difference between the particular year and the 1993 recreational benefits then divides by the tax base ratio for that particular year. This method determined that there were $3,617,000 in actual total recreation benefits or $912,000 greater than the estimated recreational benefits.

e. Duval County, Florida.

(1). General Description.

(a). Duval County is located in northeastern Florida and includes the Atlantic Ocean shoreline communities of Atlantic Beach, Neptune Beach, and Jacksonville Beach, as well as the Mayport Naval Station (see Figure 5-6). As early as 1834, this area suffered extensive instability and erosion. The erosion and damage to the beach, seawalls, and oceanfront property were greatly accelerated and magnified during storms, especially the storms of 1925, 1932, 1947, 1962, and Hurricane Dora in 1964.

(b). The authorized project consisted of restoration of the ten miles of shoreline with a 60-foot berm at elevation +11.0 feet MLW and natural seaward slopes to intersection with the existing bottom. Initial beach restoration was completed in the 1978 to 1980 period. Periodic nourishments were done in 1985-1987, and again in 1990.

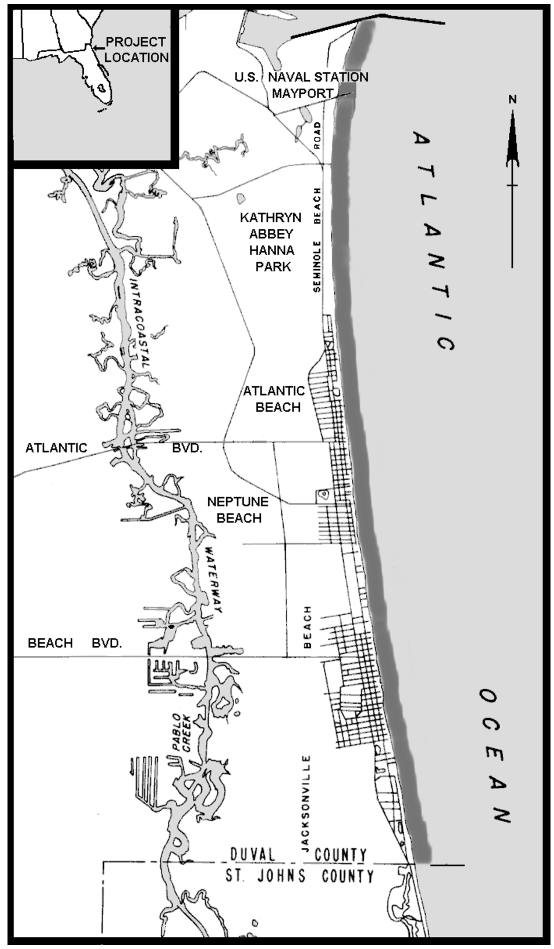


Figure 5-6 Duval County, FL

(2). Analysis of Benefits.

(a). Calculation. Storm damage prevention benefits for the project were determined using an empirical computer model developed by the Jacksonville District called the Storm Damage Model (SDM). The extent of damages to upland development are generated as a result of annual shoreline position change and the damage probabilities from frequency vs. storm-induced recession data. The estimated market value of lands and improvements along the coast of Duval County used in the analysis was based upon the May 1989 market.

(b). Storm Damages Prevented. September 1979 and October-November 1979 storm events occurred approximately 1 year after construction of the project segment north of Atlantic Boulevard. If the project had not been in place, these storms would have caused damages of $1,818,900 and $79,000, respectively, according to the model. By October 1980, construction of both the north and south segments of the project was complete. Northeasters occurred in December

1980 and February 1981. Without the project in place, these storms would have caused $79,000 of damages. Another northeaster in October 1981 prevented an estimated $321,000 of damages, and the storm tide associated with the events of January and February 1983 prevented approximately $79,000 in damages. The storm tide associated with the "Turkey Day Storm" of 1984 corresponds to a 25 to 30 year return interval. The resulting storm-induced beach recession would have been between 169 and 178 feet without the project, and would have caused damages of $25 million. The "Halloween Storm" of 1991 storm tide corresponds to a 5 to 10 year return interval storm event. Such a return interval would result in storm-induced beach recession of 75 to 110 feet, and damages of $4.5 million without the project. Total damages prevented by the project to date are estimated to be $32 million. If these estimated benefits based on actual storms were spread out over the life of the project (i.e. from 1979 to 1993), they would average $2.3 million dollars per year.

(c). Estimated Benefits. The Section 934 of WRDA '86 Study report estimated the annual project benefits to be $5.9 million, with a benefit cost ratio of 1.7.

f. Palm Beach County, Florida - Delray Beach.

(1). General Description.

(a). Delray Beach is located on the lower Atlantic Ocean coast of Florida about 50 miles north of Miami Beach (see Figure 5-7). The project was authorized in 1962, and provided for initial beach fill and periodic nourishment for an 8.4 mile segment between South Lake Worth Inlet and Boca Raton Inlet. In 1972, the City of Delray Beach requested Federal financial assistance for a 2.7 mile segment of Delray Beach. This segment is the project discussed below.

(b). Initial beach restoration took place during June and July 1973. A total of 1,634,500 cubic yards of sand was dredged from a borrow area located about 2500 feet offshore and was placed on a reach of shore extending 2.62 miles from the north boundary of the city. Excess material, 294,500 cubic

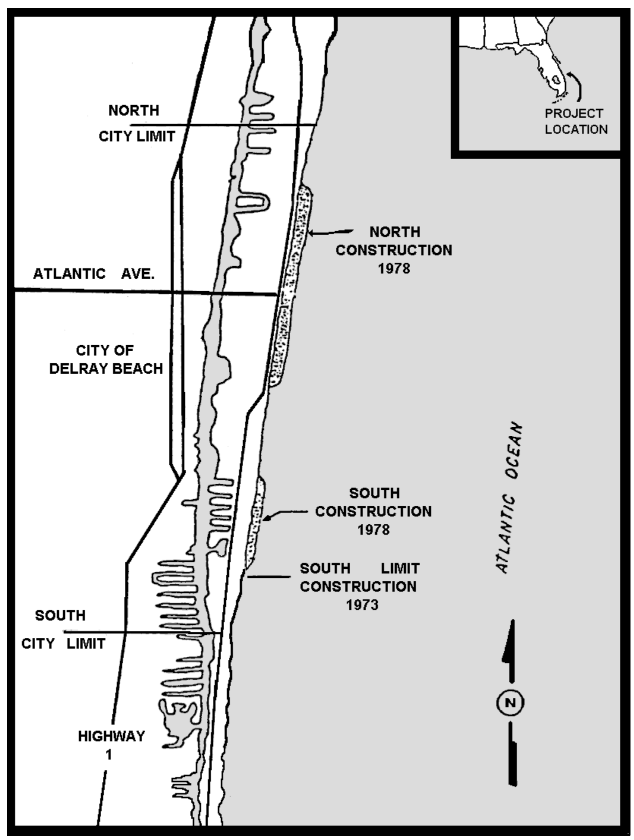


Figure 5-7 Palm Beach County, FL- Delray Beach

yards, was stockpiled on the north end of the project. The construction cross-section of the project had a width of 100 feet at mean high water and an elevation of +9 feet NGVD. Nourishments were completed in 1978 (701,266 cu. yds.), 1984 (824,000 cu. yds.), and 1992 (1,052,000 cu. yds.).

(2). Analysis of Benefits.

(a). Calculation. The evaluation of benefits realized since project construction is based on information contained in the Section 934 of WRDA '86 Re-evaluation report which was done in 1990. Storm damage prevention benefits for the project were determined using an empirical computer model developed by the Jacksonville District called the Storm Damage Model (SDM). Damages to upland development are generated as a result of annual shoreline position change and the damage probabilities from frequency vs. storm-induced recession data. The estimated market value of land and structures was based on 1990 price levels.

(b). "Actual" Storm Damages Prevented. Three major storms have impacted the Delray Beach area since the project was constructed. The first was Hurricane David in 1979 which generated a storm tide of 4.0 feet. The associated storm, induced recession (without the project) was estimated to be 87 feet, resulting in $2.4 million in damages. The second storm was the "Turkey Day Storm" of 1984 which would have caused storm induced beach erosion of 101 feet had the project not been in place. This recession would have caused an estimated $3.4 million in damages. The third storm was the Halloween Storm of 1991. Damages were estimated to be $2.4 million, the same as for Hurricane David. Based on this analysis, the Delray Beach project has prevented approximately $8.2 million (1990 price level) in damages to upland development since its construction in 1973. Over the project's 20 years of existence, this amounts to an average of $0.4 million per year.

(c). Estimated Storm Damage Reduction Benefits. Expected average annual storm damage benefits to upland development for the Delray Beach project were $1.8 million (1991 price level) in the Section 934 Re-evaluation Report.

g. Broward County, Florida, Segment II, Hillsboro Inlet to Port Everglades.

(1). General Description.

(a). Broward County is located on the lower Atlantic Ocean coast of Florida, just north of Dade County (Miami Beach) (see Figure 5-8). Section II covers the central portion of the county. The Broward County, Florida Beach Erosion Control and Hillsboro Inlet Navigation Report (March 1963) was initiated by application of the Broward County Board of County Commissioners (BCBCC) dated March 1960. The BCBCC requested the study due to erosion along the county shoreline which was undermining or threatening to undermine shorefront structures. The study covered the entire 24 mile coastline of Broward County. The purpose of the study was to determine the best method of restoring and maintaining beaches, as well as navigability in Hillsboro Inlet.

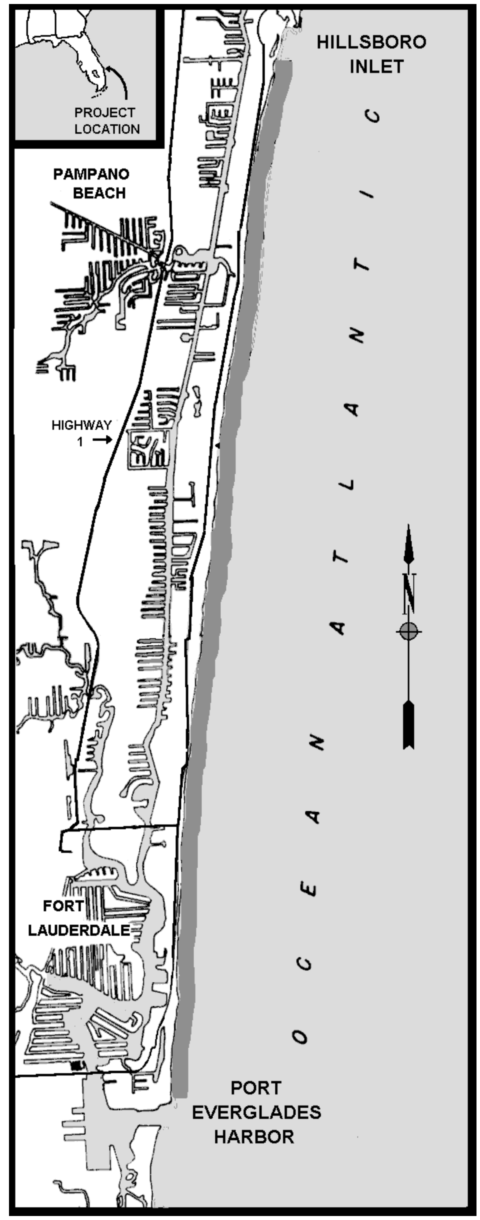


Figure 5-8 Broward County, FL- Segment II, Hillsboro Inlet to Port Everglades

(b). The authorized beach erosion control project provided for restoration of a protective beach to a general width of 75 to 125 feet with a berm elevation of +10 feet above mean low water and periodic nourishment as needed and justified for the first ten years of project life. Three separable segments were identified in the authorizing document. This summary pertains to Segment II, Hillsboro Inlet to Port Everglades Inlet.

(c). Initial restoration was completed along approximately 3.2 miles of shoreline in 1970. The volume of material placed was approximately 1.1 million cubic yards. The project was constructed by the non-Federal sponsor and later reimbursed by the Federal government. In 1976, Federal participation in the cost of periodic nourishment was extended to 15 years, until 1985. The first nourishment was done in 1983 and consisted of the placement of 1.9 million cubic yards of material along 5.3 miles of shoreline starting at Hillsboro Inlet and proceeding south to Lauderdale-by-the-Sea.

(d). A Section 934 of WRDA '86 Re-evaluation report was prepared in 1993 by the Corps of Engineers. The purpose of this report was to determine if additional time extension of Federal participation in future nourishment of Segment II is warranted. The report is currently (as of July 1994) under Department of the Army review.

(2). Analysis of Benefits. The evaluation of the benefits realized since construction is based on information contained in the Section 934 Study Report for the project dated April 1993.

(a). "Actual" Storm Damages Prevented. Two storms of record have affected

Broward County since project construction. Hurricane David impacted Broward County in 1979, nine years after initial construction. According to the Storm Damage Model developed by Jacksonville District, the surge associated with Hurricane David would have caused $48.2 million in damages if the project had not been in place. These figures are based on pre-project conditions, using 1990 real estate values. Hurricane Andrew impacted the project in the 22nd year after initial construction. Using the storm damage model again, a reasonable estimate of the damages prevented by the project during Hurricane Andrew is $96.0 million. Therefore, it is estimated that the Broward County - Segment II project has prevented about $144.2 million in damages to upland development since its construction in 1970. This amounts to an average annual figure of $6.3 million (1990 price level).

(b). Estimated Storm Damage Reduction Benefits. The 1993 Section 934 Re-Evaluation report estimated average annual storm damage benefits of this project to be $8.6 million.

(c). Recreation Benefits. The average annual recreation benefit for the project was estimated to be $ 0.6 million. Beach attendance records for Pompano Beach indicate that 2.6 million people used the beach for recreation in 1990.

h. Broward County, Florida- Segment III - Port Everglades to the South County Line

(1). General Description.

(a). The Broward County, Segment III project is located on the lower Atlantic Ocean coast of Florida. It includes the communities of Hollywood and Hallandale, and a state park (see Figure 5-9).

(b). Initial restoration was completed at the state park, approximately 1.5 miles of shoreline adjacent to the Port Everglades Inlet south jetty, in 1977. The volume of material placed was approximately 1.1 million cubic yards. The first nourishment of this shoreline was completed in 1990, and consisted of placement of an estimated 603,000 cubic yards of sand. Initial restoration of 5.3 miles of Hollywood/Hallandale shoreline was completed in 1979. The volume of material placed was approximately 2 million cubic yards. The first nourishment of the Hollywood/Hallandale beaches was completed in 1991, and consisted of the placement of 1.1 million cubic yards of sand.

(2). Analysis of Benefits. The evaluation of the benefits realized since project construction is based on information contained in the Section 934 of WRDA ‘86 Study Report dated October 1990.

(a). <u>"Actual" Storm Damages Prevented</u>. Hurricanes David and Andrew are the two storms of record that have affected Broward County since project construction. The surge associated with both hurricanes corresponded to a ten to twenty year return interval storm event. This would have resulted in storm induced beach recession of 90 to 140 feet if the project had not been there. The estimated damages prevented by the project during these two hurricanes total $11.8 million , using 1990 real estate dollars, or approximately $0.8 million per year for the 14 year period since initial construction was completed. This can be compared to the average annual storm damage benefits expected for the project area of $2 million (from the Section 934 Re-evaluation Report).

(b). <u>Recreation Benefits</u>. Expected annual recreation benefits for this project are $1.1 million, but no information was available on actual beach attendance.

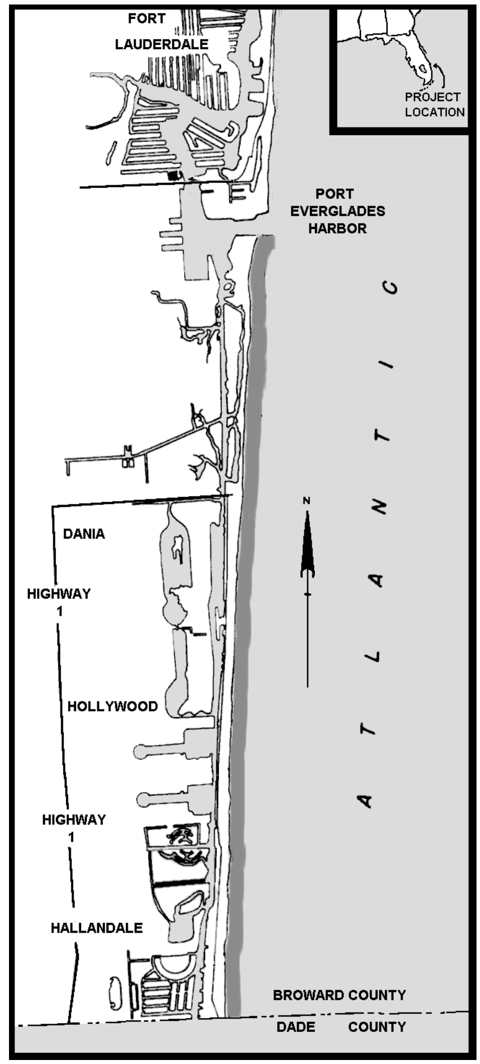


Figure 5-9 Broward County FL- Segment III, Port Everglades to the South County line

i. <u>Manatee County (Anna Maria Island), Florida</u>.

(1). <u>General Description</u>.

(a). Manatee County is located on the Gulf of Mexico shore of Florida about mid-way up the coast (see Figure 5-10). The authorized project consisted of restoration of 3.2 miles of shoreline of Anna Maria Island with a 50-foot berm at elevation +6 above mean low water and natural slopes as would be shaped by wave action. Periodic nourishment was authorized for the entire 7.5 miles of the island.

(b). The September 1991 General Design Memorandum describes several modifications to the authorized project. The initial restoration length was extended to 4.2 miles of shoreline. The design section was changed to a 75-foot berm with nine years advance nourishment. Initial beach restoration took place from December 1992 to March 1993, and consisted of the placement of 2.2 million cubic yards of material. A 0.5 mile taper was added at the south end of the initial fill to reduce potential end losses. Removal of derelict groins and other debris from the beach disposal area was also added as a project feature.

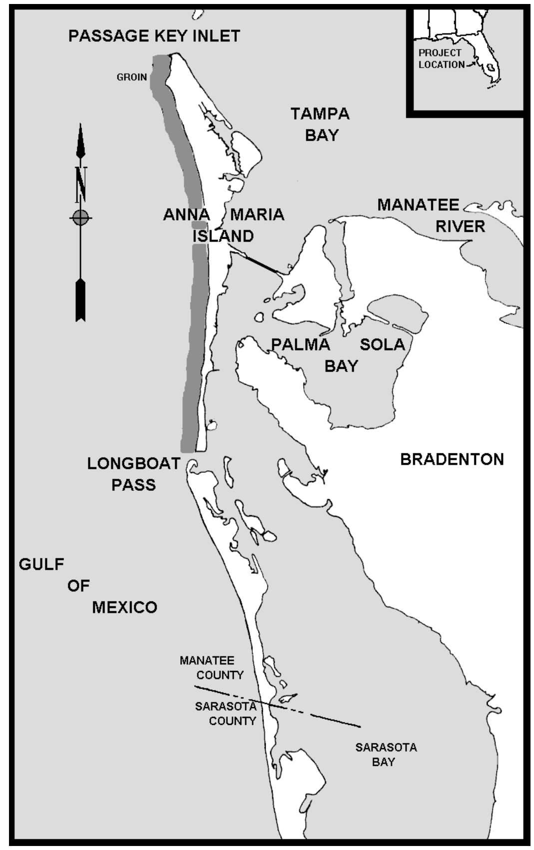


Figure 5-10 Manatee County, FL-Anna Maria Island

(2). <u>Analysis of Benefits</u>.

(a). <u>“Actual” Storm Damages Prevented</u>. The "Storm of the Century" is the one storm of note since the project was constructed. This storm occurred in March 1993, less than two weeks after project completion. Tide data from NOAA included a peak surge of +5.85 feet NGVD at Clearwater Beach in Pinellas County, Florida, about 20 miles north of Anna Maria Island. This exceeded the design elevation of the Manatee County Shore Protection project of +5.0 feet NGVD. No upland development was adversely affected in the project area. The surge of the storm corresponded to a 10 to 20 year return interval storm event, which would have resulted in storm-induced beach recession of 132 to 167 feet if the project had not been there. Based on Jacksonville District's Storm Damage Model for the Manatee area, this recession would have caused damages of approximately $12 million.

(b). <u>Expected Storm Damage Benefits</u>. Expected annual storm damage benefits of this project (from the 1991 GDM) were $3.8 million.

(c). <u>Recreation Benefits</u>. Recreation benefits were estimated at $167,000 for the first year of project construction. Beach counts have not been taken to verify if the estimated recreation benefits have been realized.

j. Pinellas County, Florida - Sand Key Segment.

(1). General Description.

(a). This Gulf Coast area of Florida is bounded by Clearwater Pass on the north, Clearwater Harbor and Boca Ciega Bay on the East, on the south by Johns Pass, and on the west by the Gulf of Mexico. The entire gulf shoreline of Sand Key, which is about 14.2 miles in length, includes the cities of Clearwater Beach, Belleair Beach, Belleair Shores, Indian Rocks Beach, Indian Shores, Redington Shores, North Redington Beach, Redington Beach and Madeira Beach (see Figure 5-11).

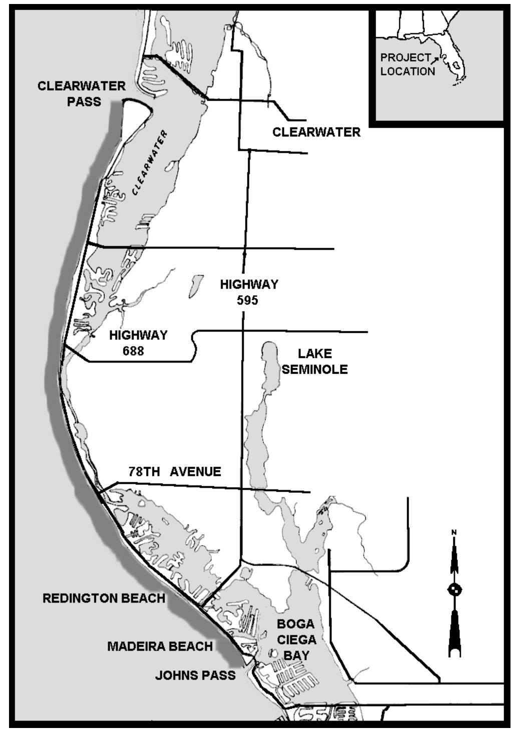


Figure 5-11 Pinellas County, FL-Sand Key Segment

(b). Erosion problems in the project area prompted many private owners to construct seawalls, bulkheads, groins and revetments prior to 1950. Many additional seawalls and groins were added immediately after a severe hurricane in 1950. In 1957, the city of Madeira Beach built 37 groins over its entire frontage. In 1961, the city built a curved jetty on the north side of John's Pass and placed about 30,000 cubic yards of fill immediately north of the jetty. In 1975, the City of Clearwater Beach completed construction of a curved jetty on the south side of Clearwater Pass. Maintenance dredging of the Federal navigation project for Clearwater Pass in 1977 placed 186,000 cubic yards of fill on Sand Key just south of the jetty. The city of Clearwater Beach placed about 600,000 cubic yards of material on the beach just south of Clearwater Pass during 1982-83.

(c). Construction of a breakwater at Redington Shores was completed in January 1986. Rehabilitation of the groin on the north side of Johns Pass due to damages caused by Hurricane Elena (29 August - 2 September 1985) was completed in September 1987. Initial restoration of the beach at Redington Beach/Redington Shores was completed in 1988 through the placement of approximately 380,000 cubic yards of material along the 1.5 miles of shoreline south of Indian Shores. Work performed under this contract included the lowering of the crest elevation of the Redington Shores breakwater to 0.0 feet MLW. Initial restoration of 2.65 miles of shoreline at Indian Rocks beach was completed in January 1991 with the placement of 1,325,000 cubic yards of material. Initial restoration of 2.57 miles of shoreline at Indian Shores was completed in December 1992 with the placement of 1,002,000 cubic yards of material.

(d). The first renourishment of the project was accomplished in 1992. Approximately 58,000 cubic yards of sand were placed along the southernmost 1800 feet of North Redington Beach to offset excessive end losses.

(2). Analysis of Benefits. The evaluation of benefits realized since project implementation is based on information contained in the Limited Re-evaluation Report and Environmental Summary for the Pinellas County, Florida Beach Erosion Control project dated April 1994.

(a). "Actual" Storm Damages Prevented.

((1)). On March 13, 1993, the project area was hit by a storm event referred to as the "Storm of the Century". The tide hydrography from the NOAA tide gauge at Clearwater Beach indicated that the storm surge in the project area lasted for approximately 15 hours with a peak storm tide of +5.85 feet NGVD. The storm's peak tide overtopped the project beach berm elevation of +5.2 feet NGVD. No damage to upland development occurred in the project area. Based on storm-induced recession modeling, this storm would have caused a recession of 150 to 170 feet in Pinellas County, and damages of between $78 and $129 million if the project had not been there.

((2)). Prior to construction of the Sand Key project, Hurricane Elena (1985) destroyed or caused substantial damage to 11,000 feet of seawalls and bulkheads and substantially damaged 80 major structures within the limits of the project area. Based upon the real estate appraisal data obtained for the reevaluation report, the average per structure value of the front row development along the project shoreline is $800,000. The replacement cost per lineal foot of concrete bulkhead can be estimated as approximately $400 per lineal foot. Therefore, a damage estimate based on 1993 values for damages caused by Hurricane Elena would total approximately $68 million.

((3)). Hurricane Elena produced a peak storm tide of +4.5 feet NGVD which corresponds to a 7-year return interval storm event, based on surge. The March 1993 storm produced a peak storm tide of +5.85 feet NGVD. Given the comparison of storm events and the estimate of observed damages caused by Hurricane Elena, $78 million is a reasonable estimate of the storm damages prevented by the project during the March 1993 storm. If the $78 million in benefits based on actual storms were spread evenly over the 6 years since the project was constructed, the average annual damages prevented would be $13 million.

(b). Estimated Storm Damage Reduction Benefits. Expected annual storm damage reduction benefits, from the 1994 Limited Reevaluation Report, are $19 million.

k. Grand Isle, Louisiana.

(1). General Description.

(a). Grand Isle is an island located twenty five miles west of the Mississippi River, across the Barataria Bay in the Gulf of Mexico. The island is roughly 7 miles long and is about 3/4 mile wide (see Figure 5-12). Prior to 1951, the island had no comprehensive approach for the control of beach erosion. Individuals tried to protect their property by constructing bulkheads that generally accelerated beach erosion.

(b). In 1958, the state authorized the construction of a jetty at the eastern end of the island. During the 1970s additional protection measures were authorized by the State of Louisiana and Federal government. In 1983, the Corps began construction of a 7 mile beach with a vegetated dune in conjunction with a jetty at the western end of the island. Both sections of the project were completed in 1984.

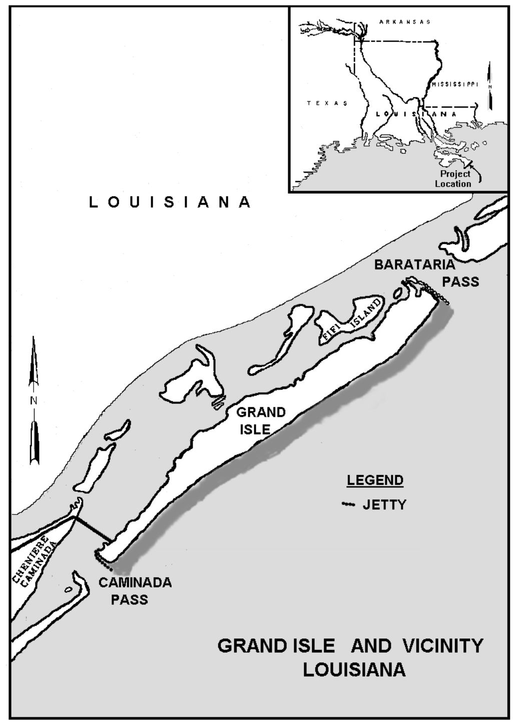


Figure 5-12 Grand Isle, LA

(c). During the 1985 hurricane season, three hurricanes created high tides and strong wave action along the shoreline. The successive hurricanes resulted in erosion of 6,000 feet at either end of the dune. In 1987, the Corps restored the dune, nourished the beach and extended both jetties. In 1990, the first periodic nourishment was placed in conjunction with the restoration work of 1987.

(2). Analysis of Benefits. The benefits for this project were based on erosion prevention, inundation reduction, and intensification. While the project's 1978 GDM report cited area redevelopment and recreational benefits, the project was ineligible to claim these benefits in the 1986 Reevaluation. The Grand Isle area, under current guidelines, is not qualified as a "substantial and persistent" unemployment area. Therefore, area redevelopment benefits from employing previously unemployed laborers could not be claimed. Recreation benefits were excluded because the dune in the area of the state park was virtually intact and still providing 45 to 50 years protection.

(a). "Actual" Storm Damages Prevented. Damages prevented based on actual storms were calculated for the largest of the historical storms through the use of a storm damage model. Damages prevented by the project during Hurricane Juan in 1985 were estimated to be $14 million in 1993 dollars. In 1992, Hurricane Andrew occurred and the project prevented an additional $21 million dollars of damage in 1993 dollars. This is a total of $35 million in damages prevented based on actual storms. If this figure were spread evenly over the nine year life of the project, annual damages prevented would be $3.9 million.

(b). Estimated Storm Damage Reduction Benefits. Based on the 1978 GDM, the Grand Isle project was expected to prevent $1.1 million in damages annually.

F. SUMMARY

1. Storm Damage Benefit Performance. Each of the 11 projects examined in detail in this chapter is unique. Summarizing their performance is a challenge. Table 5-2 draws together some key indicators to summarize project performance in terms of storm damage benefits. When reviewing Table 5-2, one should keep in mind that all benefit numbers are generated with models; none are actual measurements. Also, because of the storm damage modeling methodology, a major factor affecting the "actual" storm damage benefits is the incidence of storms during the life of the project. This factor is unknown at the time of project evaluation. Therefore, estimates must be based on "normal" weather patterns and "normal" incidence of storms. If the project life turns out to be stormier than normal, then the storm damages prevented will likely be higher than predicted, and vice versa. Percentage differences between actual annual storm damage benefits (averaged over the life of the project) and predicted average annual storm damage benefits are presented in Table 5-2. Of the 11 projects, six had actual storm damage benefits higher than expected and five had actual storm damage benefits lower than expected. As mentioned above, the number and severity of storms are likely to have been a significant factor here. Some projects have simply not had an opportunity to demonstrate their damage prevention capabilities because they have not been confronted with major storms.

2. Recreation Benefit Performance. "Actual" recreation benefits were measured for only two of the 11 projects. Virginia Beach, VA reported $496,000 in actual annual recreation benefits compared to $115,000 in predicted annual recreation benefits. Carolina Beach, NC calculated the total cumulative recreation benefits to be $3,616,700, significantly higher than the predicted cumulative recreation benefits of $2,705,000. So, although Carolina Beach had less storm damage benefits than expected, the recreation benefits for that project were higher than expected.

Table 5-2 Storm Damage Reduction (SDR) Benefits Comparison Table for Selected Projects

Project	Years Project has been in place	"Actual" SDR Benefits (average annual) million $	Predicted SDR Benefits from most recent project evaluation (average annual) million $	Percent Difference between Actual and Predicted SDR Benefits
Rockaway, NYC	19	6.4	3.4	88
Ocean City, MD	4	23.3	13.5	73
Virginia Beach, VA	30	6.9	6.6	5
Carolina Beach, NC	29	1.9	4.1	-54
Duval Co., FL	16	2.0	2.2	-9
Palm Beach Co., FL - Delray	21	0.4	1.8	-77
Broward Co, FL - Segment II	24	6.0	8.6	-30
Broward Co, FL - Segment III	14	0.8	2.0	-65
Manatee Co, FL	2	6.0	3.8	59
Pinellas Co, FL - Sand Key	9	8.7	4.9	77
Grand Isle, LA	9	3.9	1.1	254

G. REFERENCES

1. Skaggs, L. Leigh and Frank L. McDonald. National Economic Development Procedures Manual, Coastal Storm Damage and Erosion. U.S. Army Corps of Engineers Water Resources Support Center, Institute for Water Resources, Fort Belvoir, VA, IWR Report 91-R-6, September 1991.

2. The U.S. Army Corps of Engineers, Engineering Regulation No. 1105-2-100, Guidance for Conducting Civil Works Planing Studies, 28 December 1990.

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CHAPTER 6 - THE IMPACT OF CORPS SHORE PROTECTION PROJECTS ON DEVELOPMENT

A. INTRODUCTION

1. Objective. The purpose of this investigation was to ascertain whether Federally sponsored projects increased the rate and extent of development in protected areas, i.e. whether they induced development.[1]

2. Coastal Growth Rates. Beachfront communities all over the United States have experienced fairly high rates of residential development in comparison to inland communities. For the 42 beachfront communities identified for intensive statistical analysis in this chapter (see Table 6-1), the average annual rate of growth in housing units over the 33 year period from 1960 to 1992 was 3.9 percent. This is more than 50 percent above the average annual growth rate of approximately 2.4 percent for the entire nation. There is a concern that the high rate of growth in coastal areas may be artificially stimulated by programs of the Federal government, with the National Flood Insurance program and the Federal shore protection program receiving particular attention.

3. Growth Rates and Corps Projects. Measuring induced development is difficult. Given that U.S. Army Corps of Engineers (Corps) projects are evaluated based on potential damage avoided, shore protection efforts are concentrated in areas that are already heavily developed. Turning again to the data base on the 42 beachfront communities for this study, the average annual rate of growth in housing units in the 30 communities that had Corps activity at some time during the entire 1960-1992 period was 4.1 percent while the rate of growth in the 12 communities where the Corps was not active was 3.8 percent. However, the measurement of induced growth requires that one compare rates of growth with and without, and before and after Corps projects are implemented. In this same data set, the rate of growth in housing units during periods when there was a Corps-sponsored project active in a community was only 3.7 percent, compared to 4.9 percent for years when there was no Corps activity. In other words, for those areas receiving Corps projects, the rate of growth in residences was higher before the Corps project was approved than afterward.

4. Question of Causality. These simple statistics suggest a real potential for confusion regarding induced development. The benefit-cost criteria used to justify Corps projects require substantial existing development, and thus substantial previous growth, in order to gain approval. Therefore, many high growth communities are selected for Corps projects, making it easy to confuse continued high growth following initiation of a Corps shore protection project with growth that would have

[1] Given the extensiveness of such an endeavor, a separate IWR research effort was undertaken and a report was produced. This chapter represents an abridged version of that investigation and report. For the complete discussion of this topic, see IWR Report 95-PS-1, “Shore Protection and Beach Erosion Control Study, Economic Effects of Induced Development in Corps Protected Communities” .

occurred without the project. Given the difficulty of separating the forces that drive coastal development, it is understandable that there is some disagreement about the extent to which Federal shore protection programs encourage or "induce" development in coastal areas. Critics of shore protection programs believe that such programs encourage significantly more development in coastal areas, and thereby impose costs on society by increasing the amount of property that is exposed to risk from storm damage and beach erosion. This view is disputed by others who contend that shore protection results in little, if any, induced beachfront development.

5. Research Methodology. The research summarized in this chapter was conducted in two stages. First, a model of the determinants of beachfront development was formulated based on economic theory. Second, three independent empirical tests were executed simultaneously in order to evaluate whether such theory is actually a sound reflection of the relations between the variables modeled in practice. These empirical tests included: a survey of beachfront homeowners; an econometric analysis of 42 beachfront communities; and, a spatial housing price appreciation analysis over time in three selected Florida counties.

B. ECONOMIC THEORY OF SHORE PROTECTION AND INDUCED DEVELOPMENT

1. Model Specification. To address the broad questions of induced development, a general theoretical model was formulated of how shore protection might affect the location of private investment in coastal areas and at other alternative sites. This model is used to compare the pattern of economic development in coastal areas that would be observed with and without programs that lower expected economic losses from storms suffered by coastal property owners such as shore protection and the National Flood Insurance program. A complete description of this model is contained in the report referenced as footnote 1.

2. Induced Development. To explore the relation between shore protection and coastal economic development, it is necessary to develop a general model that allows one to examine not only how shore protection affects economic development at the beach being protected, but also at other beaches, and elsewhere in the economy. Such an economy-wide perspective is needed in order to properly analyze the two distinct potential sources of induced development, as defined below. The model is set up to explore the circumstances under which induced development may result from shore protection projects. However, theory cannot establish the magnitude of induced development. The tests presented later deal with the empirical question of measuring the magnitude of the possible induced development effects which are identified by this theory. However, it is important that these empirical tests be logically consistent with the theoretical model developed.

a. Relocated vs. Additional Development. Relocated development represents induced development that would have occurred in another beachfront area, but instead is shifted to the protected beach. Additional development consists of development that takes place when shore protection shifts development from nonbeach areas to the protected beach. The distinction is important. Additional development is a net increase in the total amount of beachfront development; relocated development shifts the location of development from one beachfront area to another, without affecting the total.

b. Induced Development Impacts. Development that is induced by shore protection can have rather different effects on subsequent flood and erosion hazard risks, as well as on environmental impacts, depending on whether the induced development is relocated development or additional development. Relocated development results in beachfront development becoming more concentrated in areas that are relatively well protected. Depending on the risk of storm damage elsewhere on the coast, such relocated development may actually reduce long run storm damage to beachfront areas. In contrast, additional development places more property in beachfront areas where storm and erosion hazards are greater than in the inland area.

C. SURVEY OF BEACHFRONT COMMUNITY RESIDENTS

1. Introduction. Economic theory indicates that induced development can occur at a protected beach when a Corps project lowers expectations of future storm damage problems. This suggests that the mere approval of an area for study or future protection could induce development if there is a perception of a Corps guarantee of reduced future damages. The principal results of a survey conducted in beachfront communities facing significant erosion problems are presented below. The survey was designed to answer a number of questions about the perceptions of homeowners in these areas. Do property owners perceive the danger of economic losses from storm damage? Are they aware of the role played by shore protection activities of the Corps in mitigating these losses? Do they perceive a Corps guarantee of reduced damages? How does the presence of an active Corps project influence their perceptions of the role of the Corps in providing protection? Do all homeowners have similar perceptions or are there differences based on their personal characteristics?

2. Survey. To answer these questions about resident perceptions, a survey was conducted in beachfront communities where erosion and/or flood damage threats were significant. The areas were selected to reflect a level of Corps activity from zero to substantial. The results allow some inferences to be drawn about whether residents are actually aware of storm and/or erosion hazards, as well as programs such as insurance, that spread the risk of loss from such hazards, and Corps shore protection projects that mitigate such risks. The most important inferences to be made concern the factors which cause homeowners to perceive the Corps as an actual or potential solution to problems

of erosion or flooding. Survey questions were designed to determine if the presence of Corps activity in an area is perceived as providing a guarantee, real or implicit, of reduced future damages. The perception that Corps activity provides a reduced risk could lower expected future damages in the fashion illustrated by the economic theory. If a Corps project in an area results in such perceptions, then it could encourage significant amounts of induced development. Conversely, failure of homeowners to view the presence of Corps projects as providing significant relief from erosion hazards would indicate that induced development affects associated with Corps projects could be negligible.

3. Bias. As is the case with all surveys, some caution must be exercised in interpreting the results. Survey respondents were necessarily told that the survey was being conducted by the Corps, which, almost inevitably, should have drawn attention to the agency. This Corps identification bias could have two effects on their answers. First, the knowledge that respondents were speaking to a representative of the Corps should make them more aware of the role of the Corps in shore protection. Second, some respondents could behave strategically and overstate their concerns about beach erosion in order to give the impression that Corps projects were needed. Surveying owners of beachfront property could also introduce selection bias because ownership of such property may reflect certain attitudes toward erosion and flooding hazards. Other things being equal, individuals purchasing and continuing to own beachfront real estate are likely to be less concerned about flooding and erosion than similar individuals who are not willing to purchase such property. Given that perceptions of risk vary, those who hold risky assets are likely to have lower estimates of the likelihood of loss than those who do not hold such assets. Finally, there is always a problem of response bias which arises because individuals most concerned with an issue are most likely to take the time to respond to a survey.

4. Area Surveyed. In order to elicit responses from property owners who had a range of experiences with Corps beach projects, the survey was administered in three different types of beachfront areas. One area was made up of adjacent beachfront communities in which problems of erosion had caused the Corps to become active in some, but not all, of the communities. The area selected includes southern Duval County, Florida (Jacksonville, Atlantic, and Neptune beaches) that had protection projects and northern St. Johns County (Ponte Vedra), where the Corps has not been active. The survey was also administered in an area where two adjacent beaches both have had Corps projects. This area is near Wilmington, North Carolina, and includes two beach areas, Carolina Beach and Wrightsville Beach. Finally, the survey was administered in an area with beaches that have no Corps projects. This third group of adjacent beaches was in New Jersey in the Manasquan area where erosion problems have recently received considerable attention. The Corps has not been active in these areas, but there are proposals for such activity. Thus, the sample was selected to elicit responses from property owners in beachfront areas with different ranges of Corps beach protection activities: an area of adjacent beachfront communities with Corps projects at each beach; an area of adjacent beachfront communities with Corps activity at some but not all beaches; and an area of

adjacent beachfront communities with no Corps projects at any beach. The specific areas selected for the survey were the first and second row of beachfront residential single family housing. Housing units were surveyed consecutively. No attempt was made to stratify the sample by type of housing unit or by demographic characteristics of the occupant. Instead, the sample was stratified in order to produce approximately equal numbers of observations from the three areas.

5. Administering the Survey. In order to minimize response bias, attempts were made to get a high response rate by making the cost of responding as low as possible. First, the questionnaire was administered by enumerators who went door-to-door along the first and second row of housing in beachfront areas. Second, the questionnaire was short, so that it could be administered in about ten minutes. Third, the questions did not require factual responses which would necessitate searching records. Lastly, individuals were given the option of filling out the questionnaire and mailing it in. The survey was limited to homeowners.

6. Questionnaire.

a. Design. The questionnaire was designed to elicit information on the characteristics of the property and the attitudes of the homeowner. Specific attitudes included: awareness of flood and erosion risk, importance of insurance, and perception of public sector efforts at protection. A copy of the questionnaire is included in Appendix F. Questions were adapted from those approved for use by the Office of Management and Budget, OMB 0710-0001.

b. Role for the Corps. Questions regarding the role of public agencies were designed for open-ended responses, and were placed at the end of the questionnaire in order to reduce the problem of Corps identification bias noted earlier. Three different approaches to this issue were taken. First, respondents were asked if the local beach was threatened and why they felt that the threat did or did not exist. The Corps could be mentioned either as a reason for lack of concern, or as a possible source of relief from the threat. This response indicates the perception of a general role for the Corps. Second, there was a question about the role of public agencies in which respondents were asked to record all names of agencies perceived to have taken actions to reduce any problems. This question asked about the specific role of the Corps. The third approach asked about activity of local agencies. Given that cost sharing is required for Corps projects, it is possible that individuals attribute Corps activities to local agencies. The response to this question allows determination of any indirect role for the Corps acting through local agencies.

7. Survey Results.

a. Response. A total of eighty-nine questionnaires were completed. The survey responses were divided almost equally between the Florida, North Carolina, and New Jersey beachfront areas. Beach erosion is a significant problem in these areas; 39 percent of the respondents had observed erosion damage to either their own property or nearby property. Furthermore, over 25 percent of the respondents felt that this erosion had a moderate or large effect on the sale price of their homes. The majority of households responding to the survey (over 70 percent) participated in the National Flood Insurance program. These results suggest high levels of concern with erosion and storm damage.

b. Awareness of the Corps. Awareness of Corps activity among beachfront property owners was remarkably low. In response to a question designed to reveal the general role of the Corps in relation to local storm damage or erosion problems, public agencies were not mentioned often, and the Corps was mentioned by less than 10 percent of the respondents. When responses regarding the specific role of the Corps were elicited, over 20 percent of the respondents mentioned the Corps, and it was clearly more important than other public agencies. However, a third question which was designed to determine an indirect role of the Corps resulted in a pattern of responses where the Corps was mentioned by only 10 percent of those surveyed. This level of recognition was higher than the rate at which specific local agencies were identified, but it is still quite low considering the fact that the Corps has long-standing projects in three of the six beach areas.

c. Interpretation. It is tempting to conclude from these summary statistics that the Corps is perceived as being more important than local agencies in dealing with storm damage or beach erosion problems. However, these results could be due to Corps identification bias which causes recollection of the Corps to crowd out other entities. Indeed, given the likely presence of Corps response bias, it is surprising that the rate at which the Corps is mentioned in response to separate questions on the general, specific, and indirect role is not higher. This suggests that the perceived connection between Corps activities and coastal flooding or beach erosion problems is not strong. It is evident that the Corps is not widely regarded as a solution to these problems.

8. Cross Tabulation.

a. General. Given the small sample size, some caution must be exercised in interpreting the responses. Nonetheless, some simple cross-tabulations allow the sample to be disaggregated so that the relations between household characteristics and perception of storm damage or beach erosion problems and the Corps can be examined. Years of residence is an obvious factor influencing such perceptions. Less obvious, but potentially important given requirements for Corps projects, is the influence of income. Because Corps projects require provision for public access, it is possible that more affluent, exclusive communities find them less attractive. Although the survey did not ask about income directly, number of bedrooms in the house provides a reasonable proxy variable for income and/or wealth.

b. Length of Ownership. There appears to be a relation between length of home ownership in years and the perceived threat of flood damage to real estate or erosion damage to the local beach. Overall, it appears that more recent owners are slightly more likely to feel threatened by flooding or erosion problems. As for the relation between length of home ownership and mention of a role for the Corps, the probability of mentioning the Corps in response to any of the three questions on its role, increases with time of ownership. This result is logical. As time passes, homeowners can observe Corps activity, and also observe the actual threat of storm damage and erosion. An interesting relation is that the more recent investors in beachfront property, who perceive the threat of erosion and storm damage stronger than those older residents, and who also have less knowledge of the Corps' risk-reducing activity, are those economic agents who are making the investment decision. They are making the decision to invest with a greater awareness of the threat, but without knowledge of the activity by the Corps.

9. Conclusions. Perhaps the most remarkable result is the finding that the presence of an active Corps project at the local beach is not associated with a greater likelihood that residents recognize a role for the Corps. It appears that the Corps has a very low profile indeed. The presence of a Corps project in an area does not raise perceptions that the Corps provides a possible solution to problems of coastal flooding or beach erosion. Furthermore, recent home buyers appear to be particularly unaware of Corps protection. These survey results are consistent with the hypothesis that the Corps has little effect on residential real estate development in beachfront communities. Even when the Corps is active in nourishing the beach, awareness of the Corps is not raised significantly. Longer term residents are more aware of the Corps, but these are not the residents who are responsible for induced development. It is possible that some relations among variables that are non-significant given the small sample size available for this study would be significant in a larger, more elaborate study.

10. Real Estate Perceptions. At the same time that the household survey described above was being conducted, an informal attempt was made to determine the perceptions of local real estate agents in the Duval County, Florida and Wrightsville, North Carolina areas, where Corps activity has been significant. Local real estate offices in these beachfront communities were visited and agents were asked about the effects of Corps activity on local real estate markets as well as the role of insurance cost in residential real estate development decisions. These interactions with real estate professionals produced a number of insights which appear consistent with the survey results. First, there was a general inability to recognize which areas were protected by Corps projects. Second, Corps protection was not regarded as an important factor influencing the pattern of real estate development. Third, flood insurance was regarded as a rather minor expense category which was not important in pricing real estate.

D. ECONOMETRIC MODELS OF BEACHFRONT DEVELOPMENT

1. Statistical Significance of Corps Actions. If induced development is a significant phenomenon, it should be possible to detect its effects on the economy of beachfront communities using standard local area econometric models. Application of standard econometric techniques allows direct testing for the statistical significance of Corps actions on the economy of a beachfront community ranging from approval of a project to periodic physical nourishment measured in tons of sand through dollars of expenditure for protection. Thus, it is possible to estimate the size and significance of any induced development effects. The statistical test implicitly holds constant the stimulus to local development provided by general growth of income and employment in the national economy. It is important to differentiate between beachfront development that occurs after a Corps project is built, but which is due to general economic growth of income and employment, and any induced development which took place because of Corps activity. The results of such tests are reported in this section.

2. Multiple Regression. The basic statistical technique used in this model is multiple regression analysis. The idea of regression analysis is to describe the relationship between two or more variables, so that if one knows the values of the independent variables, one can predict the value of the dependent variable. In this case, the independent variables are such things as the presence of a Corps project, the availability of National Flood Insurance, storms and their associated damages, and aggregate economic activity. The dependent variable is new residential building permits. Regression analysis shows which independent variables are related to the dependent variable (i.e., those that are statistically significant), and which ones have no significant relation to the dependent variable.

3. Communities. The 42 beachfront communities which constituted the sample used, were selected based on data availability and are listed in Table 6-1 with their associated Corps project, if any. The time period covered by the data includes 1960 to 1992, yielding 33 observations for each area. The sample includes communities where the Corps was active for the entire period, areas where the Corps had no authorization to act, and communities in which the Corps gained authorization during the 1960 to 1992 period. Within the sample of communities, it is possible to observe cases of development both before and after Corps projects as well as with and without Corps activity.

4. Data.

a. Development. New beachfront development is measured by the number of new housing units authorized by building permits during a given year. The building permit data includes units in both single family and multi-family structures. If there is substantial induced development it should be evident in the building permit data. These are annual data and are not subject to problems

Table 6-1 Induced Development Study Selected Communities

(Continued on Next Page)

Community	Corps Project	Project Status
Anna Maria, FL (Manatee County)	Manatee Co, FL	Constructed
Holmes Beach, FL (Manatee County)	Manatee Co, FL	Constructed
Bradenton, FL (Manatee County)	No project	
Longboat Key, FL (Manatee County)	No project	
Atlantic Beach, FL (Duval County)	Duval Co., FL	Constructed
Jacksonville Beach, FL (Duval Co)	Duval Co., FL	Constructed
Neptune Beach, FL (Duval County)	Duval Co, FL	Constructed
Bal Harbor, FL (Dade County)	Dade Co, FL	Constructed
Miami Beach, FL (Dade County)	Dade Co, FL	Constructed
North Miami Beach, FL (Dade Co)	Dade Co, FL	Constructed
Boca Raton, FL (Palm Beach Co)	Palm Beach Co, Boca Raton , FL	Constructed
Delray Beach, FL (Palm Beach Co)	Palm Beach Co, Delray Beach, FL	Constructed
Boynton Beach, FL (Palm Beach Co)	Palm Beach Co, FL - All segments from south Lake Worth Inlet to Boca Raton Inlet	Preconstruction Engineering Design
Riviera Beach, FL (Palm Beach Co)	Palm Beach Co, FL - all segments from south Lake Worth Inlet to Boca Raton Inlet	Preconstruction Engineering Design
West Palm Beach, FL (Palm Beach Co)	No Project	
Clearwater, FL (Pinellas Co)	Pinellas Co, FL - Clearwater Beach Island Segment	Authorized, awaiting funds
Naples, FL (Collier County)	No Project	
Daytona Beach, FL (Volusia County)	No Project	
Treasure Island, FL (Pinellas Co)	Pinellas Co, FL - Treasure Island Segment	Constructed
St. Petersburg, FL (Pinellas Co)	Pinellas Co, FL - Long Key Segment	Constructed
Indian Rocks Beach, FL (Pinellas Co)	Pinellas Co, FL - Sand Key Segment	Constructed
Cocoa Beach, FL (Brevard Co)	No project	
Melbourne Beach, FL (Brevard Co)	Brevard Co, FL- Indialantic/Melbourne segment	Constructed
Fernandina Beach, FL (Nassau Co)	Nassau Co, FL	Preconstruction Engineering Design
Vero Beach, FL (Indian River Co)	Indian River Co, FL - Vero Beach Segment	Preconstruction Engineering Design
Venice Beach, FL (Sarasota Co)	Sarasota Co, FL - Longboat Key and Venice Beach segments	Preconstruction Engineering Design
Ormond Beach, FL (Volusia Co)	Daytona Beach Shores, FL	Reconnaissance Study
New Smyrna Beach, FL (Volusia Co)	No project	
Panama City, FL	Panama City Beaches, FL	Preconstruction Engineering Design
Ocean City, MD	Ocean City, MD	Constructed
Long Beach Twp, NJ (Ocean Co)	No project	

Table 6-1 Induced Development Study Selected Communities (Continued)

Community	Corps Project	Project Status
Union Beach, NJ (Monmouth Co)	No project	
Ocean City, NJ (Cape May Co)	Great Egg Harbor Inlet and Peck Beach, NJ	Constructed
Sea Isle City, NJ (Cape May Co)	No project	
Long Beach, NY (Nassau Co)	Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, NY	Feasibility study
Southampton, NY (Suffolk Co)	No project	
Carolina Beach, NC (New Hanover Co)	Carolina Beach, NC	Constructed
Wrightsville Beach, NC (New Hanover Co)	Wrightsville Beach, NC	Constructed
Isle of Palms, SC (Charleston Co)	No project	
Myrtle Beach, SC (Horry Co)	Myrtle Beach, SC	Preconstruction Engineering Design
Virginia Beach, VA	Virginia Beach, VA	Constructed

of seasonal peaks that render use of other indicators of beachfront community development questionable.

b. Corps Activity. In order to detect any possible influence of Corps activity on beachfront communities, a variety of indicators of the Corps' presence were selected. The specific variables used include: **TSAND**, tons of sand used in beach nourishment each year; **TCOST**, total cost of nourishment in 1993 dollars each year; **YRAUTH**, a dummy variable equal to unity only in the year when the project was initially authorized and zero otherwise; **YRMOD**, a dummy variable equal to unity in any year in which the project authorization was modified and zero otherwise; and **ACTIVE**, a dummy variable equal to unity in any year when the Corps project was active in the community (beginning with the date of authorization) and zero in earlier years. Taken together these variables appear to reflect the various ways in which Corps activity could reduce expectations of future losses that could stimulate induced development as described by the theory.

c. National Flood Insurance. In addition to Corps activity, the second category of government policy variable which was tested for possible influence on beachfront development was the National Flood Insurance program. **NFI** is a dummy variable equal to unity in years when the community participated in the National Flood Insurance program and zero in earlier years. **FEMAP** is a dummy variable equal to unity in years when a completed flood insurance map was available and zero otherwise. Information necessary for coding these variables was taken directly from microfiche records supplied by the Federal Emergency Management Agency.

d. Demand. A third category of variables entering the model measure effects of changes in aggregate economic activity on development in the beachfront communities. These variables, **DINCOME** and **DEMPLOY** reflect the effects of general economic growth in the economy on beachfront community development.

e. Storms. It is also possible that storms could have a significant effect on development in beachfront areas. Storm damage could make the beachfront less attractive and lower beachfront development, or it could prompt a wave of rebuilding which would result in a significant number of new building permits. **STORM1** is an index, ranging from 1 to 5, of the strength of any hurricane force tropical storm which reached a landfall in the county in which the beachfront community is located in the year in question. It is set equal to zero for any year in which there was no landfall by a hurricane-strength storm in the county. **STORM2** is an index of storm damage to the beachfront area available only for areas with authorized Corps projects. It is set equal to zero for areas lacking Corps authorized projects. There is significant measurement error involved in the use of either of these storm damage indexes. **STORM1** ignores damage by storms which are not hurricanes and **STORM2** does not measure damage in areas lacking Corps activity.

f. Time. The estimating equations also include a time trend, **TIME**, and a series of zero-one dummy variables for the various states in which beachfront communities are located. State location dummy variables should be associated with differences in local economic activity, infrastructure development, taxes and subsidies, zoning and land development policy, etc. The constant term reflects the reference state, Virginia.

5. Estimation Results.

a. General. The analysis proceeds in a series of steps beginning with a very simple model that includes only variables reflecting Corps activity through a final model that includes all variables discussed above. The large model is the most appropriate because it includes the influence of growing income and employment in inland areas on the demand for beachfront housing. However, the simple models which include only Federal government policy variables are presented initially so that the interaction between the estimated coefficients of these models and variables reflecting economic growth may be observed. Two functional forms, linear and double-logarithmic, are tested. In the linear model, estimated coefficients reflect the relation between changes in the level of the independent variables and change in the level of new residential construction. In the log-linear model, estimated coefficients reflect the relation between percentage changes in the independent variables and the percentage change in new residential construction. The addition of an "L" as a prefix to the name of a variable indicates that it is the logarithm of the variable. [2] Estimation results are presented in Tables 6-2, 6-3, 6-4, and 6-5.

b. Corps Variables. First, and most important for this study, are the variables reflecting various aspects of Corps activity, including **TSAND, TCOST, YRAUTH, YRMOD,** and **ACTIVE**. Overall, these estimation results support the null hypothesis that, at the level of the entire beachfront community, the presence of a Corps project has little effect on new housing production. Thus, it appears that the effect of the projects analyzed in this sample on residential development is, at most, very small.

(1). Sand and Cost. It may appear that **TSAND** has a generally positive and significant effect on new housing while **TCOST** has a corresponding negative and significant effect. However, the estimated coefficients for these two variables should be considered together because a change in sand moved implies a change in project cost. Examination of their estimated coefficients in the double-log form in Tables 6-4 and 6-5 indicates that they are approximately equal in magnitude and opposite in sign. The implication of these results is that a one percent increase in tons of sand and a one percent rise in total cost leave new housing permits unchanged. If the price of sand is constant, then tons of sand and total cost should both change by a corresponding percentage and there would be no impact on building permits. The positive and significant estimated coefficient for **LTSAND** does not imply that projects which add more sand for nourishment purposes result in additional residential housing because such projects also result in greater cost. This interpretation is easily confirmed by running the same models with **LTCOST** removed and noting that the estimated coefficient of **LTSAND** is then non-significant.

(2). Authorization and Modification. Initial authorization of a project, **YRAUTH**, generally has a negative and sometimes significant relation to higher levels of development. Overall, there does not appear to be a consistent relation between **YRAUTH** and residential real estate activity in these communities. Effects of modifications in the nature of Corps activity, reflected in the estimated coefficient of **YRMOD**, appear to bear a negative and marginally significant relation to permits.

(3). Active. Finally, the general indicator of Corps activity, **ACTIVE**, is positively related to new housing in simple versions of the linear model (Tables 6-3 and 6-4). However, the estimated coefficient of **ACTIVE** is non-significant in all versions of the double-log model and the extended form of the linear model. Considering all the evidence, **ACTIVE** appears to have no significant relation to development.

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[2] In cases where a variable may take on a value of zero, the prefix "L" added to the variable name indicates the logarithm of one plus the variable so that the logarithmic transformation can be performed.

c. National Flood Insurance. For both the linear and double-log forms of the expanded model, the estimated coefficient of the National Flood Insurance program variable **NFI** is positive and significant. Furthermore, its magnitude indicates a large effect on development. The estimated coefficient of **FEMAP** is generally non-significant. These results indicate that initial approval of a community for the National Flood Insurance program had a significant positive effect on residential development, but that publication of the first flood maps had no effect. This result is plausible given that, between its initiation in 1968 and significant changes in 1974, the National Flood Insurance program had a significant subsidy component but publication of flood maps might acquaint residents with hazards and, hence, depress development.

d. Storm Damage. The estimated coefficients of the two storm variables, **STORM1** and **STORM2**, indicate that the second variable is most effective in reflecting short-term effects of serious storms. The estimated coefficient of **STORM2** is negative and significant in both the linear and double-log forms in Table 6-5. It is important to remember that the expected sign of these coefficients was in doubt because storm activity can have multiple effects on new residential construction. Major storms can depress activity by raising expectations for future losses. However, storm damage can also stimulate replacement construction and/or actual damage can be less than expected and hence, expectation of future losses can actually fall. This may explain why **STORM2**, which is a measure of actual storm damage, was more likely to have a negative and significant effect than **STORM1** which was simply a measure of storm intensity independent of damage done.

e. Demand. The variables reflecting the aggregate economy had the largest effect on beachfront community development. The indexes of proximity-weighted demand based on income and employment, specifically **DINCOME** and **DEMPLOY**, are positive, have estimated coefficients in Table 6-5 that are statistically significant, and large. It is apparent that residential development of beachfront communities is driven by a large economic growth effect from metropolitan areas east of the Mississippi River. In the double-log version of the new housing equation, the estimated coefficient of **LDINCOME** is 0.17 and the estimated coefficient of **LDEMPLOY** is 0.20. These estimated coefficients imply that a 10 percent rise in weighted real income in metropolitan areas in the east generates a 1.7 percent rise in new construction in beachfront communities. Similarly, a 10 percent rise in employment in these same metropolitan areas generates a 2.0 percent rise in new construction in the beachfront communities. This increase in construction occurs independent of Corps activity in the communities.

6. Robustness. Final indicators of the overall validity of an econometric model are the general test statistics measuring goodness of fit. For the extended models these statistics are quite satisfactory. Both the F-statistic and the coefficient of determination are quite large given a sample which pools time series data across a panel of areas and the fact that lagged values of the dependent variable are not used as arguments of the regression. The estimated equations appear to provide a satisfactory

description of the determinants of differences in new residential development across communities and over time.

7. Conclusion. The presence of a Corps project has little effect on new housing production. The econometric results presented here imply that general economic growth of inland communities is sufficient by itself to drive residential development of beachfront areas at a rapid pace. Many beachfront communities have experienced substantial residential development following approval and construction of Corps shore protection projects. However, this statistical analysis shows that such development is generated by growth of income and employment in inland areas and would have taken place without Corps projects. Indeed, high levels of development have occurred in areas where the Corps has never been active.

Table 6-2 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Only Corps Activity Variables

Linear Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
NEWHOUSE					389.7872
TSAND	.064498	.1292615	0.499	0.618	76.87049
TCOST	-.0130583	.014242	-0.917	0.359	708.5938
YRAUTH	33.30272	151.1374	0.220	0.826	.021645
YRMOD	-374.2743	235.9832	01.586	0.113	.008658
ACTIVE	237.3648*	45.44739	5.223	0.000	.466811
CONSTANT	285.7973*	30.45336	9.385	0.000	1
Number of obs = 1386		F(5, 1380) = 5.89		Prob > F = 0.0000	
R-square = 0.0209		Adj R-square = 0.0173		Root MSE = 810.83	

Double Log Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
LNEWHOUSE					4.842448
TSAND	.2762271*	.0681952	4.051	0.000	.5101688
TCOST	-.2011257*	.0496944	-4.047	0.000	.8241782
YRAUTH	-.1812183	.2982113	-0.608	0.543	.021645
YRMOD	-.9017528*	.4722832	-1.909	0.056	.008658
ACTIVE	.0118803	.0935026	0.127	0.899	.466811
CONSTANT	4.873473*	.0600881	81.106	0.000	1
Number of obs = 1386		F(5, 1578) = 4.94		Prob > F = 0.0002	
R-square = 0.0176		Adj R-square = 0.0140		Root MSE = 1.5999	

Table 6-3 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity and Flood Insurance Variables

Linear Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
NEWHOUSE					389.7872
TSAND	.0645506	.1294549	0.499	0.618	76.87049
TCOST	-.01307	.0143056	-0.914	0.361	708.5938
YRAUTH	33.53691	151.827	0.221	0.825	.021645
YRMOD	-374.4191	236.5784	-1.583	0.114	.008658
ACTIVE	237.1739*	47.0226	5.044	0.000	.466811
NFI	1.206754	92.16171	0.013	0.990	.6507937
FEMAP	-.4416711	88.91244	-0.005	0.996	.5829726
CONSTANT	285.3591*	39.83982	7.163	0.000	1
Number of obs = 1386		F(7, 1378) = 4.20		Prob > F = 0.0002	
R-square = 0.0209		Adj R-square = 0.0159		Root MSE = 811.42	

Double Log Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
LNEWHOUSE					4.842448
TSAND	.274452*	.068211	4.024	0.000	.5101688
TCOST	-.195534*	.0497962	-3.987	0.000	.8241782
YRAUTH	-.1578954	.2993581	-0.527	0.598	.021645
YRMOD	-.8961543*	.4729092	-1.895	0.058	.008658
ACTIVE	.0012721	.0960856	0.013	0.989	.466811
NFI	.2528726	.1818292	1.391	0.165	.6507937
FEMAP	-.2232901	.1755789	-1.272	0.204	.5829726
CONSTANT	4.842261*	.0785391	61.654	0.000	1
Number of obs = 1386		F(7, 1378) = 3.81		Prob > F = 0.0005	
R-square = 0.0190		Adj R-square = 0.0140		Root MSE = 1.5999	

* indicates that the estimated coefficient is statistically significant at the 90% level

Table 6-4 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity, Flood Insurance, Time Trend, and State Dummy Variables

Linear Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
NEWHOUSE					389.7872
TSAND	.1055238	.0973705	1.084	0.279	76.87049
TCOST	-.0182877*	.0107706	-1.698	0.090	708.5938
YRAUTH	-74.43573	109.4164	-0.680	0.496	.021645
YRMOD	-266.8399	170.2807	-1.567	0.117	.008658
ACTIVE	19.12682	38.10312	0.502	0.616	.466811
NFI	12.52976	80.80765	0.155	0.877	.6507937
FEMAP	67.85086	71.44683	0.950	0.342	.5829726
TIME	19.1825*	3.31666	-5.770	0.000	17
WEST FLA	-3612.837*	107.7954	-33.516	0.000	.2380952
EAST FLA	-3657.339*	109.7597	-33.321	0.000	.2142857
SOUTH FLA	-3333.314*	107.8389	-30.910	0.000	.2380952
NY	-3559.875*	128.6531	-27.670	0.000	.047619
NJ	-3721.507*	113.6619	-32.742	0.000	.1190476
MD	-3244.585*	146.4474	-22.155	0.000	.0238095
NC	-3832.483*	125.4388	-30.553	0.000	.047619
SC	-3682.554*	129.3887	-28.461	0.000	.047619
CONSTANT	3671.051*	117.4749	31.250	0.000	1
Number of obs = 1386		F(16, 1369) = 80.56		Prob > F = 0.0000	
R-square = 0.5003		Adj R-square = 0.4941		Root MSE = 581.80	

Double Log Model

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
LNEWHOUSE					4.842448
TSAND	.1285279*	.0631301	2.036	0.042	.5101688
TCOST	-.1672128*	.0463393	-3.608	0.000	.8241782
YRAUTH	-.3163906	.2731474	-1.158	0.247	.021645
YRMOD	-.9089958*	.4316965	-2.106	0.035	.008658
ACTIVE	-.108045	.0964888	-1.120	0.263	.466811
NFI	.3336622*	.1851197	1.802	0.072	.6507937
FEMAP	-.1475288	.1659869	-.889	0.374	.5829726
LTIME	-.0349289	.0849187	-0.411	0.681	2.577408
WEST FLA	-3.894016*	.2821614	-13.801	0.000	.2380952
EAST FLA	-3.759197*	.2838714	-13.243	0.000	.2142857
SOUTH FLA	-3.113222*	.2784612	-11.180	0.000	.2380952
NY	-3.386219*	.3318719	-10.203	0.000	.047619
NJ	-4.209176*	.297088	-14.168	0.000	.1190476
MD	-2.797112*	.3720411	-7.518	0.000	.0238095
NC	-4.546761*	.3166344	-14.360	0.000	.047619
SC	-3.896039*	.333137	-11.695	0.000	.047619
CONSTANT	8.54364*	.303013	28.196	0.000	1
Number of obs = 1386		F(16, 1369) = 20.82		Prob > F = 0.0000	
R-square = 0.1957		Adj R-square = 0.1863		Root MSE = 1.4534	

* indicates that the estimated coefficient is statistically significant at the 90% level

Table 6-5 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity, Flood Insurance, Demand, Storm Damage, Time Trend, and State Dummy Variables

(Continued on Next 3 Pages)

Linear Model with Demand Driven by Employment Growth

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
NEWHOUSE					389.7872
TSAND	.1225096	.099211	1.235	0.217	76.87049
TCOST	-.0225531*	.0109019	-2.069	0.039	708.5938
YRAUTH	-114.2679	109.7862	-1.041	0.298	.021645
YRMOD	-251.398	172.2112	-1.460	0.145	.008658
ACTIVE	48.50302	37.82735	1.282	0,200	.466811
NFI	203.0134*	70.91693	2.862	0.004	.6507937
FEMAP	73.49837	71.38072	1.030	0.303	.5829726
STORM1	29.37165	26.35208	1.115	0.265	.1544012
STORM2	-105.7905*	63.03167	-1.678	0.094	.0425685
DEMPLOY	.4030984*	.0766931	5.256	0.000	222.2303
TIME	-14.27453*	3.267929	-4.368	0.000	17
WEST FLA	-3106.667*	142.2071	-21.846	0.000	.2380952
EAST FLA	-3165.935*	140.8296	-22.481	0.000	.2142857
SOUTH FLA	-2863.473*	137.234	-20.866	0.000	.2380952
NY	-3034.494*	159.3036	-19.048	0.000	.047619
NJ	-3280.401*	138.6808	-23.654	0.000	.1190476
MD	-3492.877*	155.0659	-22.525	0.000	.0238095
NC	-3332.828*	154.6834	-21.546	0.000	.047619
SC	-3360.976*	140.4092	-23.937	0.000	.047619
CONSTANT	3393.263*	142.2125	23.861	0.000	1
Number of obs = 1386		F(19, 1366) = 72.69		Prob > F = 0.0000	
R-square = 0.5027		Adj R-square = 0.4958		Root MSE = 580.80	

* indicates that the estimated coefficient is statistically significant at the 90% level

Table 6-5 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity, Flood Insurance, Demand, Storm Damage, Time Trend, and State Dummy Variables (Continued)

Linear Model with Demand Driven by Income Growth					
Variable	**Coefficient**	**Std. Error**	**t**	**Prob > |t|**	**Mean**
NEWHOUSE					389.7872
TSAND	.1225096	.099211	1.235	0.217	76.87049
TCOST	-.0211474*	0.109008	-1.940	0.053	708.5938
YRAUTH	-121.6471	109.9249	-1.107	0.269	.021645
YRMOD	-249.1657	172.3571	-1.446	0.149	.008658
ACTIVE	54.27997	37.87795	1.433	0.152	.466811
NFI	216.6493*	70.99608	3.052	0.002	.6507937
FEMAP	70.44238	71.42768	0.986	0.324	.5829726
STORM1	25.34954	26.39739	0.960	0.337	.1544012
STORM2	-102.6592*	63.07374	-1.628	0.104	.0425685
DINCOME	1.119225*	.2229013	5.021	0.000	57.9235
TIME	-16.6985	3.369991	-4.955	0.000	17
WEST FLA	-3243.434*	128.5078	-25.239	0.000	.2380952
EAST FLA	-3292.983*	128.6837	-25.590	0.000	.2142857
SOUTH FLA	-2984.309*	125.8595	-23.711	0.000	.2380952
NY	-3184.086*	145.8203	-21.836	0.000	.047619
NJ	-3369.543*	131.2019	-25.682	0.000	.1190476
MD	-3291.247*	146.968	-22.394	0.000	.0238095
NC	-3525.06*	133.0391	-25.506	0.000	.047619
SC	-3492.335*	133.0391	-26.250	0.000	.047619
CONSTANT	3566.564*	125.0598	28.519	0.000	1
Number of obs = 1386		F(19, 1366) = 72.43		Prob > F = 0.0000	
R-square = 0.5019		Adj R-square = 0.4949		Root MSE = 581.30	

* indicates that the estimated coefficient is statistically significant at the 90% level

Table 6-5 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity, Flood Insurance, Demand, Storm Damage, Time Trend, and State Dummy Variables (Continued)

Double Log Model with Demand Driven by Employment Growth					
Variable	**Coefficient**	**Std. Error**	**t**	**Prob > |t|**	**Mean**
NEWHOUSE					4.842448
LTSAND	.1317549*	.0626096	2.104	0.036	.5101688
LTCOST	-.1662381*	.0459951	-3.614	0.000	.8241782
YRAUTH	-.3499372	.2719229	-1.287	0.198	0.21645
YRMOD	-.8012403*	.4320752	-1.854	0.064	.008658
ACTIVE	-.0706443	.0958217	-0.737	0.461	.466811
NFI	.313942*	.1835137	1.711	0.087	.6507937
FEMAP	-.1625444	.1644793	-0.988	0.323	.5829726
LSTORM1	.0670711	.0654757	1.024	0.306	.1544012
LSTORM2	-6.119795*	.2790012	-2.193	0.028	.0247323
LDEMPLOY	.1951873*	.0396918	4.918	0.000	4.487639
LTIME	-.0656433	.084936	-0.773	0.440	2.577408
WEST FLA	-3.234556*	.3015899	-10.516	0.000	.2380952
EAST FLA	-3.171374*	.3015899	-10.516	0.000	.2142857
SOUTH FLA	-2.576936*	.2933138	-8.786	0.000	.2380952
NY	-2.64167*	.3574655	-7.390	0.000	.047619
NJ	-3.6496*	.3122149	-11.689	0.000	.1190476
MD	-2.837016*	.3698573	-7.671	0.000	.0238095
NC	-3.933733*	.3355893	-11.752	0.000	.047619
SC	-3.406025*	.3421078	-9.956	0.000	.047619
CONSTANT	7.188815*	.3953833	18.182	0.000	1
Number of obs = 1386		F(19, 1366) = 19.45		Prob > F = 0.0000	
R-square = 0.2129		Adj R-square = 0.2020		Root MSE = 1.4393	

* indicates that the estimated coefficient is statistically significant at the 90% level

Table 6-5 Determinants of New Residential Building Permits in Beachfront Communities - Estimates Using Corps Activity, Flood Insurance, Demand, Storm Damage, Time Trend, and State Dummy Variables (Continued)

Double Log Model with Demand Driven by Income Growth					
Variable	**Coefficient**	**Std. Error**	**t**	**Prob > |t|**	**Mean**
NEWHOUSE					4.842448
LTSAND	.136205*	.0628502	2.167	0.030	.5101688
LTCOST	-.1685439*	.0462128	-3.647	0.000	.8241782
YRAUTH	-.3520084	.27299	-1.289	0.197	0.21645
YRMOD	-.7784236*	.4337647	-1.795	0.073	.008658
ACTIVE	-.0680478	.0964501	-0.706	0.481	.466811
NFI	.3200446*	.1842608	1.737	0.083	.6507937
FEMAP	-.222441	.1660494	-1.340	0.181	.5829726
LSTORM1	.0885788	.0852358	1.039	0.299	.120004
LSTORM2	-.6221634*	.2801718	-2.221	0.027	.0247323
LDINCOME	.1687254*	.0464011	3.636	0.000	3.150971
LTIME	-.0959131	.0872685	-1.099	0.272	2.577408
WEST FLA	-3.33039*	.3127567	-10.649	0.000	.2380952
EAST FLA	-3.25483*	.3077755	-10.575	0.000	.2142857
SOUTH FLA	-2.660056*	.2979054	-8.929	0.000	.2380952
NY	-2.884983*	.3519592	-8.197	0.000	.047619
NJ	-3.677426*	.3233194	-11.374	0.000	.1190476
MD	-2.778978*	.3709214	-7.492	0.000	.0238095
NC	-4.165021*	.3297802	-12.630	0.000	.047619
SC	-3.60674*	.3379658	-10.672	0.000	.047619
CONSTANT	7.734884*	.3601105	21.479	0.000	1
Number of obs = 1386		F(19, 1366) = 19.45		Prob > F = 0.0000	
R-square = 0.2068		Adj R-square = 0.1957		Root MSE = 1.4449	

* indicates that the estimated coefficient is statistically significant at the 90% level

E. ECONOMETRIC ANALYSIS OF BEACHFRONT HOUSING PRICES

1. House Price Analysis. The econometric model of beachfront community development presented previously allows a direct test of the hypothesis that shore protection projects generate induced development. However, it is also common to use indirect tests for the neighborhood effects of public projects. These indirect tests are based on spatial house price responses and, hence, require estimation of the spatial distribution of house prices (i.e., how house prices vary by location). The

statistical test then attempts to find a relation between proximity to the public project and changes in house prices.

2. Method. The first step in this testing effort is the estimation of spatial house price change indexes for three Florida counties in which the Corps has been active (Dade, Duval, and Pinellas). Then, tests are performed to determine if the differential between inland and beachfront house price changes is related to the level of shore protection activity. These tests should be even more sensitive measures of shore protection effects than the econometric modeling. First, it is possible to estimate price changes in the "first row" of residences. Second, price changes are more variable and immediate than changes in new construction. Even if coastal development regulations severely limit the ability to increase development along the beachfront and effectively prevent significant amounts of induced development, spatial house price index measures should still show the effects of shore protection on expected future losses. For a detailed description of the methodology for estimating the spatial house price change indexes utilized in this test, please refer to the report in footnote 1.

3. House Price Indices. Figures 6-1, 6-2, and 6-3 show the pattern of house price indexes for Dade, Duval, and Pinellas Counties, respectively, over the 1972 to 1991 period. All indexes have been normalized so that the inland price index in 1972 equals 1.0. Overall, the computed price indexes follow a similar pattern that agrees well with expectations. In all cases, the 1972 value of the index at the inland location is highest and the index for the beachfront is the lowest. Similarly, for all three counties, the rate of price appreciation for the beachfront area is highest, so that the price index is uniformly highest for the beachfront area by 1991.

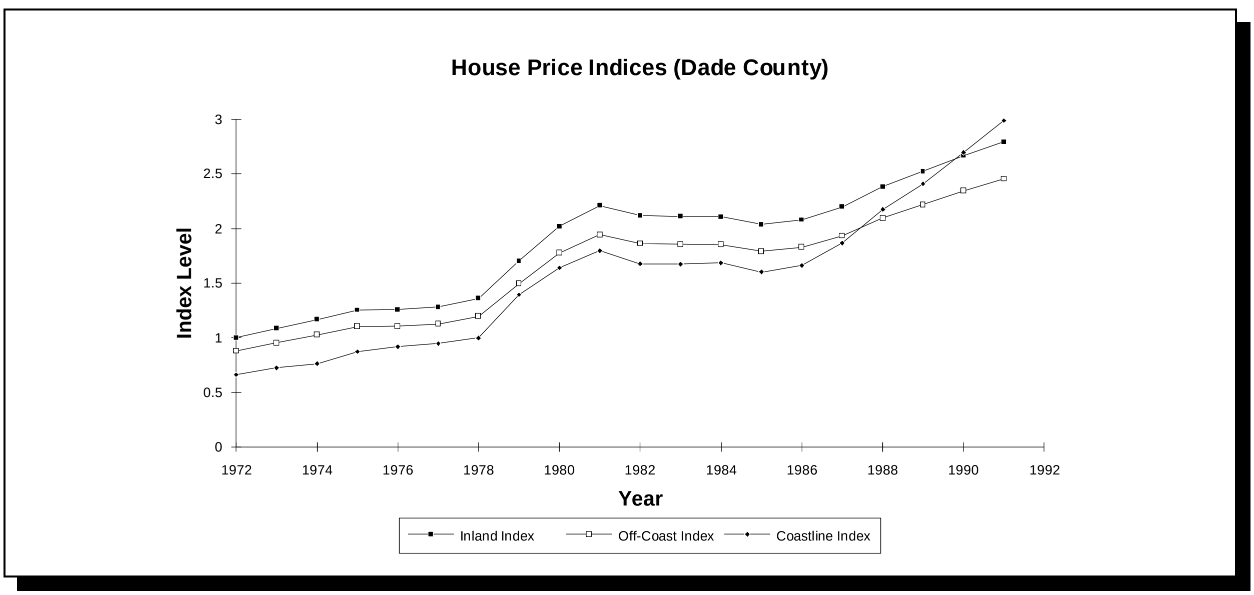

Figure 6-1 House Price Indices (Dade County)

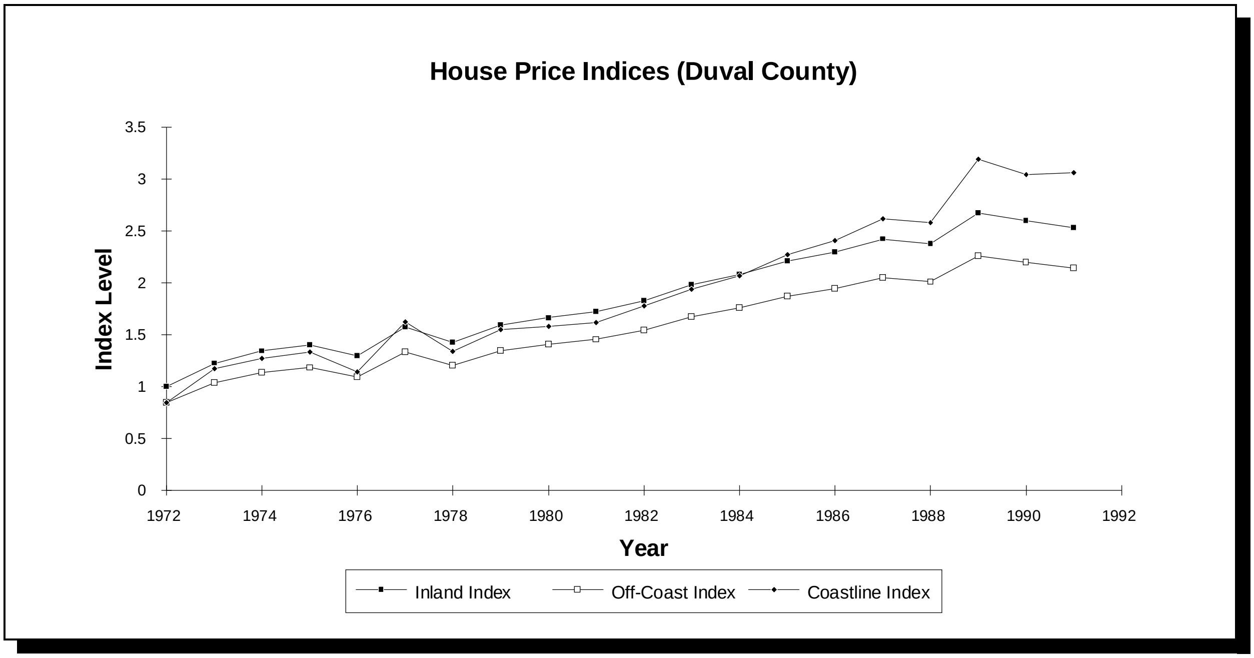

Figure 6-2 House Price Indices (Duval County)

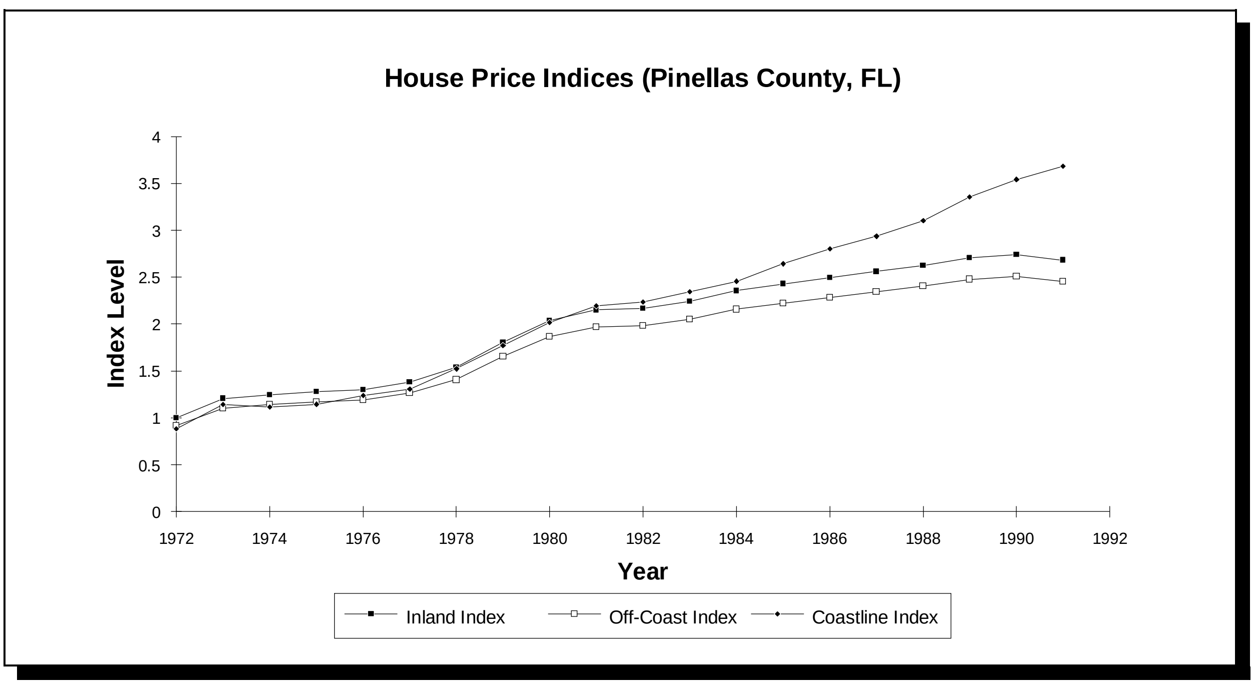

Figure 6-3 House Price Indices (Pinellas County)

4. House Price Appreciation. Figures 6-4, 6-5, and 6-6 display changes in the house price index at the three locations over the 1972 to 1990 period. The rate of appreciation in the price index for beachfront areas often differs significantly from that of either the off-coast or inland areas. There is a high variation in the rate of change in house prices over the period, including periods of very rapid appreciation and even some periods when prices fell slightly. It appears that the beachfront real estate market is subject to some influences that do not characterize either off-coast or inland areas.

5. Beachfront Investment. Given that, by the 1990's, the housing price index in all three counties is higher on the beachfront than inland, it is not surprising that these areas have significant rates of investment in beachfront real estate. Market prices are clearly directing development to beachfront areas of all three counties. The estimates reported here are an attempt to determine the extent to which more rapid rates of beachfront price appreciation are determined by Corps shoreline protection activities.

6. Corps Activity. The Corps has been authorized to act on the shorelines of all three counties since the 1960s. There was insufficient data to extend the repeat sale price index to that period. Hence, the estimates are designed to determine the effects of actual Corps activity rather than initial authorization. For all three counties, there was a significant gap between initial authorization and actual construction of the projects, so that the construction falls within the period covered by the house price index.

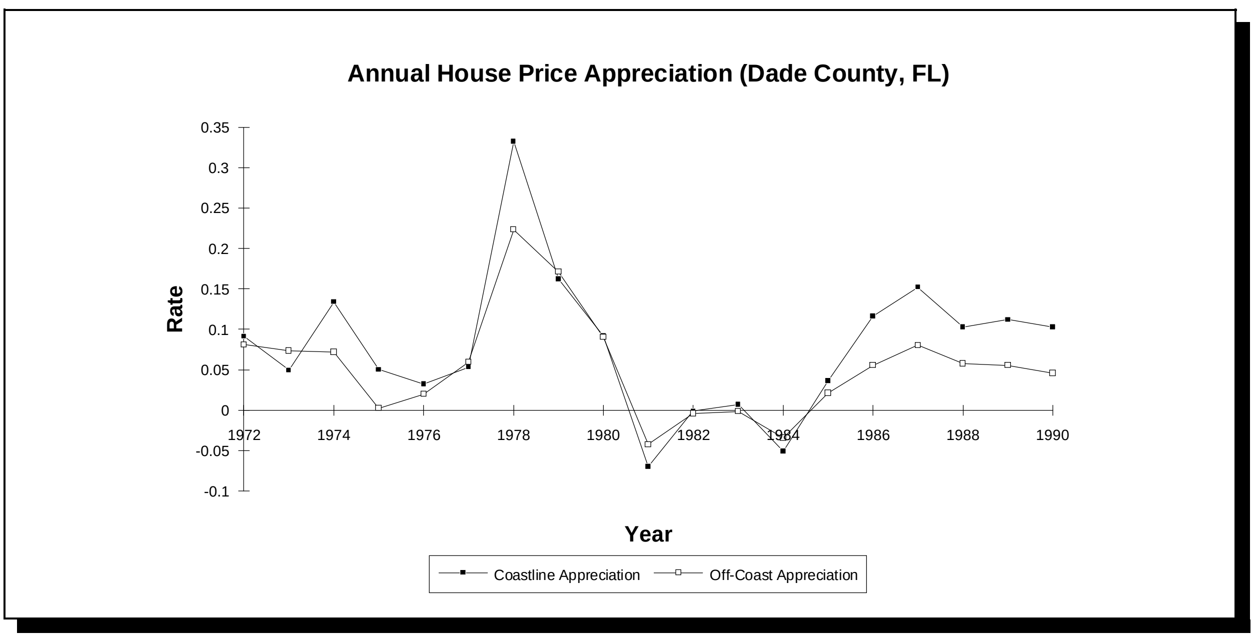

Figure 6-4 Annual House Price Appreciation (Dade County)

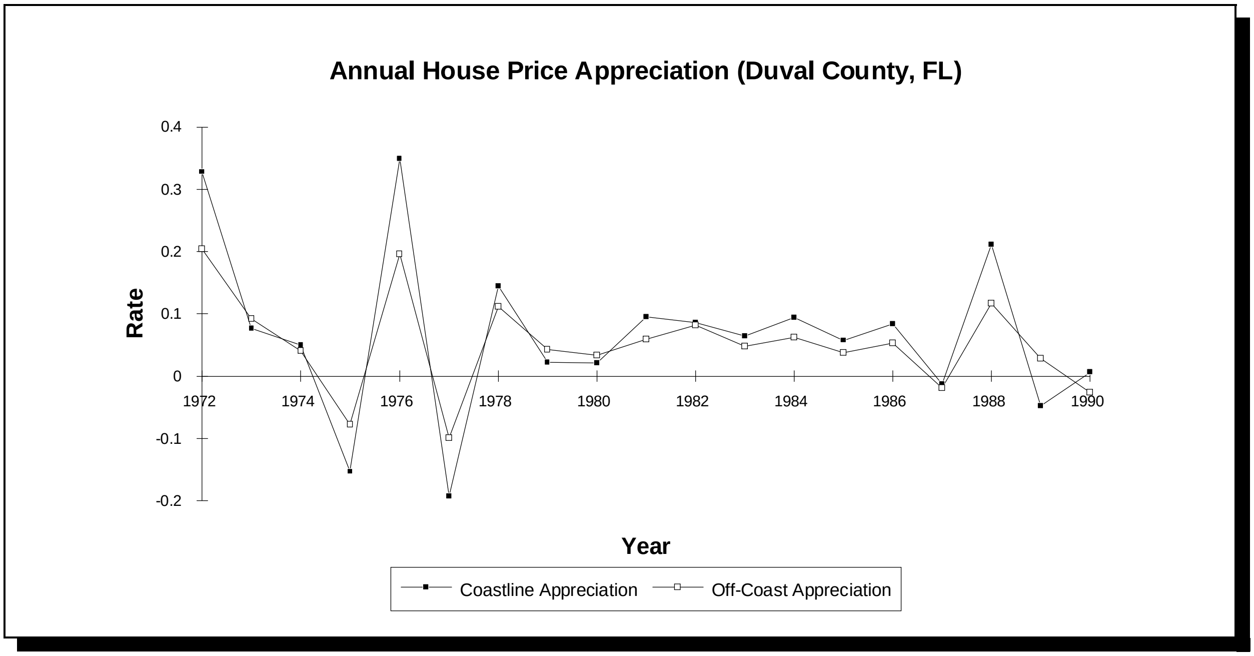

Figure 6- 5 Annual House Price Appreciation (Duval County)

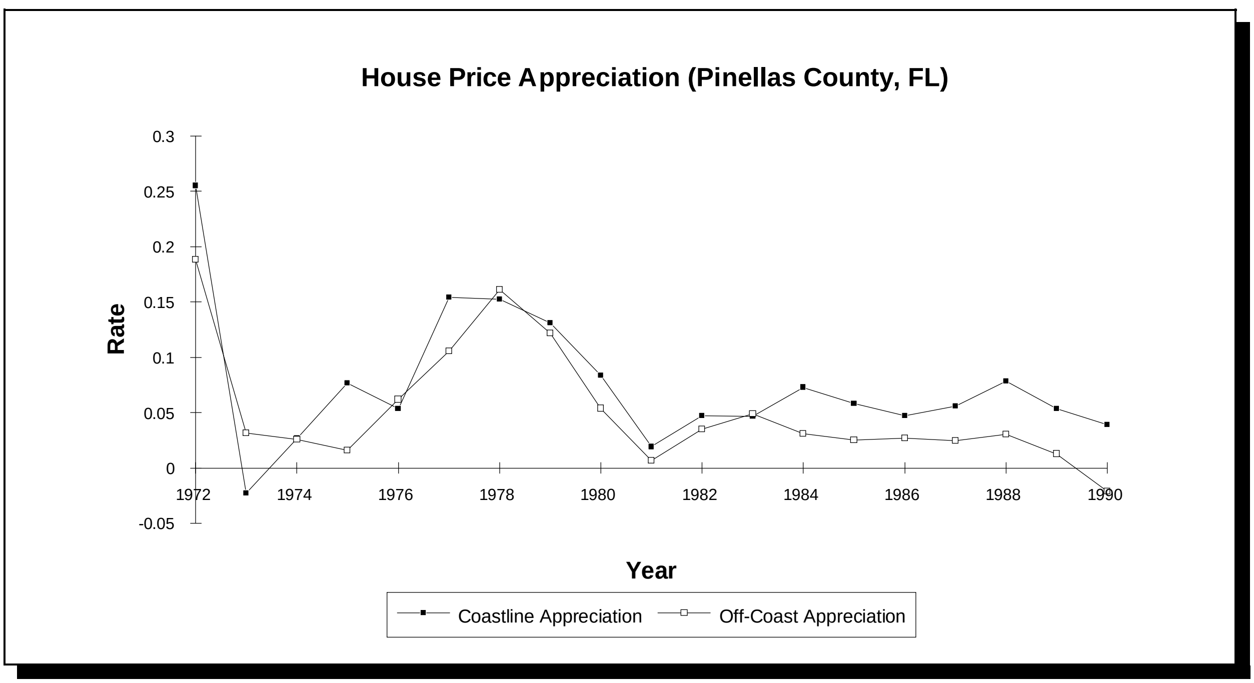

Figure 6- 6 House Price Appreciation (Pinellas County)

7. Statistical Analysis. The average annual beachfront appreciation rate was 12 percent, with a substantial standard deviation of 22 percent, including some years in which the rate of change in housing prices was as low as minus 19 percent. Table 6-6 presents estimation results for a series of equations in which Coast (the annual percentage change in estimated house prices at the shoreline) is the dependent variable. The first equation (Model 1) shows that beachfront appreciation is largely a function of inland appreciation. That is, changes on the coast reflect inland economic growth.

8. Results. Adding the two variables reflecting the presence and level of Corps activity, Active and Tcost, and the Storm variable indicating significant storms, adds essentially nothing to the predictive power of the model. These variables are added sequentially in a series of estimates reported in Models 3 through 5 in Table 6-6. While estimated coefficients Active and Tcost generally have the expected positive sign, they are always non-significant. Similarly, the estimated coefficient of Storm is negative and non-significant. Even if the estimated coefficients of all three variables were statistically significant, their combined effect on the rate of beachfront housing price appreciation would be modest compared to the average rate of appreciation of beachfront real estate. The failure to have a single hurricane strength storm hit any of the three counties during the 1971 to 1992 sample period limited the opportunity to observe effects of a major storm in the area. However, Corps activity on these beaches was not trivial during this period and yet there is no significant effect observable on the differential between price appreciation in inland and beachfront areas due to this activity.

9. Conclusion. The results presented here for beachfront housing price appreciation are consistent with the findings from the more general econometric model of real estate development in beachfront communities. The demand for beachfront development is growing at a greater rate than the demand for inland or off-coast development. The increasing demand for beachfront development can be directly related to the economic growth occurring in inland areas. There is no observable significant effect on the differential between price appreciation in inland and beachfront areas due to Corps activity. It could not demonstrate the Corps shore protection projects influence future shorefront development. Corps activity typically follows significant development.

Table 6 - 6 Determinants of Beachfront Housing Price Change (Continued)

Model 1: Effect of Inland Price

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
Coast					11.97733
Inland	1.011864*	.025829	39.176	0.000	9.853667
Constant	2.006762*	.6086612	3.297	0.002	1
Number of obs = 60	F(1, 58) = 1534.72		Prob > F = 0.0000		
R-square = 0.9636	Adj. R-square = 0.9630		Root MSE = 4.2827		

Model 2: Estimates Using Inland Price and County Variables

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
Coast					11.97733
Dade	.2002201	1.375675	0.146	0.885	.3333333
Duval	-.4220977	1.375686	-0.307	0.760	.3333333
Inland	1.011752*	.0262374	38.561	0.000	9.853667
Constant	2.081825*	1.006728	2.068	0.043	1
Number of obs = 60	F(3, 56) = 495.89		Prob > F = 0.0000		
R-square = 0.9637	Adj. R-square = 0.9618		Root MSE = 4.3502		

Model 3: Estimates Using Inland Price, County, and Corps Activity Variables

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
Coast					11.97733
Dade	-.2591782	1.472525	-0.176	0.861	.3333333
Duval	-.2263416	1.395904	-0.162	0.872	.3333333
Inland	1.06282*	.0270023	37.266	0.000	9.853667
Active	1.315599	1.484134	0.886	0.379	.2666667
Constant	1.872782*	1.035859	1.808	0.076	1
Number of obs = 60	F(4, 55) = 370.69		Prob > F = 0.0000		
R-square = 0.9642	Adj. R-square = 0.9616		Root MSE = 4.3586		

* - indicates that the estimated coefficient is statistically significant at the 90% confidence level.

Table 6 - 6 Determinants of Beachfront Housing Price Change

Model 4: Estimates Using Inland Price, County, Corps Activity and Corps Cost Variables

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
Coast					11.97733
Dade	-.3957683	1.552963	-0.255	0.800	.3333333
Duval	-.3089655	1.434234	-0.215	0.830	.3333333
Inland	1.008507*	.0282189	35.739	0.000	9.853667
Active	.912123	2.011203	0.454	0.562	.2666667
Tcost	.0000353	.0001176	0.300	0.765	3146.767
Constant	1.920372*	1.056488	1.818	0.075	1

Number of obs = 60 F(5, 54) = 291.66 Prob > F = 0.0000

R-square = 0.9643 Adj. R-square = 0.9610 Root MSE = 4.3951

Model 5: Estimates Using Inland Price, County, Storm, Corps Activity and Corps Cost Variables

Variable	Coefficient	Std. Error	t	Prob > |t|	Mean
Coast					11.97733
Dade	-.4603655	1.557026	-0.296	0.769	.3333333
Duval	-.4009376	1.440037	-0.278	0.782	.3333333
Inland	1.010759*	0.283721	35.625	0.000	9.853667
Active	.5306881	2.057417	0.258	0.797	.2666667
Tcost	.0000903	.0001324	0.682	0.498	3146.767
Storm	-2.341485	2.569889	-0.911	0.366	.0333333
Constant	1.957012*	1.058918	1.848	0.070	1

Number of obs = 60 F(6, 53) = 242.43 Prob > F = 0.0000

R-square = 0.9648 Adj. R-square = 0.9609 Root MSE = 4.402

* - indicates that the estimated coefficient is statistically significant at the 90% confidence level.

F. INDUCED DEVELOPMENT: FINDINGS

1. Types of Induced Development. Theoretical analysis indicates that shore protection projects have the potential to generate two distinct types of induced development: additional development that increases total beach development; and relocated development that moves development from unprotected beachfront areas to the newly protected area. Any conclusions regarding the effects of induced development on changes in expected future storm damage or beach environment requires separation of total induced development into these two components. If induced development relocated from alternative unprotected beachfront areas is significant, then development is likely moving from areas where expected damage is high to areas where it is low.

2. National Economic Development Procedures. Benefit/Cost procedures as currently described in the National Economic Development Procedures Manual: Coastal Storm Damage and Erosion (1991) provide appropriate guidance regarding the criteria for undertaking projects. Projects identified as having a benefit/cost ratio greater than one using these procedures should be considered for funding. No special or additional consideration of costs associated with possible future damage of induced development is appropriate as part of a proper benefit/cost analysis.

3. CBRA Restrictions. Induced development which may be relocated from other beachfront areas provides an opportunity to manage beachfront development. Current Coastal Barrier Resource Act restrictions on government actions reflect a concern about the location of development along the coastline. However, these restrictions do not prevent completely private beachfront development that excludes the general public. Federal shore protection projects offer a positive incentive to relocate development in ways that serve a public purpose, including preservation of the right of easy public access.

4. Empirical Findings. Empirical research on induced development in beachfront areas included a survey of residents and two types of econometric studies of beachfront development. These three empirical studies were undertaken simultaneously and independently. The overall findings of these efforts are remarkably consistent and can be presented as a single set of conclusions.

5. Determinants of Development. The primary determinant of development in beachfront communities is growth in demand based on rising income and employment in inland areas. Changes in inland economic activity dominate statistical models of changing numbers of building permits and residential real estate prices in beachfront areas. Areas receiving Corps project approval tend to be growing very fast, but that growth generally began before the project approval date. Indeed, prior development is needed to justify Corps activity.

a. Corps Activity.

(1). General. Various indicators of the presence and/or level of Corps activity in beachfront communities, including: tons of sand, total expenditure, initial authorization for a project, modification of the Corps agreement, and dates of Corps involvement, generally have no statistically significant relation to development in those areas. Thus, the statistical evidence indicates that the effect of the Corps on induced development is, at most, insignificant compared to the general forces of economic growth which are stimulating development in these areas.

(2). Survey. Residents of beachfront communities are generally not aware of Corps projects and are just as likely to mention the Corps as being a solution to storm damage and erosion problems in areas where the Corps is not active as they are in areas where the Corp is active. Length of residence appears to increase perception of erosion problems and of the Corps, but higher income owners are less likely to mention Corps intervention as a solution. Taken together, these findings suggest that Corps projects have little, if any induced development effects. It appears that Corps activity has little effect on the decisions of developers, homeowners, and housing investors. These results are supported by informal interviews with real estate agents which revealed that they are generally not aware of the locations of Corps projects. Furthermore, they regard payments for flood insurance as a minor consideration in making real estate development decisions.

(a). Why no Effect. There are many possible reasons for this lack of effect found in the formal empirical tests and informal surveys. It may be that recent buyers of real estate in beachfront communities are not aware of Corps activity or do not perceive it as an important factor in lowering the risk of flooding or erosion problems. Maybe they are not aware of the real risks of storm damages. Perhaps they believe that state and local governments will protect developed beach areas without Corps involvement. Or it may be that the attractions of the coast overshadow the possibility of future damages.

(b). Wealth. There is direct evidence that wealthy homeowners prefer local or private efforts at protection because of the requirements for public access that accompany Corps protection projects. Given that the subsidy component of the National Flood Insurance program has been essentially eliminated for recently constructed units, homeowners face insurance prices that signal the possibility of direct flood damage. Perhaps these payments are not large enough to have an important effect on development. There may be problems of inadequate information regarding risks of investing in beachfront real estate.

b. Non-Corps Public Projects. Aside from the fact that most people are unaware of Corps shore protection projects, one possible explanation for the finding of little or no impact of Corps projects on development is that other policies and activities, such as building highways, bridges, and sewer systems, are likely to have far larger induced development effects. Given that the amounts spent for these infrastructure projects are far larger than the Corps shore protection budget and the fact that they may impact upon relatively undeveloped areas, their effects on the spatial pattern of development may be large.

CHAPTER 7 - ENVIRONMENTAL CONSIDERATIONS FOR SHORE PROTECTION PROJECTS

A. FEDERAL INTEREST

1. Objective. The Federal objective in water resources planning, as stated in the P&G is to contribute to National Economic Development (NED) (see Chapter 3, Paragraph D) in order to alleviate problems and/or realize opportunities related to water and related land resources, consistent with protecting the Nation's environment. The P&G allows for the formulation of alternative plans which reduce net NED benefits in order to address other Federal, state, county and municipal concerns not fully addressed by the NED plan. The P&G states the NED plan is to be selected unless the Secretary of the Army grants an exception to selecting the NED plan when there are overriding reasons for selecting another plan. Such overriding reasons include Federal, state, tribal, county and municipal concerns, as well as the provision of significant environmental concerns.

2. Authorities. The Federal interest in environmental quality is supported in law, Executive Order, and treaty. For the U.S. Army Corps of Engineers (Corps) Civil Works program, the Federal interest in the quality of environmental resources is broadly supported by the legislation identified in Box 7-1. This legislation is in addition to the various flood control and water resource development acts which have become law over the years.

Box 7-1

Major Legislation that Supports Federal Interest in Environmental Considerations for Shore Protection Projects

- Fish and Wildlife Coordination Act of 1958, as amended (PL 85-264)
- Federal Water Project Recreation Act of 1965, as amended (PL 89-72
- National Historic Preservation Act of 1966, as amended (PL 89-655)
- National Environmental Policy Act of 1969 (NEPA) , as amended (PL 91-190)
- Water Pollution Control Act of 1972, as amended (PL 92-500)
- Ocean Dumping Act of 1972, as amended (PL 92-532)
- Coastal Zone Management Act of 1972, as amended (PL 92-583)
- Endangered Species Act of 1973, as amended (PL 93-205)
- Coastal Barrier Resources Act of 1982, as amended (PL 97-348)

3. Policies.

a. The planning, design, construction, and operation and maintenance activities of coastal shore protection projects must be consistent with the Administration's national environmental policies. Those policies require that such activities be done to the extent practicable in such a manner as to be in harmony with the human and natural environment, and to preserve historical and archaeological resources. Corps project development is documented by a series of studies, each being more specific than the previous study (see Chapter 3, Paragraph D). The series of reports produced for a project varies due to the unique conditions specific to each project. Environmental studies are included along with engineering, economic, and other types of analysis. In complying with Federal statues, executive orders and memoranda, Corps regulations require careful study of existing environmental conditions and those expected to occur in the future with and without shore protection.

b. A more specific environmental framework in which the Corps will pursue Civil Works water resources development was contained in memorandums from the Chief of Engineers dated 14 February 1990[1] and from the Assistant Secretary of the Army (Civil Works) dated 26 June 1990[2]. The philosophy contained in these memorandums will guide current and future changes in the environmental aspects of the Corps civil and military programs in support of the Administration's goal of maintaining and restoring the health of the environment. In this guidance, it is specified that Civil Works funds are to be used for justified (based on consideration of both monetary and non-monetary effects), cost shared proposals which restore to modern historic levels, environmental values in situations where (1) a Civil Works project has contributed to their degradation, or (2) where the restoration can be most cost effectively accomplished through modification of an existing Civil Works project. This commitment to restoration, which is made in light of Civil Works missions and capabilities, current obligations, and budgetary constraints, does not extend to improvements in environmental values beyond modern historic levels.

c. Examples of studies where the Corps is implementing this new philosophy are the regional coastal erosion and storm effects studies for the coasts of California and Florida. Past civil works projects are being examined with a view to modify them as needed to improve performance, reduce costs and restore the environment. Regional inventories are being made of environmental resources, which will allow multiple project impacts to be addressed and rectified as necessary.

4. Compliance with Federal Law. To the fullest extent possible, Environmental Quality (EQ) evaluation and its documentation should be conducted and prepared concurrently, and integrated with, the analyses and documentation required by other review, coordination, and consultation related to EQ evaluation, as described in the Council of Environmental Quality regulations. Such regulatory requirements include, but are not limited to, those Acts enumerated in Box 7-1 above.

B. ENVIRONMENTAL STUDIES

1. Study Factors. During each stage of project planning, design and construction, major environmental concerns and corresponding information needs should be identified. Forecasting of information needs is necessary in order to schedule sufficient time for field data collection, physical

or numerical modeling if needed, and other needs. Scheduling of field studies should allow for administrative time related to contract preparation, contractor selection, report and NEPA document preparation, review of findings, and coordination or consultation with concerned Federal agencies and interested public. Box 7-2 provides a checklist of some of the environmental factors that should be considered for coastal shore protection projects. Environmental factors selected for study will depend upon the type project being considered. This checklist is not all inclusive and not all factors are appropriate for all projects.

Box 7-2

Checklist of Environmental Factors

1. Determine the bounds of the project areas.
2. Characterize existing environmental (physical, ecological, cultural, economic) conditions at a project site and associated borrow areas.
3. Be aware of the other planned construction activities likely to be associated with the Federal project and evaluate their cumulative impacts.
4. Identify the future without-project environmental condition for the life of the project.
5. Evaluate project effects on long-shore sedimentation processes, circulation patterns, currents, and wave action.
6. Evaluate project effects on water quality, including characterization and testing of sediments as required in Section 103 of the Ocean Dumping Act (PL 92-532) or Section 404 of the Clean Water Act (PL92-500) evaluations.
7. Evaluate the no action alternative and nonstructural solutions.
8. Evaluate the project effects on erosion and deposition.
9. Evaluate all reasonable and practicable construction alternatives (construction equipment, timing, etc.).
10. Evaluate the effects of the final array of alternative plans on significant biological, aesthetic, cultural and recreational resources.
11. Describe relationships of each plan to the requirements of environmental laws, executive orders, Federal permits and state and local land use plans and laws.
12. Include feasible designs, operational procedures, and appropriate mitigation measures to reduce or avoid adverse environmental impacts in the preferred plan and alternatives evaluated.
13. Coordinated with other agencies, the public, and private groups.
14. Plan and design an environmental monitoring program as needed.

Time and money constraints and the magnitude of potential adverse impacts will generally dictate the level and scope of investigation and data collection for all environmental areas of interest. It is, therefore, essential that the issues investigated fully account for all significant effects of a project and that a realistic balance be achieved between the study requirements and available funds.

2. Environmental Resource Categories. There are five environmental resource categories that should be considered in evaluating the coastal shore protection alternatives. The five categories are physical, water quality, ecological, aesthetic, and cultural. These requirements apply equally to "borrow" areas as well as the "project" site.

a. Physical. The physical modifications of the environment from coastal shore protection projects can result in both desirable and undesirable impacts. Many adverse impacts can be avoided by evaluating alternatives for siting and design. Consideration of physical impacts must occur during both the design stage and impact assessment stage. Structural and, to a lesser extent, nonstructural measures have the potential of altering the hydrodynamic regime (circulation) and the hydraulic and wave energy conditions of the project area. Furthermore, construction frequently alters the shoreline configuration and/or bathymetry at the project site and occasionally up or down coast, by modifying the littoral transport system. In many instances, these modifications are the objective of the design process. Environmental impacts should be identified during the impact assessment stage and, if necessary, the project redesigned or relocated to minimize unwanted effects, such as excessive maintenance dredging and beach nourishment.

b. Water Quality. Unlike physical impacts, water quality impacts involve changes in the water column's characteristics rather than change in shoreline configuration or bathymetry. Again, these impacts are manifested on both a short-term and long-term basis. The construction process is often responsible for increases in local turbidity levels, changes in salinity, releases of toxicants or biostimulants from fill materials, introduction of petroleum products, and/or the reduction of dissolved oxygen levels. These construction impacts are short-lived, and ambient water quality conditions will rapidly return unless long-term changes in the hydrodynamics and hydraulics have occurred. It is these long-term impacts that must be identified during the design process. The long-term impact on water quality of nonstructural alternatives, i.e., planting beach grasses for dune stabilization, marsh grasses for bank stabilization and seagrasses for bottom sediment stabilization, is generally negligible, whereas structural alternatives have a range of potential impacts. The range is a function of the location, size, and type of structure.

c. Ecological. Nearshore marine and estuarine biological systems are diverse and complex. Shore protection projects may benefit one or more components of the biological system while adversely impacting others. Biological assessments of shore protection projects are used to predict the kind of ecosystem and importance, spatial extent, and severity of expected biological changes. In practice, analysis usually focuses upon species of commercial or recreational importance; rare, threatened, or endangered species; and sensitive or highly productive habitats. The construction of shore protection measures usually produces short-term physical and water quality disturbances. The perturbations directly impact biological communities and may result in long-term impacts. For example, some ecosystems damaged by construction or water quality degradation may recover slowly and take years to achieve preconstruction levels of development. Many of these impacts are unavoidable. However, construction activities can often be timed to avoid critical events such as turtle and shorebird nesting and fish or shellfish migrations. Construction activities also can often be located to avoid sensitive areas. The assessment of biological impacts must begin very early in the planning process. All shore protection projects result in some modification of coastal habitats. Beach nourishment results in smothered benthic communities, although the recovery of these communities following nourishment is reported to be generally rapid. Structures provide a permanent alteration of the bottom. In some cases, the tradeoff made in replacing mud or sand bottom habitat with rock or rubble mound structures bottom habitat has generally been viewed as a beneficial impact associated with coastal structures where diversity is desired. Such habitat modification is typically not a major biological impact issue except when highly productive habitats such as coral reefs, sea grass beds, and spawning and nesting areas are involved.

d. Aesthetic. Coastal shore protection projects affect aesthetic characteristics of the environment through changes caused by construction and maintenance activities, the presence of the coastal structures, and changes in public use patterns. Changes in public use patterns include the increased use of the coastal area for recreation or increased use of an area resulting from the protection afforded by the coastal structure. The aesthetic value of an environment is determined by the combination of landscape components, e.g., water resources, vegetation, and the perceptions and expectations for the resources user or visitor. Perceptions of aesthetic value encompass all of the perceptual stimuli in the environment.

e. Cultural. Cultural resources are the physical evidence of past and present habitation that can be used to reconstruct or preserve human history. This evidence consists of structures, sites, artifacts, and objects that may be studied to obtain relevant information. Cultural resources found in coastal shore protection project areas provide physical evidence of how the areas were used for commercial and game fishing, navigation, agriculture, and other activities during historic and prehistoric periods. Identification and interpretation of cultural resource sites clarify the relationship between present-day use and past use. Corps regulations require all actions involving unavoidable effects on Natural Register or eligible historic properties to be fully coordinated with the State Historic Preservation Officer and the Advisory Council on Historic Preservation.

C. PROTECTIVE BEACHES AND DUNES

1. General. Beaches and dunes form a natural system of shore protection for coastal lowlands and associated development. The sloping beach and berm are the outer line of defense in absorbing most wave energy; dunes are the last zone of defense in absorbing the energy of storm waves that overtop the berm. See Figure 7-1 for coastal area terminology. In the figure, the term “bluff or escarpment” also refers to the “dune line”. When the natural protection system provides inadequate protection from large storms, the first solutions frequently chosen are quasi-natural methods such as beach

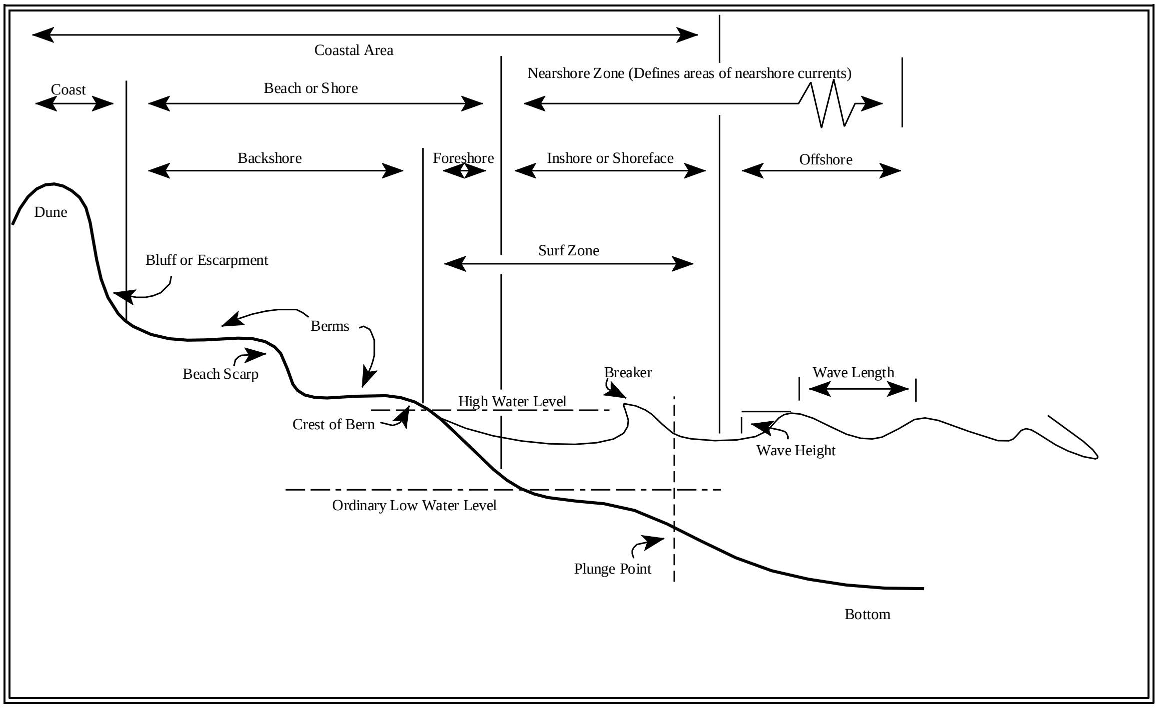

Figure 7-1 Coastal Area Terminology

restoration and nourishment or artificial sand-dune construction. Such solutions retain the beach as a very effective wave energy dissipater and the dune as a flexible last line of defense. Poorly conceived construction practices, involving removal of berms and sand dunes or changes in long shore transport, often aggravates shoreline erosion within and adjacent to the project area. Beach sediments on most beaches range from fine sands to cobbles. The size and character of sediments and the slope of the beach are related to the forces to which the beach is exposed and the type of material available on the coast. Generally, the larger the sand particles the steeper the slope. One of the most environmentally desirable and cost-effective shore protection alternatives is beach nourishment. However, as with any construction activity, environmental changes occur. These changes are equally applicable to both the project site and the borrow area selected for the beach fill material. Management techniques are implemented to minimize detrimental changes and to encourage beneficial changes. The next paragraphs present an overview of these environmental changes and management techniques.

2. Environmental Categories.

a. Habitats. From onshore (highest elevation) to offshore (lowest elevation), the beach habitats (zones) discussed in this chapter include dunes, berm, swash (intertidal), near shore subtidal, and offshore subtidal. A unique biological community is associated with each habitat. The sensitivity of these communities to environmental changes that may result from beach nourishment is dependent on the natural stability or instability of the substrata and the organisms' ability to cope with substrata changes.

b. Plants and Animals. The biological communities within each beach habitat are occupied by plants and animals that range from birds and beach mice in the dunes to corals and benthic invertebrates in the offshore subtidal waters. Beach organisms which have historically required special consideration are threatened and endangered species such as sea turtles, and environmentally sensitive habitats such as sea grass and coral beds.

c. Cultural Resources. Cultural resource investigations and coordination with State Historic Preservation Officers (SHPO) are conducted for shore protection studies in compliance with the National Historic Preservation Act of 1966, as amended, and the Archeological and Historic Preservation Act, as amended. Surveys are conducted to determine whether beach nourishment activities could have any indirect impacts on submerged cultural resources, particularly historic shipwreck sites. A combination of techniques are used to locate submerged cultural resources. These techniques include geomorphological analyses and literature research, interviews with local divers, and detailed reconstruction of the history of the shoreline. Side scan and magnetometer remote sensing surveys, and underwater archeological investigations may be undertaken to confirm resource locations. A terrestrial survey may be required if the borrow material will be obtained from an upland non-commercial source. All cultural resource field investigations are conducted by a marine survey archeologist who meets the education and experience requirements described in the Secretary of Interior's standards for Archeology and Historic Preservation. The report resulting from the fieldwork is coordinated with the SHPO. Cultural resource surveys can cost thousands for small scale studies to tens of thousands for larger, more extensive surveys.

3. Management Alternatives and Costs.

a. General. Environmental costs of beach nourishment projects can be identified as the cost of assessing the potential effects of a project; the cost to the biological community in terms of positive and negative changes in individuals, species, and habitats; the costs of project modifications to prevent a negative change or encourage a positive change; the cost of monitoring to verify predictions of a change; and, the cost of mitigation and enhancement.

b. Environmental Assessment Costs. Each beach nourishment project has costs for environmental assessments which document environmental change. Pre-project surveys may be required as part of the assessment process to determine if environmentally sensitive organisms may be put at risk. The surveys may include nest, plant, and animal counts and evaluations.

c. Biological Community Costs. While dollar values for certain habitats have been established for litigation purposes, the costs to the biological community in both the project site and the borrow area are difficult to establish. These biological community costs include: the loss or gain to society as a result of marine environmental change; the short-term or long-term loss or gain of individuals from burial; the short-term displacement of individuals from disturbance; the increase of one habitat type, the berm, which results in the shift seaward of the near shore subtidal; and the secondary effects of increased pedestrian traffic and disturbance.

d. Project Modification Costs. Costs of changes in project plans to accommodate environmental considerations may include; changes in material handling and placement, changes in timing of material placement (seasonal restrictions), equipment modifications, silt screen installation, and changes in the source of material (borrow site). These changes are made to avoid potential impacts to threatened and endangered species such as sea turtles and right whales.

e. Monitoring Costs. Before, during, and after construction, costs may be incurred for monitoring of changes in water quality, changes in reproduction (e.g. nesting, spawning, etc.) of beach animals, and changes in species and numbers of beach organisms.

f. Mitigation and Enhancement Costs. Costs may be incurred for relocating nests of birds or reptiles, replanting of vegetation, tilling of hard beach substrata, restoring of reefs, or other impact reduction and enhancement measures.

4. Environmental Change

a. Dune Stabilization and Beach Plants. Beach grasses have been planted after nourishment primarily for sand conservation, dune creation, and for aesthetics. Beach plants can be used to reduce or prevent wind erosion of beach sand. Stabilizing sand is particularly desirable where roadways or private property may be covered by blowing sand. Dunes can serve as a reservoir of sand to replenish the beach during wave erosion. Species most commonly used for sand stabilization are salt meadow sea grass, bitter panicum, American beachgrass, European beachgrass, and sea oats. Herbaceous plants are being added to the list of species planted to provide a greater habitat diversity.

b. Beach Hardness. Coincident with changes in grain size and shape in beach material, an increase in beach hardness can result from beach nourishment. Increase in fine material, binding together of particles, and the layering of flat-shaped grains may contribute to an increase in hardness. When sand is pumped onto a beach in a water slurry, maximum crowding together of sand grains can occur and a very dense, hard beach will be the result. Heavy equipment operation on the beach can cause compaction, particularly narrow-tracked vehicles which do not distribute the weight of the equipment as well as wider-tracked vehicles.

c. Sand Deposition in the Intertidal Area (Swash zone). The swash zone or intertidal area is the most dynamic area of the beach in terms of profile change and wave energy. It is constantly subjected to perturbations from waves and currents. Invertebrates and fish that occupy this zone may be buried or displaced by the nourishment sand. Sand deposition, disturbance from project activities, or substrata changes can cause animals to leave the area.

d. Placement of Equipment. Placement of equipment such as dredge anchors and pipelines can damage environmentally sensitive habitats such as coral reefs and sea grass beds. Damage to coastal reefs can be caused by dragging anchors or other equipment across the reef.

e. Change in Beach Sediment Composition. The beach sediments may be in equilibrium, eroding, or accreting due to the prevailing physical forces. When material is deposited on a high-energy beach, it modifies the beach sand/water interface and sand grain-size distribution, thereby increasing the turbidity of the adjacent near shore waters. The composition of sediment deposited on the beach is selected to closely match that of the natural beach sediments and to be low in pollutants, silts, and clays. High-energy coastal beaches are usually composed of coarse material that allows oxygenated water to penetrate the sediments, thus preventing the accumulation of sulfides and saturating the sediment pore space with oxygen. Waves and currents tend to winnow the finer sediments and to suspend them in the water column. In most cases, changes in water quality and turbidity in the near shore zone do not appear to be a major concern because the fine sediments that contain high levels of organic material and other constituents are rapidly transported offshore and sulfides are oxidized. However, high turbidities resulting from prolonged beach nourishment and/or erosion degradation of nourishment material may occur. Minimum damage to beach animals will occur when clean sand is placed on a sandy substratum. The damage may be great to beach animals if fine organic-rich sediments are used. When the particle size and composition is changed, upward and downward migration of animals within the sediment may be inhibited.

f. Sedimentation. Finer sediments are transported offshore and deposited in the deeper, calmer waters. In some cases, these sediments may smother near shore reefs and sea grass beds. Since benthic communities are substrata dependent, changes in the grain size of the bottom sediments may result in changes in the benthic communities. High sedimentation rates may affect larvae by delaying their final descent onto the bottom, thereby subjecting them to increased predation.

g. Burial and Removal of Bottom Dwelling Animals from Borrow Areas. Burial and removal of offshore benthic animals in borrow areas by nourishment projects has a potential for adverse impacts because subtidal organisms are not generally adapted to large or frequent perturbation.

h. Excavation and Burial of Cultural Resources. For shoreline stabilization and protection projects, cultural resources may be included in the existing beach, the near shore sand placement area, and the offshore sand borrow area. While the excavation of cultural resources at the borrow site poses the greatest potential risk, shifting or resettling of sand in the vicinity of the dredging activities and burial by sand placement also may occur.

5. Environmental Resources Potentially Affected

a. Dune Plants and Animals. Dunes and associated plants provide feeding, resting, and nesting habitat for birds and mammals. When herbaceous species are included with the beach grasses during planting, a much more diverse habitat for attracting wildlife is created. Additional consideration is given to threatened and endangered plants and animals that occupy the vegetated portion of the beach.

b. Sea Turtles. Nourishment can affect sea turtles directly by burying nests or by disturbing nesting females during their spring and summer nesting season. Nesting females may reject a nest site, select a less suitable nest site, abort eggs due to disturbance during construction by noise, lights, and equipment in their path or after construction by scarp formation. Indirectly, beach nourishment has the potential of affecting sea turtle nest site selection, clutch viability, and hatching emergence by altering the physical makeup of the beach. Sand grain size, grain shape, moisture content, color, temperature, and density of the sand may be altered. A hard beach will inhibit nest excavation by sea turtles and limit emergence of hatchlings. The optimum range of grain size for hatching success is medium to fine. Even though sand particle size for nesting sea turtles varies greatly from one nesting beach to another, if sands are too coarse, the nest collapses and the hatching turtles are unable to emerge to the surface. If sands are too fine, gas diffusion required for embryonic development is inhibited. A change in sand coloration may affect beach temperature which, in turn, can influence sea turtle nest site selection, incubation duration, sex ratio, and hatching emergence. Beach moisture content can influence hatching success of sea turtles. Beach moisture content can be affected by sand grain size, sand grain shape, beach pore space, and beach compaction and density. When eggs are relocated due to construction during the nesting season, nests may be missed and buried. When relocated nests are placed close together, they may be more susceptible to catastrophe, predation, altered sand temperatures thus hatching sex ratios, and inappropriate hatching release. Proper placement of relocated nests may provide them protection from storms, pedestrian traffic, and other threats. Increased beach width and elevation provides increased habitat for nesting turtles.

c. Shorebirds. Shorebirds can be disturbed from feeding, resting, and nesting directly by construction activities on the beach. Secondary effects may be the change in food availability from the sand deposition and the potential for increased disturbance from increased pedestrian traffic. Increased beach width provides increased habitat for nesting shorebirds.

d. Marine Bottom Communities. Marine bottom communities on most high-energy coastal beaches survive periodic changes related to natural erosion/accretion cycles and storms. Most animals that occupy this habitat are adapted to unstable bottom conditions. However, rapid burial of nonmotile forms with beach nourishment material can be lethal, whereas motile animals might escape injury. Improper design of offshore borrow areas can also cause entrapment of organisms, water quality problems, etc. Some infaunal bivalves and crustaceans can migrate vertically through more than 30 centimeters of sediment. Survival depends not only on the depth of deposited sediment, but also on length of burial time, season, particle-size distribution, and other habitat requirements of the animals. Following the initial burial and dredging of benthic animals, a short-term increase in diversity and number of opportunistic species may occur. These opportunistic species, which initially invade the disturbed area, are later replaced by resident species which tend to be larger, deeper sediment dwelling, and longer living. A similar response can also result from natural events such as storms and hurricanes. The recovery rate of pre-project resident species will vary from one site to another. The recovery time can vary from 5 weeks to 2 years. Recovery will depend on the species affected, the season in which nourishment occurs, and the recruitment of larvae into the area. The ability of most macrofauna to recover rapidly is due to (1) their short life cycles, (2) their high reproductive potential, and (3) the rapid recruitment of planktonic larvae and motile macrofauna from nearby unaffected areas.

e. Shoreline Rocks and Corals (Hard Bottoms). Hard bottoms in the swash zone are often ephemeral, exposed and reburied by seasonal storms. These hard surfaces may be occupied by sponges, soft corals and other members of a biological community which is unique to the intertidal environment. Because intertidal hard bottoms are easier to access and are occupied by organisms often considered aesthetically pleasing, the general public is generally more aware of their presence and express concern when hard bottoms are covered during beach nourishment.

f. Fish and Other Motile Animals. Turbidity may affect the migration and feeding of visually oriented adult and juvenile fishes and the recruitment of larval and juvenile animals to the beaches. Suspended solids in the water can affect fish populations by delaying the hatching time of fish eggs, killing the fish by abrading their gills, and reducing available oxygen. Fish tolerance to suspended solids varies from species to species and by age. Silt and sediment in the water may reduce light and the reduced light may prevent or postpone larval settlement. Motile animals generally leave an area of disturbance temporarily, but return when the disturbance ceases, usually in less than one year. Bottom-living (demersal) fishes, lobsters, crabs, and shrimp leave disturbed areas, but reappear within one day to four months after the disturbance. Motile animals which have stringent environmental requirements, i.e., a critical habitat requirement or food source, are most likely to be affected. In general, demersal fishes are more tolerant to suspended solids than filter-feeding fishes. The loss of a food source by burial with nourishment sediments may also have some effect on motile populations. However, there is evidence that nourishment benefits some fish by suspending food material. In contrast, high water turbidity may provide prey temporary protection from predators which would make them temporarily unavailable as a food resource. Offshore clam beds and fish spawning areas related to potential borrow sites are also a cause of special concern.

g. Seagrasses. Burial, uprooting, turbidity, and sedimentation as result of beach nourishment may damage coastal vegetation. Seagrasses are slow to recover when rhizomes are severed and plants are uprooted. Siltation and turbidity can cause suffocation and reduce photosynthetic activity in seagrasses.

h. Corals. Corals are sensitive to covering by fine sediments. The hard corals are more sensitive than soft corals because they are unable to cleanse themselves of heavy sediment loads and are easily smothered. The soft corals are better adapted for survival when covered by fine beach nourishment sediments. Coral damage as a result of beach nourishment is usually caused by elevated sedimentation rates and by direct physical damage to the reef. Sedimentation may inhibit the food-acquiring capability of the coral polyps and inhibit photosynthesis of symbiotic algae, eventually killing the coral. Coral reefs can withstand some sedimentation. The recovery time for corals is directly related to the extent of initial reef damage. A reef that is extensively broken or heavily covered with fine sediment may take a long time to recover or may never recover.

i. Offshore Subtidal Bottom Animals. Reductions in benthic species and abundance may occur in the borrow area following excavation. However, pre-dredging levels may return within days or months. The rate of recovery will depend on the species affected, the season in which nourishment occurs, and the recruitment of larvae into the area. Small, surface dwelling, short life cycle animals usually return to the area very quickly, while larger, deeper sediment dwelling, longer living organisms take much longer to recolonize an area.

j. Cultural Resources. The potential for submerged resources exists in the offshore borrow areas and the near shore zone, where sand is placed. Resources anticipated include abandoned vessel, historic shipwreck sites, and the remains of waterfront structures, such as piers and wharves, with their associated artifacts.

6. Management Techniques and Costs

a. Plant Beach Plants. The costs of planting beach plants includes the initial planting in addition to the replanting of damaged plants and pedestrian barriers.

b. Restrict Seasons for Construction. The potential for disturbance of spawning and nesting animals can be reduced by adjusting construction activities to the fall and winter season. The best time ecologically for beach nourishment and borrowing is usually during the winter when there would be minimal effect on the adult and developmental stages of most nearshore and beach animals.

During the winter months, adults have usually migrated out of the area and would be less concentrated in the shallow beach zone and the nesting and spawning season would be past. However, in the winter, increased wave and storm conditions can delay construction and create hazardous operating conditions for equipment.

c. Reduce Beach Hardness. The potential for beach hardness can be reduced by selecting coarse, round sand; by placing material in the intertidal area; by overfilling with more compatible material; and, by tilling hard material. Placement of material into the intertidal portion of the beach provides two benefits. First, the maximum amount of existing berm is preserved. Second, the material is sorted and reworked by wave action, which reduces compaction. When less desirable material must be used, a medium-coarse sand could be placed over the finer material. This would allow the surface of the beach to be more compatible to burrowing animals. The natural softening and reworking of the beach can be simulated by tilling of a hardened beach. Equipment that will till to a depth of 90-120 cm (36-48 in.) is recommended.

d. Avoid Nearshore Rocks and Corals. When hard bottoms (rock, coral) are present within the swash zone, these habitats can be protected by minimizing burial and siltation and mitigated by placing hard substrata offshore to be colonized.

e. Place Material Near Shore. Nourishment material should be placed as close to shore as possible to ensure the least harm to the more stable, but less resilient, offshore populations and to avoid environmental sensitive areas such as sea grass beds, clam beds, and coral reefs.

f. Reduce Silt. To minimize siltation and consequently potential anoxic conditions following beach nourishment, the percentage of fine sediment (less than 125 micrometers in size) should be kept to a minimum in the dredge material. Silt curtains can be used for containing silt sediments during construction; however, they are not effective for use in areas with high waves and for preventing long-term turbidity when silt is present in the material.

g. Selection and Placement of Equipment. A cutterhead is often used on the suction dredge. The action of the cutterhead agitates the substrata to a greater degree than a suction dredge without a cutterhead, creating a greater potential for elevated turbidity levels and increased sedimentation rates. A suction dredge with a cutterhead may be less desirable than a dredge without a cutterhead for use in the vicinity of live coral reefs or other light sensitive resources. Disturbance of beach animals such as shorebirds and sea turtles can be reduced by minimizing vehicle use on the beach, limiting lighting on the beach, reducing storage of pipe on the beach, and locating the pipeline parallel to the beach and as distant from the high tide line as possible.

h. Select Borrow Site Distant from Sensitive Habitats. The borrow site should be located as distant as possible and down drift from sensitive habitats such as hard corals, sea grass beds, and shellfish beds. However, the location of a site is often limited by the substantially increased costs with longer transport distances.

i. Avoid Cultural Resources. If potentially significant magnetic anomalies are identified in the proposed borrow or beach fill area, avoidance is the preferred alternative. Buffer zones are established to protect the potentially significant resources from dredging and construction activities. The size of the buffer zone is based on the recommendations of the archeological consultant, staff review, and consultation with the State Historic Preservation Officers. If avoidance is not possible, then further investigations, including diving and probing, are conducted by a qualified archeologist to determine the nature and significance of the anomalies.

j. Management Practices to Protect Both Property and Rare Species Habitat. Construction and maintenance of a beach and dune for protection of shoreline property attempts to create a wide gently sloping beach, high volume dunes, and stabilization of dunes with grass and fencing. Management of barrier beaches for protection of rare species habitat seeks to maintain natural process and achieve beach and dune profiles that are nearly opposite those recommended for shoreline property protection. These differences and a possible configuration for integrating management for protection of both property and rare species habitat is shown in Box 7-3 [3].

D. HARD STRUCTURES

1. Bulkheads, Seawalls and Revetments.

a. General. Where beaches and dunes protect shore developments, additional protective works may not be required. However, when natural forces do create erosion, storm waves may overtop the beach and damage backshore structures. Hard protective structures may then be constructed or relocated to provide protection. In general, measures designed to stabilize the shore attempt to either harden the shore to enhance resistance to wave action, prevent waves from reaching the shore, prevent waves from overtopping an area, or attempt to retard the longshore transport of littoral drift. Onshore structures, termed bulkheads, seawalls, and revetments, provide protection, based on their use and design, for the upper beach which fronts backshore development or erodible bluffs. Shorefront owners have resorted to shore armoring by wave-resistant walls of various types when justified by the economic or aesthetic value of the property to be protected.

b. Role in Shore Protection. Onshore structures slow the rate of change by protecting the shore from wave impact or by preventing overwash. Bulkheads are primarily soil-retaining structures which are designed to also resist wave attack. Seawalls are principally structures designed to resist wave attack, but also retain some soil to assist in resisting wave forces. For ocean-exposed locations, vertical bulkheads alone do not provide a long-term solution because of foreshore erosion,

Box 7-3

Beach Management to Protect Both Property and Rare Species Habitat

Beach and Dune Characteristics	Configuration to Protected Property [1]	Configuration to Protected Rare Species Habitat [1]	Possible Configuration for Integrated Management [1]
Beach width and shape	Wide and gently sloping	Wide and flat or gently sloping	Wide and mixed gentle to flat slope
Dune elevation	High	Low	Moderate
Dune Volume	Large (high volume)	Small	Moderate
Dune location and continuity	As far seaward from the high water line as possible	No dune; or, when present, inland and landward of shore	Inland, landward of high water line
Dune length	Long and continuous	Broken	Moderate length
Dune fencing	Constructed in long rows, parallel to beach	None present	Least amount of fencing that will achieve stabilization; fencing patterns that permit movement of birds across beach and dunes
Dune vegetation	Densely vegetated	Bare sand mixed with spares vegetation	Least amount of fencing that will achieve stabilization; fencing patterns that permit movement of bird across beach and dunes
Washover areas	Presence not desirable; install sand fencing and plant dune grasses immediately following overwash event [2]	Presence desirable; permit washover areas to persist	Washover areas permitted to persist in specified places and at specified times

Notes:
[1] Configurations are relative and must be designed according to site-specific needs.
[2] Some overwash may be desirable when considering long-term stability of a barrier beach; when sole interest is short-term property protection, sand fencing and grass plantings are recommended.

toe scour, and flanking. Seawalls have vertical, curved, stepped, or sloping faces. Although seawalls protect the upland, they often create a local problem. Downward forces of water, produced by waves striking the wall, can rapidly remove sand from in front of the wall. A stone apron is often necessary to prevent excessive scouring and undermining. A revetment armors the existing slope face of a dune or embankment. Because the sloping face of a quarrystone revetment is a good energy dissipater, revetments have a less adverse effect on the beach in front of them than a smooth-faced vertical bulkhead.

c. Physical Considerations. The littoral system at the site of a structure is always moving toward a state of dynamic equilibrium where the ability of waves, currents, and winds to move sediment is matched by the available supply of littoral materials. When there is a deficiency of material moving within a system, the tendency will be for erosion at some locations to supply the required material. Once a structure has been built along a shoreline, the land behind it will no longer be vulnerable to erosion, (assuming proper design of the structure), and the contribution of littoral material to the system will be diminished along the affected shoreline. Though the structure provides a measure of stability to a portion of the shoreline, it may indirectly increase the rate of erosion along other reaches of the shoreline. In addition, some structures such as bulkheads may cause increased wave refection and turbulence with a subsequent loss of fronting beach. Smooth, vertical structures will have the greatest impact on the beach and nearshore sediment loss.

d. Water Quality Considerations. The impacts of onshore structures on water quality result from increased suspended solids during construction and altered circulation patterns produced by the structure. Construction of onshore structures may require excavation, backfilling, pile driving, and material transport. These activities can result in suspended solid loads within the adjoining water body. Although these are generally short-term impacts, construction activities should be designed to minimize generation of suspended solids. Structures can influence water quality by altering circulation patterns. Modification in circulation can result in changes in the spatial distribution of water quality constituents, differences in the flushing rates of potential contaminants, and changes in the scour patterns and deposition of sediments. Environmental assessment of the effects on circulation should initially emphasize fundamental parameters such as salinity, temperature, and current velocity.

e. Biological Considerations.

(1). A wide variety of living resources is present in coastal shore protection project areas and includes species of commercial, recreational, and aesthetic importance. Because shore protection projects exist in arctic, temperate, and tropical climates, biological impacts will generally be highly site-specific and depend upon the nature and setting of the project.

(2). Short-term biological impacts are usually associated with the actual construction phase of the project. Nesting, resting, or feeding waterfowl, fish, and other wildlife may be disrupted. Projects should be timed, where possible, to avoid waterfowl and turtle nesting periods and fish spawning periods. Construction will also temporarily reduce water quality, generally by suspending sediments and generating turbidity. The environmental impacts on the benthic communities resulting from suspended solids in the water around shore protection construction are for the most part minor. Such impacts are particularly true in the surf zone on open coast beaches where rapid natural changes and disturbances are normal and where survival of the benthic community requires great adaptability. Temporary turbidity will also interfere with respiration and feeding, particularly of nonmotile bottom dwellers. Most motile organisms will avoid or flee the disturbed area.

(3). Long-term effects vary considerably, depending upon the location, design, and material used in the structures. In many locations, the placement of structures provides new habitat not available otherwise. The biological productivity of the area to be displaced is also important. Vertical structures in particular may accelerate erosion of the foreshore and create unsuitable habitat for many bottom species in front of the structure as the result of increased turbulence and scour from reflected wave energy. Bulkheads and revetments can reduce the area of the intertidal zone and eliminate the important beach or marsh habitat between the aquatic and upland environment. The result can be a loss of spawning, nesting, breeding, feeding, and nursery habitat for some species. On the other hand, rubble toe protection or a riprap revetment extending down into the water at a sloping angle will help dissipate wave energy and will provide hard-bottom habitat for many desirable species.

f. Aesthetic Considerations. The transition between land and water on a natural shoreline is either gradually sloping, consisting of a beach or marsh, or is sharply defined by a bank or scarp. Onshore structures are more similar to the latter in that they often represent an abrupt visual change. Bulkheads and revetments can sometimes be designed to blend in with the surrounding shoreline. For example, their natural appearance can be enhanced with the use of vegetation. The use of unusual construction materials such as junk cars, tires, or recycled construction debris would produce the greatest negative aesthetic impact. Because seawalls are frequently large concrete structures and are usually located in densely populated areas, particular attention should be paid to their visual impact.

g. Cultural Resource Considerations. By reducing erosion rates, onshore structures will generally preserve onsite cultural resources. However, this local protection can potentially increase the rate of erosion on adjacent shorelines. For this reason, cultural resources in the adjacent impact area must also be evaluated and projects designed so the erosion of adjacent areas is avoided.

2. Jetties and Breakwaters.

a. General. Jetties and breakwaters differ with respect to function. Jetties are structures built at the mouths of rivers, estuaries, or coastal inlets to stabilize the position and prevent or reduce shoaling of entrance channels. Jetty construction can result in stabilization of the location of an inlet on a barrier beach coastline. In contrast, the primary function of a breakwater is to protect a harbor, water basin, or shoreline from destructive wave forces. Breakwaters may also serve to create sediment traps in the nearshore zone. Since only breakwaters serve as a shoreline protection measure, the remainder of this paragraph will be limited to the environmental aspects of breakwaters. Breakwaters have both beneficial and detrimental effects on the shore. All breakwaters reduce or eliminate wave action in the lee (shadow). However, whether they are offshore, detached, or shore-connected structures, the reduction or elimination of wave action also reduces the longshore transport in the shadow.

b. Physical Considerations.

(1). Breakwater construction is invariably accompanied by localized changes in the hydrodynamic regime, creating new hydraulic and wave energy conditions. The initial disruption of the established dynamic equilibrium will be followed by a trend toward a new set of equilibrium conditions. Rapid dynamic alterations in the physical environment may occur in the short-term as the shore processes respond to the influence of the new structures. Slower, more gradual, and perhaps more subtle changes may occur over the long-term. By creating a wave-sheltered area, construction will result in changes in the erosional and depositional patterns along adjacent beaches, both inshore and offshore. A shore-connected breakwater will form a barrier to longshore transport if the structure extends seaward beyond the surf zone. The volume of sediment trapped by the structure represents material removed from the natural sand bypassing process. Consequently, the downdrift shoreline will be deprived of this sediment and become subject to erosion. Planning for adequate sand bypassing is a critical requirement of coastal structure construction.

(2). Accretion occurs along the updrift junction of shore-connected breakwaters and continues until longshore transport is deflected around the free end of the breakwater. Calm waters in the protected lee of the breakwater provide a depositional area which can rapidly shoal. Sediments trapped in the accretional area and terminal shoal are prevented from reaching downdrift beaches, and substantial erosion may result.

(3). Offshore breakwaters create depositional areas in their shadows by reflecting or dissipating wave energy. Reduction of wave energy impacting a shoreline in the lee of the structure retards the longshore transport of sediments out of the area and accretion ensues. The extent of accretion will depend on the existing balance of shore processes at a given project site.

c. Water Quality Considerations. During the construction of a breakwater, suspended sediment concentration may be elevated in the water immediately adjacent to the operations. In many cases, however, construction will be occurring in naturally turbid estuarine or coastal waters. Plants and animals residing in these environments are generally adapted to, and are very tolerant of, high suspended sediment concentrations. When construction is to occur in a clear water environment, such as in the vicinity of coral reefs or sea grass beds, precautions should be taken to minimize the amounts of resuspended sediments. Organisms in these environments are generally less tolerant of increased siltation rates, reduced levels of available light, and other effects of elevated suspended sediment concentrations.

d. Biological Considerations.

(1). Measurable amounts of bottom habitat are physically eradicated in the path of a fixed breakwater. Once a structure is in place, water currents and turbulence along its base can produce a scouring action, which continually shifts the bed material. Scour holes may develop, particularly at the ends of structures. Scouring action may effectively prevent the colonization and utilization of that habitat area by sediment-dwelling organisms. Effects of scouring are largely confined to narrow strips of bottom habitat immediately adjacent to the structure. Additional habitat losses may occur when significant erosion of downdrift shorelines impact spawning or nesting habitats of fishes, shorebirds, or other organisms and when the tidal range of a harbor or bay is modified by entrance channel modification which in turn affects coastal habitat. Short-term impacts of this type may also occur during construction activities as heavy equipment gains access to the project site.

(2). There will be losses of bottom habitat and associated bottom dwelling organisms due to physical eradication or scouring caused by the construction activity. These losses will gradually be replaced by the gain of new habitat represented by the structures themselves and the biological community, which becomes established thereon. Over the course of time, these structures develop diverse, productive, reef like communities. In some geographical areas breakwaters provide the only nearshore source of hard-bottom habitat. Also, exposed portions of detached structures may be colonized by seabirds. In essence, one environmental community is replaced by another.

e. Aesthetic Considerations. Detached breakwaters are usually far enough from the beach that they do not produce visual impacts. Shore-connected breakwaters will visually alter shore views. Their texture and shape in relation to the overall shoreline scene should be considered in design.

f. Cultural Considerations. By reducing shore erosion, breakwaters will, generally, preserve onsite cultural resources. However, this local protection can potentially increase the rate of erosion on adjacent shorelines. For this reason, cultural resources in the adjacent impact area must also be evaluated.

3. Groins.

a. General. Groins are barrier-type structures that extend from the backshore into the littoral zone. Although single groins are constructed on occasion, groins are generally constructed in series, referred to as a groin field or system, along the entire length of beach to be protected. Groins have been constructed in various configurations which are classified as high or low, long or short, permeable or impermeable, and fixed or adjustable. The prevailing wave climate at a project site is of paramount importance in the design of groins. The basic purpose of groins is to modify the longshore movement of sand and to either accumulate sand on the shore or retard sand losses. Trapping sand by a groin is done at the expense of the adjacent downdrift shore unless the groin or groin system is artificially filled with sand to its entrapment capacity from other sources. To reduce the potential for damage to property downdrift of a groin, some limitations must be imposed on the amount of sand permitted to be impounded on the updrift side.

b. Physical Considerations. The effects of groins on shore process are very similar to those discussed in reference to breakwaters. Groin construction will initially disturb the balance or equilibrium between physical processes at a given project site. With the passage of time, the system will tend to develop some new set of equilibrium conditions. By creating a barrier to littoral transport, groins cause changes in both shorelines and beach profiles. Entrapment of littoral drift results in the gradual buildup of a fillet on the updrift side of a groin. The fillet will grow until the volume of the available sediment sink reaches capacity and the rate of littoral drift is accommodated by encompassing or over passing of the structure. Accretion of the updrift beach also shifts the location of the breaker zone offshore. Downdrift shorelines, however, will be deprived of that volume of sand accreted updrift of the groin and become susceptible to erosion. Changes in beach profiles in response to groin construction can be substantial.

c. Water Quality. Groin construction may induce short-term episodes of elevated suspended concentrations in the water column. This impact will usually be limited to the water immediately adjacent to the structure. Concerns have been raised in connection with potential detrimental impacts of high suspended sediment loads on biological resources. However, the present state of knowledge on this topic allows an assessment that concentrations of suspended sediments found at groin construction projects pose minimal risk to lost flora and fauna. Because groins change local patterns of water circulation, some changes in water quality parameters may also be anticipated. Slight fluctuation in temperature, dissolved oxygen, and dissolved organics may occur in the sheltered waters in the lee of groins. These impacts should be insignificant for most groin project scenarios.

d. Biological Considerations. Habitat alterations, both losses and gains, associated with groin construction projects are analogous to those discussed for breakwater projects. Because groins are generally smaller structures by comparison, these habitat changes are usually on a smaller scale. Small groins have not been documented or implicated to have effects on the movements or migration patterns of fishes and shellfishes. Groins are very effective fish attractors and provide excellent sport fishing sites. These structures, particularly those of rubble-mound construction, may provide beneficial protective cover, as well as feeding and resting areas for both juvenile and adult fishes and shellfishes during coastal migrations.

e. Cultural Considerations. Groins can protect onsite cultural resources by reducing shore erosion. However, the downdrift erosion usually associated with groins can potentially threaten cultural resources in adjacent areas. For this reason, cultural resource losses in the adjacent impact areas must also be considered. Placement of groins should accommodate cultural resource protection in so far as practical, while accomplishing the primary purpose of the project.

4. Management Practices to Protect Both Property and Rare Species Habitat. Just as the creation of a beach and dune for property protection can create potential problems for the protection of rare species habitat (see paragraph C5), the construction of hard structures can also work at cross purposes to such habitat protection. Possible structural modifications to work more in harmony with rare species habitat is shown in Box 7-4 [3]. Critical information, however, is required before modified technologies can be recommended with confidence. Information needs to include monitoring data on effects of modified technologies, nonstructural as well as new and existing structural technologies, on property protection and rare species habitat. The rare species habitat for the study [3] is found in Massachusetts with habitat affected by barrier beach management techniques.

E. NONSTRUCTURAL ALTERNATIVES

1. Coastal-Estuarine Wetlands. Shore erosion is a common problem in the unique aquatic ecosystem composed of bays, sounds and estuaries of the coastal United States. These areas perform numerous valuable environmental functions which include the recycling of nutrients, purification of water, as well as providing habitat for wildlife and recreation for people. A wide variety of structures have been developed and used to control the erosion is this tidal area. However, due to environmental objections and economic limitations, it is often impractical to use even the most innovative of these structures. In fact, it many places it is becoming the practice to restore these wetlands which have been damaged by development. Perhaps the greatest success in at least restoring look-alike vegetation is with coastal and estuarine marshes. This success is due not only to the breadth of experience to date but also to the relative ease of determining appropriate elevations by using tide records and elevations and adjacent reference sites. However, the habitat value of restored coastal wetlands is not fully documented [4].

Box 7-4

Modification of Hard Structures to Protect Both Property and Rare Species Habitat

Structural Alternative	Effects of Management Technologies on Rare Species	Possible Modification to Protect Rare Species	Impacts of Modifications on Property Protection	Impacts of Modifications on Rare Species Habitat	Obstacles to Implementing Modified Technology
Seawalls	**Adverse:** may cause increased erosion and narrowing of adjacent beaches; may block access to feeding areas; physical presence may eliminate habitat	Relocate or remove seawall and replace with non-structural technology; elevate house or dwelling to be protected	May not protect property as much as original seawall	May provide more suitable habitat for rare species	Legal obstacles may not be present in Massachusetts; technological, economic, and social obstacles may be present; effects of modified practices need further study
Breakwaters	**Beneficial:** may create wider beach				
	Adverse: may destroy onshore habitat and increase down drift erosion and storm damage to adjacent property	Shorten and lower; use porous, floating structure; design intermittent or submerged structures	May not provide as much protection to shoreline during storm events	May provide more suitable habitat for rare species	Same as above
Groins	**Beneficial:** may widen beach				
	Adverse: may increase down drift erosion and storm damage to adjacent property	Build low and short; make porous	May not provide as much protection as higher, longer, and non-porous groin	May provide more suitable habitat for rare species	Same as above

2. Nonstructural Measures. Nonstructural measures to control shore erosion in coastal areas are normally provided by marsh plants and seagrasses.

a. Marsh Plants. Establishing marsh plants to abate shore erosion generally will be considered as an environmental improvement. Positive water quality, biological, and aesthetic stabilization is the least costly of all erosion control measures. Due to associated environmental benefits and low cost, this alternative should always be considered when shore protection is planned in sheltered bays and estuaries. However, this alternative is effective only within a limited range of wave climates and never on open, exposed coastlines, unless it is done in conjunction with energy-reducing structures.

b. Seagrasses. The establishment of sea grass meadows to aid in shore protection is recognized as a potential nonstructural alternative. Though sea grass meadows dampen waves as they approach the shore and capture sediments, sea grass plantings alone are seldom considered an adequate shore protection alternative. However, plantings can be a viable alternative when used in conjunction with other shore protection measurers. Seagrasses are almost always used in conjunction with protective beaches and dunes (see paragraph C). Sea grass planting can also be used for the repair or replacement of sea grass meadows that have been damaged or displaced by the construction of other erosion control alternatives.

F. CASE HISTORIES

1. Ocean City, Maryland. The environmental changes for the Atlantic Coast of Maryland Hurricane Protection Project were associated with dredging and placement of material from borrow areas, beach grass planting and dune construction, and constructing a steel pile bulkhead and were deemed to be minor, temporary, and localized. The dunes were to be planted with American beach grass and salt meadow cordgrass. To help alleviate noise impacts from bulkhead construction, a less noisy vibratory drive was recommended. The height of protective measures was limited to minimize adverse visual impacts. Visual assessment studies suggested that overall visual impacts would be improved. The borrow area was shifted from one location to avoid impacts to a wildlife refuge. Benthic studies of borrow sites suggested that the areas would be repopulated within a short period of time. The Ocean City project was under construction when a storm occurred. The heavy storms eroded the dunes and grasses from the beach. Any predicted environmental change resulting from project activities was completely overshadowed by waves and wind erosion resulting from the storms. The project was designed to absorb wave energy redistributing nourished sand and minimizing the loss of the pre-project beach.

2. Virginia Beach, Virginia. The environmental changes for Virginia Beach Erosion Control and Hurricane Protection were associated with dredging and placement of material from the borrow area, constructing a new seawall and raising and/or widening the existing sand dune. Assessment studies were conducted of selected beach invertebrates. These studies concluded that numbers of species or individuals of beach infauna would not be reduced by the project. While short-term adverse effects

were predicted from increased turbidity and from burial, no "far reaching" or long-lasting effects were anticipated.

3. Carolina Beach, North Carolina. The Final Environmental Impact Statement on the project was filed with the Environmental Protection Agency on July 17, 1981. The statement covered all aspects of the project including the use of Carolina Beach Inlet as a source of renourishment material. Subsequent Environmental Assessments and Findings of No Significant Impacts have been prepared and coordinated with appropriate resource agencies prior to each scheduled renourishment since 1981. The primary environmental constraint on the project is to exclude, whenever possible, renourishment operations during the period May 1 to November 15 in order to minimize impacts on juvenile fish in the surf zone and nesting sea turtles. If, for some reason, the renourishment operation extends into this period, a sea turtle nest monitoring and relocation program, which has been approved by the U.S. Fish and Wildlife Service, is to be implemented.

4. Tybee Island, Georgia. The primary environmental constraint on the project is to exclude renourishment operations from May 1 to October 31 in order to minimize impacts on juvenile fish and nesting sea turtles. If renourishment operations extend into this period, a sea turtle monitoring program has been developed for implementation.

5. Presque Isle, Pennsylvania. The environmental changes for the Presque Isle Peninsula Erosion Control Project were associated with the construction and maintenance of five sections of rubble mound, segmented breakwaters, and sand fill. Since a major objective of the project was protection of the peninsula, including portions of an ecological preserve, the project was considered "a mitigation project itself." The potential environmental benefits of the project were the preservation of recreational facilities, portions of an ecological preserve, and creation of hard bottom aquatic habitat. The potential detrimental environmental effects were reduced water quality from reduced circulation and aesthetic disruption by the rubble mound structures. Surveys and habitat mapping were incorporated into the project as part of the monitoring requirements. Since project construction, the area has maintained a "diversified group of habitats" with an associated unique fauna. The slower growth rate of new beach was noted as a potential concern since new beach is important habitat for Piping plovers, a Federally listed endangered species.

G. COASTAL ENVIRONMENTAL CONCERNS, STATE OF FLORIDA

1. Overview. The coastline of the State of Florida is an environmentally sensitive and diverse area. This approximately 1,020 mile long coastline is divided into three major areas. The east coast area from the Florida-Georgia state line to the Florida Keys, a distance of more than 500 miles, consists of a series of sandy barrier islands broken by inlets. The peninsular Gulf Coast region from Key West north to the Tampa-St. Petersburg area is 150 miles, and is also composed of offshore

barrier islands and includes the brackish zone between the Everglades and the Gulf of Mexico. The Panhandle Gulf Coast region extends from the Tampa-St. Petersburg area to the Alabama state line, 370 miles of shoreline, of which 190 miles is composed of sandy beaches backed by dune lines with heights ranging from 10 to 15 feet. Shown in Table 7-1 are the environmental concerns facing the Corps in any study and project undertaken along this 1020 mile shoreline. For example, of the total coastline, there are a total of 50.0 miles of authorized studies and projects where right whale habitat can be found. Of this distance, 29.5 miles are in areas authorized for studies, 6.1 miles in areas where projects have been authorized but not constructed and an additional 14.4 miles of constructed projects where the right whale was a concern during construction and where it will continue to be a concern during periodic nourishment cycles.

Table 7-1 Coastal Environmental Concerns, State of Florida

Environmental Concern	Study Length (miles)	Authorized but Not Constructed Length (miles)	Constructed Length (miles)	Total (miles)
1. Endangered Species	94.0	71.1	95.0	**260.1**
a. (Right Whale)	(29.5)	(6.1)	(14.4)	**(50.0)**
b. (Nesting Sea Turtles)	(94.0)	(71.1)	(95.0)	**(260.1)**
c. (Least Terns)	(0.0)	(0.0)	(0.0)	**(0.0)**
2. Tropical Reefs	0.0	58.2	34.0	**92.2**
3. Worm Reefs	17.8	65.6	39.7	**105.3**
4. Coral Reefs	0.0	1.3	18.6	**19.9**
5. Mangroves and/or Seagrasses	35.0	34.7	65.5	**135.2**
6. Cultural Resources	94.0	71.1	95.0	**260.1**

2. Historic, Cultural and Archeological Resources.

a. Many significant cultural resources are known to exist within the Coast of Florida Erosion and Storm Effects Study Area. Because the entire study area has not been subjected to a systematic survey, additional potentially significant resources may be identified. The types of cultural resources identified within the study area include: archeological resources located on the beach; underwater historic shipwrecks; and historic structures located near the shoreline.

b. Historic shipwreck sites have been identified all along Florida's coast line. The Treasure Coast, which includes Indian River, St. Lucie, and Martin Counties, is known for the large number of historic shipwreck sites discovered along the shoreline. Isolated artifacts have been relocated by dredging activities for a Federal beach nourishment project in Manatee County. A similar occurrence was reported during a Federally permitted beach nourishment project in Nassau County.

c. Significant historic structures and archeological sites have also been identified. Two examples are Fort Clinch in Nassau County and the Cape Florida Lighthouse in Dade County. Shore protection features will protect these structures and their associated archeological sites from damage or destruction due to shoreline erosion. Construction easements and upland staging areas for each of these projects have been planned to avoid adverse effects on significant archeological resources.

d. Although unidentified potentially significant cultural resources exist in the Coast of Florida study area, such resources are not likely to be located in areas that have been disturbed by previous construction activities. Areas where significant cultural resources are not anticipated include previously used borrow areas and maintenance dredged material from existing Federal projects.

3. Project Specific Examples. Several of the constructed Florida projects were examined to determine what specific environmental actions the Jacksonville District has undertaken during the construction and nourishment cycles. These projects and actions are discussed in the following paragraphs.

4. Duval County, Florida.

a. Environmental Impacts. An Environmental Impact Statement was coordinated and filed with the U.S. Environmental Protection Agency on June 4, 1974. The project was coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service under Section 7 of the Endangered Species Act in 1983 and 1989 with no unresolvable controversies. The Corps of Engineers has stipulated that before implementation of any nourishment segment of the Duval County Shore Protection Project, a supplement to the environmental impact statement would be published, documenting updated coordination in compliance with the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, the Clean Water Act and other applicable Federal and state statutes. Such documentation, and the record of updated coordination with concerned Federal and state agencies, will be made a part of implementing documents for the renourishments of the project.

b. Cultural Resources. In compliance with the National Historic Preservation Act of 1966, as amended, the project was reviewed for potential impacts to significant cultural resources and coordinated with the State Historic Preservation Officer (SHPO). It has been determined that placement of sand on the project areas will not affect cultural resources included in, or eligible for, inclusion in the National Register of Historic Places. A magnetometer survey was conducted for the borrow area. The SHPO concurred with the districts's determination that no significant cultural resources are likely to be present in the borrow area.

c. Endangered and Threatened Species. Sea turtles and right whales are endangered or threatened species that may be present in the project area. The Duval County shoreline provides nesting habitat for sea turtles. The Fish and Wildlife Service has issued a no jeopardy opinion under the Endangered Species Act provided that every effort be made to schedule dredging before May 30 and after October 5, or, if that is not possible, to follow the Service's reasonable and prudent measures to reduce incidental take. The Corps of Engineers agreed with these requests. The right whale is listed as an endangered species. The only known calving ground of the North Atlantic right whale is located off the coast of South Carolina, Georgia and Florida. The calving season for this species in northeastern Florida usually runs from December through the end on March. Critical habitat has been established for the right whale during the calving season. The critical habitat extends from the mouth of the Altamaha River in Georgia to Sebastian Inlet, Florida and out to 15 nautical miles off the Duval County coast. If dredging and beach nourishment occur during the calving season precautions will be taken to ensure that adverse impacts to right whales do not occur.

5. Broward County, Florida; Segment III.

a. Environmental Impacts. Environmental information on the project has been compiled and an Environmental Assessment has been prepared in conjunction with the Section 934 of WRDA 1986 Re-Evaluation Report. A Finding of No Significant Impact was signed by the District Engineer on April 30, 1991. Prior to all subsequent nourishments, water quality certification will be obtained from the Florida Department of Environmental Protection.

b. Cultural Resources. A review of the National Register of Historic Places indicates that no cultural resources listed on the Register are located in the project area. A cultural resources survey, including magnetometer and side-scan sonar, was performed in the project area in 1986. One magnetic anomaly was recorded during the survey and has been excluded from the present project boundary. In compliance with the National Historic Preservation Act of 1966, as amended, the Corps has determined that this undertaking will have no effect upon cultural resources listed on, or eligible for, listing on the National Register of Historic Places. By letter dated January 23, 1987, the Florida State Historic Preservation Officer has concurred with this determination. If the project area boundary is expanded to include known anomalies or previously unsurveyed areas, further cultural resources investigations will be conducted.

c. Endangered and Threatened Species. The Corps has determined that the project will not have any impact on threatened or endangered species under the jurisdiction of the National Marine

Fisheries Service (NMFS). In a letter dated February 6, 1990, NMFS concurred with that determination. The Corps of Engineers requested formal consultation with the U.S. Fish and Wildlife Service (FWS) concerning nesting sea turtles. In a biological opinion dated March 20, 1990, the FWS stated that the proposed action is not likely to jeopardize the continued existence of listed sea turtles, and included measures under incidental take requirements to minimize impacts to nesting sea turtles. These requirements include tilling the nourished beach if sand compaction exceeds 500 cone pentrometer units, and nest relocation procedures.

6. Palm Beach County, Florida; Delray Beach Segment.

a. Environmental Impacts. Environmental Impact Statements were filed with the U.S. Environmental Protection Agency on March 9, 1973 and on June 5, 1987. The project was coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service under Section 7 of the Endangered Species Act in 1973 and 1987 with no unresolvable controversies. The Corps has stipulated that before implementation of each part and segment of the Palm Beach County Project, a supplement to the environmental impact statement would be published, documenting updated coordination in compliance with the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, the Clean Water Act and other applicable Federal and state statutes. Such documentation, and the record of updated coordination with concerned Federal and state agencies, will be made a part of implementing documents for Delray Beach and any other segment of the Palm Beach County Shore Protection Project.

b. Cultural Resources. Bathymetric, seismic and side-scan sonar surveys, vibracores and jet probes, and a magnetometer survey were performed in the proposed borrow area. The magnetometer survey was conducted in October 1987 to identify possible cultural resources. Sixteen anomalies were recorded within the primary borrow area. The Division of Historical Resources of the Florida Department of State concluded in July 1988 that the proposed project will have no adverse effect on any sites listed, or potentially eligible for listing, in the National Register of Historic Places, or otherwise of national, state, or local significance. This is conditioned upon establishment of a 200 foot buffer area around anomalies in the borrow area.

c. Endangered and Threatened Species. Delray Beach, along with other portions of the Palm Beach County shoreline, provides nesting habitat for sea turtles, an endangered species. The Fish and Wildlife Service has issued a no jeopardy opinion under the Endangered Species Act provided that every effort be made to exclude nourishment activities between May 15 and October 15 and that the Service's reasonable and prudent measures to reduce incidental take are followed. The Corps has complied with these requirements.

7. Manatee County, Florida.

a. Environmental Impacts. A Final Environmental Impact Statement was filed with the Environmental Protection Agency in November 1991. State water quality certification was received in November 1991.

b. Cultural Resources. A magnetometer survey of the borrow area identified several possible cultural resources. In cooperation with the State Historic Preservation Office (SHPO), two buffer zones 1,000 feet in diameter were developed to protect known historic shipwrecks. In spite of the buffer zones, several hundred Spanish Galleon era coins were dredged up and found in the beach fill material. The dredge was operating outside of the buffer zones. The site of the coins was apparently one of the scattered magnetometer anomalies, and cultural resources were not expected to be found there. After further consultation with the SHPO, work was allowed to continue.

c. Hardgrounds. Based on side-scan sonar mapping and site inspections, approximately 37.8 acres of nearshore and offshore hardground habitat exists within or adjacent to the project footprint and borrow area. Project construction buried approximately 6.6 acres of one to three feet of low relief nearshore habitat. Impacts to hardgrounds in the borrow area were avoided by establishing buffer zones around the hardgrounds. After consultation with the Fish and Wildlife Service, 4.6 acres of nearshore moderate relief (three to five feet) habitat would be constructed as mitigation for the buried hardgrounds. The hardground habitat was constructed by Manatee County as in-kind credit toward the county's cash contribution. The mitigation constructed by the county consisted of 79 separate piles of concrete rubble placed in water depths ranging from 18 to 20 feet. The piles have a general bottom surface area 50 by 50 feet, and five to ten feet of vertical relief. The county received $736,000 in-kind credit, or $161,400 per acre.

d. Bait Fish. The borrow area constitutes one of two prime fishing grounds for the bait fish industry in Florida's Gulf of Mexico waters. Several bait fish industry groups, as well as the Environmental Protection Agency, the Fish and Wildlife Service, and the Gulf of Mexico Fishery Management Council requested that the extent of the offshore borrow area be reduced. This would minimize disruption of the natural bottom, as borrow area depressions would make purse seine nets much less effective in catching bait fish. The offshore borrow site contained over 5.4 million cubic yards of sand. The offshore borrow area was reduced in length from 20,000 feet to 17,000 feet in order to avoid bait fish impacts at the northern end of the borrow area. The borrow area was then further reduced to 15,000 feet to avoid magnetometer anomalies and hardground areas. The available borrow area quantities, therefore, were reduced from 5.4 to 4 million cubic yards of sand.

e. Endangered and Threatened Species. Without the project, less than five acres of suitable beach for sea turtle nesting was available. With the project, 78 acres of sea turtle nesting habitat was created. Adverse impacts on turtle nests were avoided since project construction was completed prior to April 1, 1993.

8. Pinellas County, Florida; Sand Key Segment.

a. Environmental Impacts. A Final Environmental Impact Statement was coordinated and filed with the U.S. Environmental Protection Agency on May 25, 1984. State water quality certifications were obtained prior to each construction operation.

b. Cultural Resources. In compliance with the National Historic Preservation Act of 1966, as amended, each segment of the Pinellas County Beach Erosion Control project was reviewed for potential impacts to significant cultural resources and coordinated with the State Historic Preservation Officer (SHPO). It has been determined that placement of sand on the project areas will not affect cultural resources included, or eligible for inclusion, in the National Register of Historic Places. A magnetometer survey was conducted for the Egmont Shoal borrow area. The SHPO concurred with the Corps determination that 500-foot radius buffer zones should be established around each of the 38 potential significant anomalies.

c. Endangered and Threatened Species. Coordination with the U.S. National Marine Fisheries revealed no significant concerns. Precautionary measures were implemented during project construction to prevent boat collision and propeller laceration injuries to manatees. All project construction contracts were specifically conditioned by the Corps to hold the contractor responsible for daily dawn patrols of the entire beach work area for the purpose of locating, taking and incubating turtle eggs and for the release of turtle hatchlings in accordance with the Florida Department of Natural Resources permit. The project beaches provide feeding areas for aquatic animals and birds and provide potential places for sea turtles to make their nests.

H. SUMMARY

1. Environmental and Biological Changes of Beach Nourishment. One of the most environmentally desirable and cost-effective shore protection and beach erosion control alternatives is beach nourishment. Beaches lost to uncontrolled erosion and beaches nourished to control erosion both have associated environmental changes. Beneficial and detrimental environmental changes create corresponding biological responses. Most fishes and other motile nearshore animals have the ability to migrate from a disturbed environment; thus, a change in habitat rather than burial and resuspension of sediments may have a greater potential effect. Marine bottom communities on most high-energy coastal beaches will recover rapidly when disturbed, although recovery rates may be slower for more sensitive and slower reproducing taxa, for animals covered by increased sediment depth, for greater change in particle size, and for nourishment projects in colder climates. Selected marine organisms

such as oysters, clams, sea grasses, mangroves, and corals are particularly sensitive to excessive turbidity, sedimentation, and direct physical alteration. Sea turtles can be affected by burial of their nests and by compaction of sand on their nesting beaches. Shore bird nesting can also be adversely affected by the disruption of their natural nesting habitat. Cultural resources may be included in the existing beach, the nearshore sand placement area, and the offshore sand borrow area. The inadvertent excavation of cultural resources at the borrow site poses the greatest potential risk. Shifting or resettling of sand in the vicinity of the dredging activities and burial by sand placement also may occur.

2. Environmental Assessment of Hard Structures. Construction activities associated with hard structures may include excavation, backfilling, and pile driving. The impacts of this construction will be similar to the impacts associated with other land-based construction activities; vegetation damage, noise and air pollution, visual clutter and other temporary impacts. One of the short-term impacts of shoreline construction is the increased levels of suspended sediments in nearshore waters which accompany this disturbance. Suspended sediments and siltation can impact benthic communities and, to a lesser extent, life forms in the water column. Project activities should be scheduled to minimize disturbances to waterfowl, spawning fishes and shellfishes, nesting sea turtles, and other biological resources at the project site. The primary long-term impacts of hard structural projects are associated with their effect on shore processes. Though these structures abate local erosion, they may indirectly accelerate erosion in adjacent shoreline areas. Wave reflection from exposed onshore structures may also produce deepening of the nearshore zone. Therefore, downdrift erosion process, if not mitigated by nourishment or sand bypassing, could be both severe and prolonged. Such losses may have recreational impacts and will alter biological habitats. Direct impacts of onshore structures include displacement of onsite habitats, modified public access and aesthetic alterations. Consequences of constructing coastal structures on far afield shore processes are understood only qualitatively.

3. Mediation of Environmental and Biological Changes. Environmental and biological changes can be mediated by selection of certain management alternatives. A suction dredge without a cutterhead has less potential for inducing physical damage and turbidity. Wide-tracked vehicles will compact a beach less than narrow-tracked vehicles. Equipment such as pipes, cables, and anchors should be placed in nonsensitive habitats such as sand. Borrow material should be low in silt, fine sediments, and pollutants. The location of the borrow area is an equally important criteria in the selection process. The borrow material can come from one or a combination of areas, e.g., navigation channels and harbors, offshore, or trucked from an inland source. Each of these areas has its own unique environmental impacts and considerations. The borrow material should match the existing beach material and should be placed in the intertidal area during fall and winter. When finer material must be used, it can be overfilled with a layer of medium-coarse sand. Compacted sand can be softened by tilling the beach. Blowing sand can be stabilized and a reservoir of sand can be built by using dune plantings in conjunction with beach nourishment. For cultural resource protection identified in the

proposed borrow area or beach fill, avoidance is the preferred alternative. Buffer zones can be established to protect the potentially significant resources from dredging and construction activities.

4. Coordination. During study, design and construction, extensive coordination between Corps of Engineers districts and numerous Federal, state, county and municipal agencies is required by the National Environmental Policy Act of 1969 (Public Law 91-190), Federal statutes and Executive Orders. The Coastal Zone Management Act of 1972 (Public Law 92-593), as amended, requires any proposed dredging activity to comply with, and be conducted in, a manner consistent with the Federal Coastal Zone Management Program. The Endangered Species Act of 1973 (Public Law 93-205), as amended, requires all Federal agencies to seek to conserve endangered and threatened species and to utilize their authorities in furtherance of the purposes of the Act, i.e., to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such endangered and threatened species. In complying with The Endangered Species Act, the Corps is required to coordinate with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. The Corps of Engineers is required by the National Historic Preservation Act of 1966 (Public Law 89-665), as amended, and Executive Order 11593, to identify potential and known sites and properties within the area of a project that are eligible for inclusion in the National Register of Historic Places and to coordinate all activities with the State Historic Preservation Office. An evaluation in compliance with Section 404 of the Clean Water Act of 1977 (Public Law 95-217) must be performed and included in all Environmental Impact Statements.

I. REFERENCES

1. Chief of Engineers memorandum, Strategic Direction for Environmental Engineering, 14 February 1990.

2. Assistant Secretary of the Army (Civil Works) memorandum, Statement of New Environmental Approaches, 26 June 1990.

3. U.S. Congress, Office of Technology Assessment, Environmental Program, Technologies to Benefit Shoreline Property and Rare Species Habitat: An Atlantic Coast Example, March 1995.

4. National Research Council, Restoration of Aquatic Ecosystems, 1992.

5. The following four U.S. Army Corps of Engineers publications:

a. EM 1110-2-1204, Environmental Engineering for Coastal Protection, 10 July 1989.

b. ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies, 28 December 1990.

c. IWR Report 91-R-6, National Economic Development Procedures Manual; Coastal Storm Damage and Erosion, September 1991.

d. EC 1105-2-210, Ecosystem Restoration in the Civil Works Program, 1 June 1995.

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A. FINDINGS

1. Scope of the Shore Protection Program. The shoreline protection program of the Corps takes the form of "hard" devices (seawalls, breakwaters, groins, etc.), "soft" measures (sand nourishment and revegetation), or a combination of the two. The portfolio of constructed Federally sponsored shore protection projects which are situated along various reaches of the Atlantic, Gulf, Pacific and Great Lakes shores, were built in response to tropical and other coastal storms and the effort of the Federal Government to preserve life and property along those coasts. As of July 1993, the Corps coastal program contained 82 specifically authorized projects of various types which span a composite shoreline distance of approximately 226 statute miles. In relation to the total 84,240 miles of open ocean, estuarine, and Great Lakes shorelines in the United States, these projects protect 0.3 percent of that total. If the State of Alaska's shorelines are excluded, these projects represent only 0.6 percent of the remaining 36,940 miles of shore. Further, if 26 projects in the latter stages of planning are constructed, the total shoreline protected would be 377 miles or 0.5 percent of total shoreline. When placed in the context of the "critical erosion areas" defined by the 1971 National Shoreline Study, the 108 authorized projects would cover 14 percent of those 2700 miles. From these comparisons (Box 8-1), it is obvious that the Federal shore protection program has been and will continue to be limited to a very small portion of the Nation's shorelines.

Of the 82 completed projects, 26 are very small in size and cost. These projects average only 0.6 miles in length, compared to an average of 3.75 miles for the remaining 56 projects and cost an average of $175,400 at the time of construction compared to an average of about $12 million for the remaining 56 projects. In addition to the relatively small size and cost of these projects, all of them were built during the 50s and early to mid 60s and have very limited historical data. Accordingly, these 26 projects were eliminated from the detailed analysis.

2. Programs to Address Risk Management. Population density in the coastal areas of the country is growing faster than other regions of the Nation. In 1990, about 45 percent of the Nation's 250 million people occupied an area that comprises just 11 percent of the United States outside of Alaska. Infrastructure needed to support that population is also rapidly expanding. This expansion results in a corresponding decrease of valuable natural habitats as well as the imposition of other direct and indirect adverse environmental impacts. The continued population increase in the coastal area and its associated pressure on the limited resources of the Nation's coastal zone has, over time, resulted in an array of Federal, state and local programs aimed at managing the associated risks. While there is no single, comprehensive program that addresses the many problems of risk management in coastal zones, there are various programs in place at each level of the government and within the private sector which are directed at the identified problems. On the Federal level, there are five major programs which are administered by four different Federal departments. A summary of these

Box 8-1

SCOPE OF U.S. ARMY CORPS OF ENGINEERS SHORE PROTECTION PROGRAM

Type of Area	Miles of Shoreline	Percent of Total	Percent of Critical Erosion Shoreline
Nation's Shoreline	84,240	100.0	-
Areas With No Significant Erosion	63,740	75.7	-
Areas With Non-Critical Erosion	17,800	21.1	-
Areas of Critical Erosion Not Covered By Federal Projects or Studies	2,072	2.4	76.7
Area Covered By 82 Completed Federal Projects	226	0.3	8.4
Area Covered By 11 Authorized Federal Projects and By 15 Projects in PED	151	0.2	5.6
Area Covered By 12 Authorized Federal Studies	251	0.3	9.3

programs is shown on Box 8-2. There is a direct linkage between the program of the Corps and each of the other four Federal agency programs. This linkage is shown in Box 8-3.

The Corps planning process is currently governed by the 1983 Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. The planning process consists of six major steps: (1) identifying problems and opportunities, and developing objectives; (2) establishing the base condition; (3) formulating plans; (4) evaluating their effects; (5) comparing them; and, (6) recommending the best plan to alleviate problems and realize opportunities. This systematic, dynamic and reiterative approach enables the public and decision makers to be involved and fully aware of the rationale employed throughout the planning process. The process that has evolved on the Federal level to assist in formulating and evaluating water resource projects is the National Economic Development objective. This principle ensures that a project will be constructed only if the project outputs -- the benefits to the Nation from the use of the resource -- exceed the costs.

Box 8-2

FIVE FEDERAL PROGRAMS INVOLVED IN RISK MANAGEMENT IN THE COASTAL ZONE

Department/ Agency	Program	Date Started	Purpose of Program
Defense/ Army Corps of Engineers	Research and Construction	1930	In cooperation with states and local governments, research and investigate problems concerning the effects of erosion and storms on developed coastal areas. Later authorizations gave Corps authority to construct shore protection projects.
Federal Emergency Management Agency	National Flood Insurance Program	1968	To provide Federally backed flood insurance coverage to property owners since it was generally unavailable from private insurance companies.
Commerce/ Office of Ocean and Coastal Research Management	Coastal Zone Management Act	1972	Authorizes Federal grants to states for development and implementation of coastal management programs for water and land resources in coastal zones.
Interior/Fish and Wildlife Service	Coastal Barrier Resources Act	1982	Establishment of the Coastal Barrier Resources System. Precludes Federal expenditures that induce development on coastal barrier islands and adjacent nearshore areas.
Interior/USGS Marine &Coastal Geologic Surveys	National Coastal Geology Program	1990	Increase the understanding of coastal problems by improving predictive capabilities required to rationally manage and utilize the Nation's coasts.

Box 8-3

Linkage Between Corps Program and that of Other Federal Programs

Program	Linkage to Corps of Engineers Program
National Flood Insurance (NFI)	Section 402 of WRDA '86, as amended, requires that non-Federal sponsors participate in the NFI program to be eligible for Federal funds for shore protection projects.
Coastal Zone Management (CZM)	The CZM Act requires that Federal shore protection projects be consistent with the state's coastal zone management plan.
Coastal Barrier Resources (CBR)	The CBR Act prohibits Federal funding for shore protection within a System unit, unless an exemption under Section 6 of CBRA is obtained.
National Coastal Geology (NCG)	The NCG Program duplicates to a considerable degree the Corps' program in that studies of physical processes, measuring and predicting erosion, societal impact of the problems, storm frequencies, sand searches and borrow area location are all facets of the Corps' program.

3. <u>Funds Expended on Large Projects</u>. The cumulative funds expended since 1950 on the 56 large shore protection projects have been disaggregated in accordance with the types of protection measures provided: (a) sand fill for initial beach restoration; (b) sand fill for periodic beach nourishment (c); structures such as groins, seawalls, breakwaters, etc.; and, (d) emergency actions to repair various project features damaged by extreme storm events. The associated expenditures are tabulated below. As indicated in Table 8-1, the Federal cost is $403.2 million, 60 percent of the total $670.2 million. The majority of the funds (77 percent) have been spent on beach nourishment.

Cumulative shore protection program expenditures adjusted to 1993 price levels are $881 million Federal and $1,489.5 million total, as shown in Table 8-2. The procedure used for adjusting the costs of beach restoration and nourishment projects involved the volumes of sand placed and the current cost in each area for obtaining, transporting, and placing the sand at the respective project sites. Structural costs were adjusted by means of the <u>Engineering News Record</u> Construction Cost Index. A complete explanation of the cost adjustment procedure and additional detail on project costs is contained in Chapter 4 of this report. If all project costs were adjusted using only the Construction Cost Index, the total cost in 1993 dollars would be $1,177.3 million. The cost of these 56 projects as well as the 26 small scope specifically authorized projects were updated to 1995 costs. This updating is summarized in Table 8-3.

Table 8-1
Total Actual Expenditures, Shore Protection Program (1950-1993)

Type Of Measure	Federal Cost ($ million)	Federal Cost ($ million)
Initial Beach Restoration	180.7	303.3
Periodic Beach Nourishment	147.2	235.4
Structures	59.4	115.6
Emergency Measures	15.9	15.9
Total	403.2	670.2

Table 8-2
Costs Adjusted to 1993 Prices, Shore Protection Program (1950-1993)

Type of Measure	Federal Cost ($ million)	Total Cost ($ million)
Initial Restoration	426.0	730.4
Periodic Beach Nourishment	270.9	420.4
Structures	153.9	308.5
Emergency Measures	30.2	30.2
Total	881.0	1,489.5

Table 8-3
Costs Adjusted to 1995 Prices, Shore Protection Program (1950-1995)

Item	1950-1993 $ million	1993 $ million	Δ 94 [1] $ million	Δ 95 [2] $ million	Total 1995 $ million
56 large projects	670.2	1,489.5	44.7	46.0	1,580.2
26 small scope specifically authorized projects	4.6	17.6	0.5	0.6	18.7
Sub total	**674.8**	**1,507.1**	**45.2**	**46.6**	**1,598.9**
Yearly costs of the 82 projects [2]	0	0	30.9	31.8	62.7
Total	**674.8**	**1,507.1**	**76.1**	**78.4**	**1,661.6**

Footnote:
[1] Assumes a 3 percent inflation factor per year for 1994 and 1995.
[2] Future cost of the program estimated at $30 million per year in 1993. This assumes full authorization and because of the limited data available and the small size of the projects, it was assumed that there were no future costs associated with the 26 small scope specifically authorized projects. Based on project costs, this could impact future costs by only 1 percent.

4. Cost Comparison.

a. Overall Program. An analysis was first conducted at the program level to determine how accurate the overall cost estimates were for each type of construction measure (initial restoration, periodic nourishment, and structures). When summing actual costs and the preconstruction estimates for the whole program, certain projects were not included in the totals due to the unavailability of complete cost data or because the constructed project differed significantly from that envisioned at the time of the preconstruction estimate. Table 8-4 shows both actual costs and estimated costs for the entire program, as well as each type of construction measure. In all types of measures, actual costs were less than estimated costs. Costs for the program as a whole have been four percent less than estimated.

Table 8-4
Comparison of Actual to Estimated Costs at the Program Level by Type of Construction Measure

Type of Measure	Number of Projects Included In Totals	Actual Cost ($ million 1993)	Estimated Cost ($ million 1993)	Percentage Difference Between Actual and Estimated
Initial Restoration	40	652.4	660.0	(-) 1
Periodic Beach Nourishment	33	389.9	431.6	(-) 10
Structures	35	298.6	311.4	(-) 4
Total		1,340.9	1,403.0	(-) 4

b. Project Level. Costs were next analyzed at the project level by size of project (small, less than $10 million; medium, $10-50 million; and large, over $50 million). Of the 56 projects, 46 had sufficient data to be included in the analysis. Cost performance varied substantially from one project to another, ranging from 74 percent less than estimated to 114 percent more than estimated. However, approximately equal numbers of projects had cost overruns (22) as had cost underruns (23). One project had actual costs equal to the estimated costs. The magnitude of the differences between actual and estimated costs is shown under the heading "mean percentage difference between actual and estimated". The standard deviation of these percentage differences is also listed. When analyzed by project size, it was found that small projects cost an average of 16 percent less than estimated; medium projects cost an average of 16 percent more than estimated; and large projects cost an average of four percent more than estimated. Standard deviations were similar for all three groups. Considering all 46 as one group, the average project had actual costs one percent less than estimated costs. It appears from this analysis that cost performance is better for larger projects than for small and medium size ones. This summary is shown in Table 8-5.

Table 8-5
Comparison of Actual to Estimated Costs at The Project Level By Project Size

Item	Number of Projects Analyzed Individually	Number of Projects With Cost Overruns	Number of Projects With Cost Underruns	Number of Projects With Costs Equal to Estimates	Mean Percentage Difference Between Actual and Estimated	Standard Deviation of Percentage Differences
Projects Costing Less Than $10 million	21	7	14	0	(-) 16	33
Projects Costing $10-50 million	17	12	4	1	16	33
Projects Costing More Than $50 million	8	3	5	0	4	39
Total	46	22	23	1	(-) 1	37

If emergency costs are included, the mean percentage difference for all projects increases to a plus three percent and the standard deviation increases to 40.

5. <u>Sand Volume Comparison</u>.

a. <u>Overall Program</u>. According to survey data, 49 of the 56 projects involved initial restoration and 40 of the 56 projects involved periodic nourishment. The total volume of sand placed was 189.7 million cubic yards (110.6 million for initial restoration and 79.1 million for periodic nourishment). Beach fill projects were also assessed in terms of the volume of sand actually placed, versus the volume that was estimated. As in the case of cost comparisons, the totals in Table 8-6 include only those projects which had sufficient information to allow for valid comparisons. Projects which were excluded from the program totals either had no estimates for quantities of sand or were only partly constructed. Considering the entire program, the actual volume placed was five percent greater than estimated. Separate tabulations by initial restoration and periodic nourishment show that sand estimation accuracy was better for initial restoration (actuals were one percent more than estimated) than for periodic nourishment (actuals were twelve percent more than estimated).

Table 8-6
Comparison of Actual to Estimated Volumes of Sand at The Program Level by Type of Construction Measure

Type of Measure	Number of Projects Included in Totals	Actual Volume of Sand (million cu. yd.)	Estimated Volume of Sand (million cu. yd.)	Percent Difference Between Actual And Estimated
Initial Restoration	39	94.5	93.7	1
Periodic Nourishment	33	72.5	64.7	12
Total		167.0	158.4	5

b. Project Level. As with costs, volumes of sand were also analyzed at the project level by project size. Of the 56 projects, 38 had sufficient data on quantities of sand to be included in this analysis. There was considerable variation between actual and estimated quantities of sand at the project level, but no overall bias towards either underestimation or overestimation. In fact, the projects were almost evenly split between sand overruns (18 projects) and sand underruns (17 projects). Three projects placed exactly as much sand as had been estimated. Quantitative analysis of the percentage differences between actual and estimated showed that the average project costing less than $10 million placed six percent less sand than estimated and projects costing $10-50 million placed an average of 34 percent more sand than estimated. There were several large sand overruns in the medium size projects built in the 1960s and early 1970s, but more recent projects have actual sand use much closer to the estimates. As with the cost performance discussed above, projects which cost over $50 million had the best sand performance, with an average sand underrun of four percent and a standard deviation of 14. A summary of this data is presented in Table 8-7.

Table 8-7
Comparison of Actual to Estimated Volumes of Sand at The Project Level by Project Size

Item	Number of Projects	Number of Projects With Sand Overruns	Number of Projects With Sand Underruns	Number of Projects With Sand Equal to Estimates	Mean Percentage Difference Between Actual and Estimates	Standard Deviation of Percentage Differences
Projects Costing Less Than $10 million	16	6	8	2	(-) 8	37
Projects Costing $10-50 million	16	10	6	0	34	55
Projects Costing Greater Than $50 million	6	2	3	1	(-) 4	14
Total	38	18	17	3	10	48

6. Possible Future Expenditures.

a. Expenditures Of Already-constructed Projects. Total already-committed Federal expenditures over the next 50 years, in 1993 dollars, are estimated to be $505.3 million. These projections assume that all planned and currently authorized nourishments are carried out, but that there will be no additional Congressional authorizations to extend Federal involvement in these projects.

b. Possible Future Expenditures For Authorized But Unconstructed Projects.

(1) As of July 1993, there were one project under construction, 10 authorized/awaiting initiation of construction, and 15 other projects were in the Preconstruction Engineering and Design stage. The total (50-year) cost for these 26 projects at 1993 conditions and dollars was estimated to be $2,055.3 million. The Federal share in 1993 dollars was estimated to be $1,259.2 million.

(2) As of October 1995, there were 12 projects under construction; six authorize/awaiting initiation of construction, and 13 other projects were in the Preconstruction Engineering and Design stage. The total (50-year) cost for these 31 projects at 1995 conditions and dollars is estimated to by $3,316.1 million with a Federal share in 1995 dollars estimated to be $2,195.5 million.

c. Possible Future Expenditures If All Existing Constructed Projects Are Extended And All Planned Projects Are Constructed. For the 1993 condition this scenario assumes that all 56 existing projects will continue to be nourished and maintained and that all 26 planned projects will be constructed and nourished until year 2050. Under these assumptions, the yearly appropriations of existing projects remains fairly steady at $30 million. After a surge of initial beach construction, the yearly appropriations for planned projects remains in the $25 to $30 million dollar range, for a total yearly program appropriation of about $55 to $60 million. Assuming a Federal share of 65 percent, the annual Federal yearly appropriation for the next 50 years is about $37 million in 1993 dollars. This projection was not developed for 1995 conditions.

7. Anticipated Benefits of Shore Protection Projects. There are three major categories of benefits for shore protection projects; "storm damage reduction", "recreation" and "other." The most important of these is storm damage reduction. This benefit category consists of wave damage reduction, inundation reduction, erosion reduction and loss of land. The category of "other" includes; reduced maintenance of existing structures, enhancement of property values, navigation, recreational boating, and area redevelopment. Expected average annual benefits of the 56 shore protection projects were obtained from project evaluation reports prepared by the various Corps district offices. Several projects were evaluated more than once because of the change in policy over time. This resulted in a total of 75 separate evaluations. There was no attempt to adjust interest rates and price levels to a common basis and, accordingly, no totals are presented. When the storm damage reduction and recreation benefits are calculated as percentages of the total project benefits, and grouped by five year periods, the following pattern emerges. The average project designed and evaluated prior to 1964 contained significant proportions of both storm damage reduction benefits and recreation benefits. From 1965 to 1979, most projects were justified mainly with recreation benefits, while storm damage benefits assumed a minor role. During the 1980s and 1990s, a reversal occurred, mainly due to the change in policy brought by budget restrictions and WRDA '86. The typical 1990's shore protection project has 73 percent of its benefits in the storm damage reduction category and 26 percent in the recreation category. Other benefits have always played a minor role, never exceeding 17 percent of total benefits.

8. Actual Benefits of Shore Protection Projects. One of the objectives of the study was to measure the performance of shore protection projects in terms of actual benefits produced. The study focused this effort primarily on storm damage reduction benefits. For this analysis, 11 projects were selected which had sufficient history and storm damage models. In most cases, these were older projects which had recently been re-evaluated. The basic technique was to put the actual storms which occurred during the life of the project into the model and to run "with" and "without" project scenarios. The difference between damages with the project and damages without the project is the damage prevented by the project.

All "actual" benefit numbers were generated with models; none are actual measurements. Because of the storm damage modeling methodology, a major factor affecting "actual" storm damage benefits is the incidence of storms during the life of the project. This factor is an unknown when projects are being planned, so estimates must be made based on "normal" incidence of storms. If the project life turns out to be stormier than normal, then the storm damages prevented will likely be higher than predicted, and vice versa. A summary of this analysis is presented below in Table 8-8.

Table 8-8
Storm Damage Reduction (Sdr) Benefits Comparison for Selected Projects

Category	Number of Projects	Average Years Projects Have Been In Place	Average Actual SDR Benefit (avg. annual million $)	Average Predicted SDR Benefit (avg. annual million $)	Average Percent Difference Between Actual And Predicted
Actual SDR Benefits Higher	6	12.2	9.2	5.5	+ 93
Actual SDR Benefits Lower	5	21.2	2.2	3.7	- 47

Of the eleven projects, six had actual storm damage benefits higher than expected and five had actual storm damage benefits lower than expected. Projects which had storm damage benefits significantly higher than expected tended to have experienced several severe storms. Projects which had actual benefits less than expected are located in areas which have not been challenged by major coastal storms since the projects have been constructed.

9. Level of Protection. The term "level of protection" is generally accepted, and expected, by the public because of the longstanding usage by the Corps and other water resource agencies for flood damage reduction projects and because it is a simple way of describing a flood event. However, a specific level of protection for a shore protection project is extremely difficult to estimate since recurrence intervals are assigned to each measurable characteristic of a storm. The current practice of the Corps is to utilize a set of design storm events to evaluate the cost effectiveness of design alternatives. These defined events are chosen to reflect realistic combinations of the various parameters which are descriptive of historic storm events which have impacted the location of interest. For tropical events; the storm should define the range of durations, maximum winds, radius to maximum winds, pressure deficits, track, etc., which have impacted that area. For extratropical

events (northeasters); duration, shape, and maximum wind speeds are appropriate descriptors. Frequency relationships are then assigned to the set of storms and/or their damages.

10. Induced Development. Theoretical analysis indicates that shore protection projects have the potential to generate different types of induced development including: additional development that increases total beach development; relocated development that shifts to the shore from more protected inland locations; and relocated development that moves from unprotected beachfront areas to the newly protected area. If induced development relocated from unprotected beachfront areas is significant, then development is likely moving from areas where expected damage is high to those where it is low. This type of relocated development results in a "bonus" of extra reduction in expected damage beyond that which would be calculated based on the initial level of development in the protected area.

Empirical research on induced development in coastline areas included a survey of residents and two econometric studies of beachfront development. This work revealed that various indicators of the presence and/or level of Corps activity in beachfront communities generally have no statistically significant relation to development in those areas. Thus, the statistical evidence indicates that the effect of the Corps on induced development is, at most, tiny compared to the general forces of economic growth which are stimulating development in these areas.

Another important finding of the induced development research was that residents of beachfront communities are generally not aware of Corps projects and are just as likely to mention the Corps as a solution to storm damage and erosion problems in areas where the Corps is not active as they are in areas where the Corps is active.

11. Environmental Considerations. Beaches lost to natural erosion as well as beaches that are protected through a variety of structural and nonstructural measures, have associated environmental changes. These environmental changes, resources potentially affected, and management techniques are listed in Box 8-4. Management techniques are implemented to minimize detrimental changes and to encourage beneficial changes. Corps studies and projects go through extensive coordination with Federal, state, county and municipalities to assure that all environmental concerns are addressed.

Box 8-4

ENVIRONMENTAL CONSIDERATIONS

ITEM	CONSIDERATION
Environmental Changes	Dune Stabilization and Beach Plants Beach Hardness Sand Deposition in the Intertidal Area Placement of Equipment Change in Beach Sediment Composition Sedimentation Burial and Removal of Offshore Bottom Dwelling Animals Excavation and Burial of Cultural Resources
Resources Potentially Affected	Dune Plants and Animals Sea Turtles Shorebirds Marine Bottom Communities Shoreline Rocks and Corals Fish and Other Motile Animals Seagrasses Corals Offshore Subtidal Bottom Animals Cultural Resources
Best Management Techniques	Grassing of Dunes Restrict Seasons for Construction Reduce Beach Hardness Avoid Nearshore Rocks and Corals Place Material Near Shore Reduce Silt Selection and Placement of Equipment Select Borrow Site Distant from Sensitive Habitats Avoid Cultural Resources

B. CONCLUSIONS

1. The Corps shoreline protection program covers a very small portion of the nation's coastline. As of July 1993, the program consisted of 82 completed projects which collectively cover 226 miles of shoreline. This represents 8 percent of the Nation's 2,700 miles of critically eroding shoreline.

2. The Corps shoreline protection program has shifted from primarily hard structures to primarily soft structures. Hard structures consists of groins, seawalls, breakwaters, etc., and soft structures consist of beach restoration and nourishment through sand placement. Early in the Corps shoreline protection program (1950s and 1960s), the majority of the projects were hard structures. Since the 1970s, approximately 85 percent of program costs have been devoted to beach restoration and nourishment as the preferred method of shore protection.

3. Federal spending on the shore protection program is less than one percent of the Corps of Engineers Civil Works Budget. The total Corps Civil Works budget for Fiscal Year 1994 was $3,857 million. Federal expenditures for the shore protection program in 1993 were $32.2 million. Expected Federal expenditures on shore protection for 1994 were $28.2 million.

4. From a cost and volumes of sand performance standpoint, the shore protection program has performed within acceptable limits, with overall costs being slightly less than estimated, and overall quantities of sand being slightly higher than estimated. Initial beach restoration measures demonstrated a higher level of estimation accuracy both in terms of costs and quantities of sand than did periodic nourishment measures. Larger projects (those costing more than $50 million) exhibited more estimation accuracy than smaller projects, both in terms of costs and quantities of sand. Although there was substantial divergence between actual and estimated costs and quantities of sand for individual projects, the numbers of projects experiencing cost and sand overruns were almost equal to the numbers of projects experiencing cost and sand underruns.

5. Benefits used as justification for shore protection projects have shifted from mainly recreation to mainly storm damage reduction. This variation has followed Congressional authorization language and funding priorities. In the early years (1950 to 1965), benefits were fairly evenly divided between these two categories. From 1965 to 1979, recreation benefits dominated. Now the pendulum has swung, with the typical 1990s project having 73 percent of benefits in storm damage reduction, 26 percent in recreation and 1 percent in other benefit categories.

6. The "actual" storm damage reduction benefits of shore protection projects can be greater or less than expected, depending largely on the storms which occur during the project life.

7. The term "level of protection" is not appropriate for shore protection projects.

8. Three specific approaches were applied to determine whether Corps shore protection projects induce development in the areas they protect. None of the approaches could verify that there is a measurable induced development link. The analyses demonstrated the primary determinant of development in beachfront communities is growth in beachfront demand based on rising income and employment in non-coastal areas.

9. Beach restoration and nourishment is the most environmentally desirable shore protection measure.

10. Historically, funding has not been provided to perform post-storm surveys of beach nourishment areas. Therefore, Corps districts have been unable to measure project performance of completed projects.

11. There is no funding mechanism to maintain a national data base of Federal shore protection projects. This makes it difficult to access the costs and other project specifics of the program and respond to inquiries from the Administration, Congress, and others.

12. There is limited public awareness of; the Federal shore protection program, where Federal projects currently exist, and the involvement of Corps in reducing risks through project construction.

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APPENDIX A - STUDY QUESTIONNAIRE

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, D.C. 20314-1000

CEWRC-IWR-P 21 JUN 1993

MEMORANDUM FOR See Distribution

SUBJECT: Shoreline Protection and Beach Erosion Study

1. The purpose of this memorandum is to inform you of a new study that was directed by the Office of Management and Budget (OMB) in the Fiscal Year 1994 Passback. OMB has requested that the "Army should conduct an analysis of the economic and environmental effectiveness of storm damage protection projects. The study should seek to compare and contrast the estimates of project benefits, costs, and environmental effects with current and projected conditions. The study should include a comparison of the anticipated and actual level of protection as well as an analysis of any induced development effects. OMB should be consulted throughout the study process."

2. The study will be completed in two phases. Phase I will concentrate on analysis of costs. Your assistance is requested in providing the basic project description and cost data for shore protection projects in your division through the enclosed questionnaire and tables. This study applies to all Congressionally authorized studies and projects. Upon receipt and analysis of these data, a report on phase I will be prepared and provided to the Acting Assistant Secretary of the Army for Civil Works by 31 August 1993. The data will also be placed in a computerized data base which can be expanded and updated as required.

3. The findings of this study could result in national shore protection policy decisions that may shape the future U.S. Army Corps of Engineers shore protection program. It is therefore extremely important that this effort thoroughly and accurately identifies pertinent empirical data. Your prompt and careful completion of the questionnaire is an essential part of the study.

4. The second phase of the study will include a comparison of anticipated and actual benefits of the projects as well as analysis of any induced development effects. A copy of the complete scope of work is enclosed for your information.

5. A task force of selected Corps shore protection evaluation experts from the North Atlantic and South Atlantic Divisions, the Coastal Engineering Research Center, HQUSACE and the Institute for Water Resources (IWR) has been formed to assist in methodology development and analyses necessary to research the areas of OMB concern. The first meeting of this task force was held at IWR on 2-3 June 1993. The enclosed questionnaire was developed by the task force.

CEWRC-IWR-P
SUBJECT: Shoreline Protection and Beach Erosion Study

6. In addition to a copy of the questionnaire and tables, we have enclosed an electronic form of the questionnaire in a Lotus format. Please use whichever form is most convenient for you. We have also included examples of completed forms.

7. I ask each division to:

a. advise the IWR point of contact, Ted Hillyer (703/355-2140, fax - 3171), or his alternate Anne Sudar (703/355-2336, fax - 3171) of the name of a principal and alternate point of contact;

b. return the required information to CEWRC-IWR-P Attn:
Ted Hillyer by 19 July 1993. Completed questionnaires may be returned to IWR on a project by project basis when available.

8. The above individuals may be contacted in relation to completion of the questionnaire, as well as Donald Barnes, CECW-PA (202/272-0120) on any methodology or policy concerns on this study.

/s/
Enclosures STANLEY G. GENEGA
Brigadier General (P), USA
Director of Civil Works

DISTRIBUTION (See Page 3)

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SUBJECT: Shoreline Protection and Beach Erosion Study

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Cost Recovery Questionnaire on Shoreline Protection and Beach Erosion Control Projects/Studies

June 16 draft

(Please complete one questionnaire for each project/study)

1. **District**: ___________

2. Project/Study **Name**:________________________
   (Name as in Authorizing Document or Resolution)

3. **Location**: Waterbody ______________

   State ___________

   County __________

   City(ies) _____________(list all)

4. Project/Study **Purpose**: (circle all that apply)

   1 - Hurricane and/or Storm Damage Reduction

   2 - Recreation

   3 - Beach Erosion Control

   4 - Environmental Restoration

   5 - Navigation

   6 - Mitigation

5. **Need** for the Project/Study and Value of Front Row Development

Please include (on a separate sheet if necessary) a narrative describing the need for the project (i.e. highlight particular storm events, historic damages, other problems, etc. which triggered the study authorization, project authorization, and project construction, as applicable). Also, if possible, provide a dollar figure (be sure to include the year and price level) of the front row development in the project/study area. If a roadway is located directly landward of the project, include the first row of development behind the roadway in this estimate.

6. **Type** of Project/Study: (circle all that apply)

1 - Initial restoration

2 - Periodic nourishment

3 - Groin Field

4 - Sand Bypassing

5 - Terminal Groin

6 - Breakwater

7 - Revetments (including seawalls and bulkheads)

8 - Tidal Surge Protection

7. **Authorization** Citation (including date):___________
(Public Law or House or Senate Resolution)

8. Project/Study **Status**: (circle one)

1 - Reconnaissance

2 - Feasibility

3 - Preconstruction Engineering Design

4 - Authorized/Awaiting Funds

5 - Under Construction

6 - Construction Complete except for Periodic Nourishment

7 - Deauthorized

9. Is there an **O & M Manual**?

- Yes - No

10. If no, is there periodic monitoring and/or inspection?

- Yes - No

11. What is the frequency of monitoring and/or inspection?___

12. Reason for Difference Between Estimate Cost and Actual Cost for the Project

If applicable, please indicate in a narrative (on a separate sheet of paper), the reasons for the difference between the estimated cost and the actual cost of the project construction (i.e. new environmental restrictions, storm occurred during construction, etc.).

Initial Engineering Data for the Project/Study

(from last report approved prior to construction, may be Feasibility report, GDM, GRR, LRR, DM)

General:

13. Length of Project: ___________

14. Pre/project average recession ___________ feet/year

15. Period of Comparison for recession rate: __________

16. Vertical Datum: ___________

For Beach Nourishment Projects/Studies:

17. Number of Berms: __________
(Note: if multiple berms are of different sizes, attach an additional sheet).

18. Berm Height: ___________

19. Berm Width: ___________

20. Dune Height: ___________

21. Dune Width: ___________

22. Average High Water Shoreline Extension: ___________

23. Predicted Depth Limit of Adjusted Fill: ___________

For Protective Structures:

24. Number of protective structures: ___________
(Note: if multiple structures are of different types, and different sizes, please attach additional sheets with detail on each one.)

25. Type of Structure: ___________

26. Structure Height: ___________

27. Structure Length: ___________

28. Structure Spacing (groins or breakwaters): _________

29. Construction Material: ___________

30. **Point of Contact**: Name: ___________

Office Symbol: ___________

Phone Number: ___________

Fax Number: ___________

SHORELINE PROTECTION AND BEACH EROSION CONTROL STUDY

UPDATE FACTORS FOR STRUCTURAL PROJECTS

TO DEVELOP OCTOBER 1993 PRICES

Year	Update Factor	Year	Update Factor	Year	Update Factor
1906	54.1	1936	25.0	1966	5.04
1907	50.9	1937	21.9	1967	4.79
1908	53.0	1938	21.8	1968	4.45
1909	56.5	1939	21.8	1969	4.05
1910	53.5	1940	21.2	1970	3.72
1911	55.3	1941	19.9	1971	3.25
1912	56.5	1942	18.6	1972	2.93
1913	51.4	1943	17.7	1973	2.71
1914	57.8	1944	17.2	1974	2.54
1915	55.3	1945	16.7	1975	2.23
1916	39.5	1946	14.9	1976	2.14
1917	28.4	1947	12.4	1977	2.00
1918	27.2	1948	11.1	1978	1.85
1919	26.0	1949	10.8	1979	1.71
1920	20.5	1950	10.1	1980	1.59
1921	25.4	1951	9.47	1981	1.45
1922	29.5	1952	9.03	1982	1.34
1923	24.0	1953	8.57	1983	1.26
1924	23.9	1954	8.18	1984	1.24
1925	24.8	1955	7.79	1985	1.23
1926	24.7	1956	7.43	1986	1.20
1927	25.0	1957	7.10	1987	1.17
1928	24.8	1958	6.77	1988	1.14
1929	24.8	1959	6.45	1989	1.11
1930	25.3	1960	6.24	1990	1.09
1931	28.4	1961	6.07	1991	1.06
1932	32.7	1962	5.89	1992	1.03
1933	30.2	1963	5.70	1993	1.00
1934	26.0	1964	5.49		
1935	26.2	1965	5.29		

Update factors based on the Engineering News Record Construction Cost Index. Base year 1913=100.

APPENDIX B - TASK FORCE ON SHORELINE PROTECTION AND BEACH EROSION CONTROL

HEADQUARTERS, U.S. ARMY CORPS OF ENGINEERS
20 MASSACHUSETTS AVENUE, NW
WASHINGTON, D.C. 20314-1000

Don Barnes	CECW-AA	Retired, 7/31/95
Harry Shoudy	CECW-AA	Tel: 202/761-1977 On special assignment, 1/1/94 to 10/1/94
Bill Hunt	CECW-PD	Transferred to CESAJ, 1/1/94
John Housley	CECW-PF	Retired, 9/2/94
John Lockhart	CECW-EH	Tel: 202/761-8503

DIVISIONS AND DISTRICTS

Edgar Lawson U.S. Army Engineer Division, North Atlantic 90 Church Street New York, NY 10007-2979	CENAD-PL-E	Retired, 6/2/94
Lynn Bocamazo U.S. Army Engineer District, New York Jacob K. Javits Federal Building New York, NY 10278-0090	CENAN-EN-HC	Tel: 212/264-9083
Christine Montoney U.S. Army Engineer District, Philadelphia Wannamaker Building 100 Penn Square East Philadelphia, PA 19107-3390	CENAP-PL-D	Transferred to CEWRC-IWR-N, 6/11/95 Tel: 703/428-9085
Gerald Melton U.S. Army Engineer Division, South Atlantic 77 Forsyth Street, SW Atlanta, GA 30335-6801	CESAD-EP-PE	Tel: 404/331-6870
Tom Jarrett U.S. Army Engineer District, Wilmington P.O. Box 1890 Wilmington, NC 28402-1890	CESAW-EN-C	Tel: 919/251-4455 Office Location: 69 Darlington Ave. Wilmington, NC

David Schmidt CESAJ-PD-PC Tel: 903/232-1697
U.S. Army Engineer District, Jacksonville Office Location:
P.O. Box 4970 400 West Bay Street
Jacksonville, FL 32232-0019 Jacksonville, FL

WATERWAYS EXPERIMENT STATION
3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

Joan Pope	CEWES-CD-S	Tel: 601/634-3034

WATER RESOURCES SUPPORT CENTER
INSTITUTE FOR WATER RESOURCES
7701 TELEGRAPH ROAD, CASEY BUILDING
ALEXANDRIA, VIRGINIA 22315-3868

Eugene Stakhiv	CEWRC-IWR-P	Tel. 703/428-6370
Ted Hillyer	CEWRC-IWR-P	Tel: 703/428-6140
Mike Krouse	CEWRC-IWR-R	Tel: 703/428-6217
Anne Sudar	CEWRC-IWR-P	Resigned
Lim Vallianos	CEWRC-IWR-P	Retired

SUBCOMMITTEE ON INDUCED DEVELOPMENT

HEADQUARTERS, U.S. ARMY CORPS OF ENGINEERS
20 MASSACHUSETTS AVENUE, NW
WASHINGTON, D.C. 20314-1000

Don Barnes	CECW-AA	Retired, 7/31/95
Bob Daniel	CECW-PD	Tel: 202/761-8586

DIVISIONS AND DISTRICTS

Pete Womack U.S. Army Engineer District, New York Jacob K. Javits Federal Building New York, NY 10278-0090	CENAN-PL-FE	Tel: 212/264-9088
Mark Mansfield U.S. Army Engineer District, Norfolk 803 Front Street Norfolk, VA 23510-1096	CENA0-PL-E	Tel: 804/441-7764
Gerald Melton U.S. Army Engineer Division, South Atlantic 77 Forsyth Street, SW Atlanta, GA 30335-6801	CESAD-EP-PE	Tel: 404/331-6870
William Niesen U.S. Army Engineer District, Wilmington P.O. Box 1890 Wilmington, Nc 28402-1890	CESAW-PD-A	Tel: 910/251-4775 Office Location: 69 Darlington Ave. Wilmington, NC
April Perry U.S. Army Engineer District, Jacksonville P.O. Box 4970 Jacksonville, Fl 32232-0019	CESAJ-PD-D	Tel: 904/232-2784 Office Location: 400 West Bay Street Jacksonville, FL

WATER RESOURCES SUPPORT CENTER
INSTITUTE FOR WATER RESOURCES
7701 TELEGRAPH ROAD, CASEY BUILDING
ALEXANDRIA, VIRGINIA 22310-3868

Gene Stakhiv	CEWRC-IWR-P	Tel: 703/428-6370
Mike Krouse	CEWRC-IWR-R	Tel: 703/428-6217
David Moser	CEWRC-IWR-R	Tel: 703/428-8066
David Hill	CEWRC-IWR-R	Tel: 703/428-9088
Ted Hillyer	CEWRC-IWR-P	Tel: 703/428-6140
Anne Sudar	CEWRC-IWR-P	Resigned

CONSULTANTS

Dr. Tony Yezer Tel: 202/994-6755
George Washington University
Department of Economics
2201 G Street N.W.
Washington, D.C. 20050

Dr. Joe Cordes Tel: 202/994-6755
George Washington University
Department of Economics
2201 G Street N.W.
Washington, D.C. 20050

APPENDIX C - AUTHORIZING LEGISLATION PERTINENT TO THE SHORELINE PROTECTION AND BEACH EROSION CONTROL PROGRAM

1. PL 71-520, (1930) River and Harbor Act of 1930. Section 2 authorizes the Chief of Engineers to conduct shore erosion control studies in cooperation with appropriate agencies of various cities, counties, or states. Amended by Section 103, PL 86-465. Section 2 also established the Beach Erosion Board to act as a central agency to assemble data and provide engineering expertise regarding coastal protection.

2. PL 79-166, (1945) An Act Authorizing General Shoreline Investigations at Federal Expense. This Act established authority for the Beach Erosion Board to pursue a program of general investigation and research and to publish technical papers.

3. PL 79-526, (1946) River and Harbor Act of 1946. Section 14 authorized emergency bank protection works to prevent flood damage to highways, bridge approaches and public works. Amended by PL 93-251 and PL 99-662.

4. PL 79-727, (1946) An Act Authorizing Federal Participation in the Cost of Protecting the Shores of Publicly Owned Property. This Act authorized Federal participation in the study cost, but not the construction or maintenance, of works to protect publicly-owned shores of the United States against erosion from waves and currents. Amended by PL 84-826, PL 87-874, and PL 91-611.

5. PL 84-71, (1955). This legislation specifically authorized studies of the coastal and tidal areas of the eastern and southern U.S. with reference to areas where damages had occurred from hurricanes.

6. PL 84-99, (1955). This legislation authorized the Chief of Engineers to provide emergency protection to threatened Federally authorized and constructed hurricane and shore protection works. It also established an emergency fund to repair or restore such works damaged or destroyed by wind, wave, or water action of other than an ordinary nature.

7. PL 84-826, (1956). This legislation expanded the Federal role by authorizing Federal participation in the cost of works for protection and restoration of the shores of the United States, including private property if such protection is incidental to the protection of public-owned shores, or if such protection would result in public benefits. It also provides for Federal assistance for period nourishment on the same basis as new construction, for a period to be specified by the Chief of Engineers, when it would be the most suitable and economical remedial measure. Amended by Section 156, PL 94-587 and Section 934, PL 99-662.

8. PL 85-500, (1958) River and Harbor Act of 1958. Section 203 added provisions of local cooperation on three hurricane flood protection projects which established an administrative precedent for cost sharing in hurricane projects. Non-Federal interests were required to assume 30 percent of total first costs, including the value of land, easements and rights of way, and operate and maintain the projects.

9. PL 87-874, (1962) River and Harbor Act of 1962.

Shore Protection. Section 103 amended Section 3 of the Act approved 13 August 1946, as amended by the Act approved 28 July 1956 and indicated the extent of Federal participation in the cost of beach erosion and shore protection (50 percent of the
construction cost when the beach is publicly owned or used, and 70 percent Federal participation for seashore parks and conservation areas when certain conditions of ownership and use of the beaches are met). Amended by Section 112, PL 91-611 and Section 915(e), PL 99-662.

Small Beach Erosion Projects. Section 103 also authorized the Secretary of the Army acting through the Chief of Engineers, to plan and construct small beach and shore protection projects without specific Congressional authorization. Federal cost share was limited to $400,000 per project and $3 million program limit per fiscal year.

10. PL 88-172, (1963). Section 1 of this legislation abolished the Beach Erosion Board, transferred its review functions to the Board of Engineers for Rivers and Harbors and established the Coastal Engineering Research Center.

11. PL 89-72, (1965) The Federal Water Project Recreation Act of 1965. This Act required that planning of water resources projects consider opportunities for outdoor recreation and fish and wildlife enhancement. It specified that the outdoor recreation benefits that can be attributed to a project shall be taken into account in determining the overall benefits of the project (e.g., recreational use of beach fill, groins or other shore protection structures).

12. PL 89-298, (1965). This legislative action allowed Federal contributions toward periodic nourishment.

13. PL 90-483, (1968) River and Harbor and Flood Control Act of 1968.

Section 111. This section authorized investigation and construction of projects to prevent or mitigate shore damages resulting from Federal navigation works, at both public and privately-owned shores along the coastal and Great Lakes shorelines. Cost is to be at full Federal expense, but limited to $1 million per project. Amended 17 November 1986 by Sections 915(f) and 940, PL 99-662 which, among other things, increased the limit on Federal costs per project to $2 million for initial construction costs. There is no limit on in Federal participation in periodic nourishment costs.

Section 215. This section authorized reimbursement (including credit against local cooperation requirements) for work performed by non-Federal public bodies after authorization of water resource development projects. Execution of a prior agreement with the Corps was required and reimbursement was not to exceed $1 million for any single project. Amended by Section 913 PL 99-662 and by Section 12, PL 100-676 to increase the limit on reimbursements per project. Project limit is now $3 million or one percent of the total project cost, whichever is greater; except that the amount of actual Federal reimbursement, including reductions in contributions, for such project may not exceed $5 million in any fiscal year.

14. PL 91-611, (1970) River and Harbor and Flood Control Act of 1970.

Section 112. This section increased the limit on Federal costs for small beach erosion projects (Section 103 of PL 87-874) from $500,000 to $1 million. The annual authorization limit was also raised to $25,000,000. Limits have subsequently been raised further, most recently by PL 99-662 to $2 million per project and $30 million program limit per year.

Section 208. This section authorized discretionary modifications in Federal participation in cost sharing for hurricane protection projects.

15. PL 92-583, (1972) The Coastal Zone Management Act of 1972. This Act required all Federal agencies with activities directly affecting the coastal zone, or with development projects within that zone, to assure that those activities or projects are consistent with the approved state program. The CZMA of 1972 was amended by the Coastal Zone Management Act Amendments of 1990. The 1990 Act amended the Federal consistency provisions (Section 307) by requiring all Federal agency activities, whether in or outside of the coastal zone, to be subject to the consistency requirements of Section 307(c) of the CZMA if they affect natural resources, land uses or water uses in the coastal zone.

16. PL 93-251, (1974) Water Resources Development Act of 1974.

Section 27. This section raised the cost limits for emergency bank protection projects to $250,000 and program fiscal funding limit to $10 million per year. Project purpose was extended to cover construction, repair, restoration and modification of emergency streambank and shoreline protection works. Eligibility definition was extended to include churches, hospitals, schools and similar non-profit public services. Amended by Section 915 (c) of PL 99-662.

Section 55. This section authorizes technical and engineering assistance to non-Federal public interests in developing structural and non-structural methods of preventing damages attributable to shore and streambank erosion.

17. PL 94-587, (1976) Water Resources Development Act of 1976.

Section 145. This section authorized the placement of beach quality sand obtained from dredging operations on adjacent beaches if requested by the interested state government and in the public interest--with the increased costs paid by local interests. Amended by Section 933, PL 99-662, to allow for Federal funding of 50 percent of the increased costs. This section was further amended by Section 207 of PL 102-580 to permit agreements for placement of fill on beaches to be with political subdivisions of a state.

Section 156. This section authorizes the Corps to extend Federal aid in periodic beach nourishment up to 15 years from date of initiation of construction. Amended by Section 934 of PL 99-662 to allow for extension of up to 50 years.

18. PL 97-348, (1982) The Coastal Barrier Resources Act of 1982. This law established the policy that coastal barrier islands and their associated aquatic habitats are to be protected by restricting Federal expenditures which encourage development on those coastal barrier islands. The Act also provides for a Coastal Barrier Resources System (the extent of which is defined by a set of maps approved by Congress on 30 September 1982) which identifies undeveloped coastal barriers within which Federal expenditures (including expenditures for flood insurance, roads, bridges, shoreline structures) may not be made. Specific exceptions to the expenditure prohibition include navigation, beach nourishment, and research works. The Act was amended in 1990. To ensure compliance with the Act, each Federal agency annually certifies compliance directly to the Senate and House Committees on Public Works and Transportation.

19. PL 99-662, (1986) Water Resources Development Act of 1986.

Section 101(c). This section provides that costs of constructing projects or measures for the prevention or mitigation of erosion or shoaling damages attributable to Federal navigation works shall be shared in the same proportion as the cost sharing provisions applicable to the project causing such erosion or shoaling. The non-Federal interests for the project causing the erosion or shoaling shall agree to operate and maintain such measures.

Section 103. Section 103(d) specifies that the costs of constructing projects for beach erosion control must be assigned to selected project purposes such as hurricane and storm damage reduction, and/or recreation. Cost sharing for these project purposes is specified in Section 103(c) (35 percent for hurricane and storm damage prevention and 50 percent for separable recreation). However, all costs assigned to benefits to privately-owned shores (where use of such shores is limited to private interests), or to prevention of losses of private lands are a non-Federal responsibility. All cost assigned to protection of Federally-owned shores are a Federal responsibility.

Section 915. Section 915(c) increased the Federal limits up to $500,000 for participating in emergency shoreline protection of public works (Section 14 projects). Section 915(e) increased the Federal limits up to $2 million for participating in small beach erosion control (Section 103 projects). Section 915(f) increased the Federal limits up to $2 million for participating in mitigation of shore damage attributable to Federal navigation works (Section 111 projects). Section 915(h) authorizes use of Section 103 of PL 87-874 and Section 111 of Pl 90-483 authorities in the Trust Territory of the Pacific Islands.

Section 933. This section modifies Section 145 of PL 94-587 to authorize 50 percent Federal cost sharing of the extra costs for using dredged sand from Federal navigation improvements and maintenance efforts for beach nourishment.

Section 934. Section 934 modifies Section 156 of PL 94-587 to authorize the Secretary of the Army, acting through the Chief of Engineers to extend aid in periodic nourishment up to 50 years from the date of initiation of project construction.

Section 940. This section amends Section 111 of PL 90-483 to allow implementation of nonstructural measures to mitigate shore damages resulting from Federal navigation works; to require local interests to operate and maintain Section 111 measures; and to require cost sharing of implementation costs in the same proportion as for the works causing the shore damage.

20. PL 100-676, (1988) Water Resources Development Act of 1988. Section 14 of the Act requires non-Federal interests to agree to participate in and comply with applicable Federal flood plain management and flood insurance programs before construction of any hurricane and storm damage reduction project.

21. PL 102-580, (1992) Water Resources Development Act of 1992. Under Section 206, non-Federal interests are authorized to undertake shoreline protection projects on the coastline of the United States, subject to obtaining any permits required pursuant to Federal and State laws in advance of actual construction, and subject to prior approval of the Secretary of the Army.

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APPENDIX D - CONGRESSIONALLY AUTHORIZED PROJECTS AND STUDIES - 1993

District	CWIS	Project
PROJECTS WHICH HAVE BEEN CONSTRUCTED (56)		
NED(1)	0027	Prospect Beach, CT
NED	00275	Seaside Park, CT
NED	39027	Sherwood Island State Park, CT
NED	00461	Quincy Shore Beach, MA
NED	74976	Revere Beach, MA
NED	00464	Winthrop Beach, MA
NED	00515	Hampton Beach, NH
NED	00516	Wallis Sands State Beach, NH
NED	03450	Cliff Walk, RI
New York	05210	Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY (1)
New York	05880	Atlantic Coast of Long Island, Fire Island Inlet & Shore Westerly to Jones Inlet, NY - BEC and Navigation Project
New York	05870	South Shore of Long Island, Fire Island to Montauk Point, Moriches to Shinnecock Reach, NY
New York		South Shore of Long Island, Fire Island to Montauk Point, Southhampton to Beach Hampton Reach, Area of Georgica Pond, NY
New York		Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ
New York		Raritan Bay and Sandy Hook Bay, NJ BEC and Hurricane Project, Keansburg and East Keansburg, NJ

Philadelphia		Delaware Coast, DE - Sand Bypass
Philadelphia	76095	Cape May Inlet to Lower Township, NJ
Philadelphia	74963	Great Egg Harbor Inlet and Peck Beach, NJ
Baltimore	13056 59540	Atlantic Coast of Maryland - Ocean City, MD
Norfolk		Virginia Beach (1), VA
Wilmington	13091	Wrightsville Beach, NC
Wilmington	02710	Carolina Beach and Vicinity, NC
Wilmington		Fort Macon, NC
Charleston	13005	Folly Beach, SC
Savannah	58860	Tybee Island, GA
Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment II, Hillsboro Inlet to Port Everglades
Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment III, Port Everglades to South County Line
Jacksonville	74360	Brevard County, FL - Indialantic/Melbourne Segment
Jacksonville	74360	County, FL - Cape Canaveral Segment
Jacksonville	74365	Fort Pierce Beach, FL
Jacksonville	74364	Duval County, FL
Jacksonville	14100	Pinellas County, FL - Sand Key Segment
Jacksonville	14100	Pinellas County, FL - Long Key Segment
Jacksonville	14100	Pinellas County, FL - Treasure Island Segment
Jacksonville	19050	Virginia Key and Key Biscane, FL

Jacksonville	74363	Dade Co, FL (Including Sunny Isles)
Jacksonville	74974	Lee County, FL - Captiva Island Segment
Jacksonville	74382	Palm Beach County, FL (62) - Boca Raton Segment
Jacksonville	74382	Palm Beach County, FL (62) - Delray Beach Segment
Jacksonville	13580	Palm Beach County, FL - (Palm Beach Island) Lake Worth Inlet Sand Transfer Plant (58)
Jacksonville	79207	Manatee County, FL
Mobile	74567	Harrison County, MS
New Orleans	75315	Grand Isle and Vicinity, LA
Galveston	74979	Corpus Christi Beach, TX
Galveston	74843	Galveston Seawall, TX
Buffalo		Presque Isle, PA
Buffalo	73948	Lakeview Park Cooperative, OH
Buffalo	07220	Hamlin Beach State Park, NY
Buffalo	13050	Maumee Bay State Park, OH
Buffalo	74202	Point Place, OH
Buffalo	74024	Reno Beach, OH
Los Angeles	22740	Surfside/Sunset, CA
Los Angeles	79214	Oceanside, CA
Los Angeles	14360	Channel Islands Harbor, CA
Los Angeles	74654	Coast of California, Point Mugu to San Pedro Breakwater, CA
Los Angeles	79100	Ventura-Pierpont Area, CA

PROJECTS UNDER CONSTRUCTION OR IN THE PLANNING STAGES: (55)

Under Construction **(1)**

Alaska	12379	Homer Spit Storm Damage Reduction, AK

Authorized/Awaiting Initiation of Construction **(10)**

New York	13052	Atlantic Coast of New York City from Rockaway Inlet to Norton Point (Coney Island Area), NY
New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet (reach 1 (Sea Bright to Ocean Township) Design), NJ
Norfolk	19170	Virginia Beach (2), VA
Wilmington	02710	Area South of Carolina Beach (Kure Beach), NC
Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment I, North County Line to Hillsboro Inlet
Jacksonville	14100	Pinellas County, FL - Clearwater Beach Island Segment
Jacksonville	74974	Lee County, FL - Estero Island Segment
Jacksonville	74974	Lee County, FL - Gasparilla Island Segment
Jacksonville	74382	Palm Beach County, FL (62) - South Lake Worth Inlet to Boca Raton Inlet (except Boca Raton and Delray Beach)
Jacksonville	74485	Charlotte County, FL

Preconstruction Engineering Design **(15)**

New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Reach 2 (Asbury Park to Manasquan), NJ
Norfolk	13001	Willoughby Spit and Vicinity, Norfolk, VA
Wilmington	79211	Fort Fisher, NC
Charleston	13041	Myrtle Beach, SC
Jacksonville	13009	Martin County, FL

Jacksonville	13049	Monroe County, FL
Jacksonville	13006	Nassau County, FL
Jacksonville	13044	St. Johns County, FL
Jacksonville	13043	Indian River County, FL - Sebastian Segment
Jacksonville	13043	Indian River County, FL - Vero Beach Segment
Jacksonville	13058	Sarasota County, FL - Longboat Key & Venice Beach Segments
Jacksonville	74382	Palm Beach County, FL - Palm Beach (62) South Lake Worth Inlet Sand Transfer Plant
Mobile	01303	Panama City Beaches, FL
Galveston	53895	Gulf Intracoastal Waterway, Sargent Beach, TX
Chicago	13038	Indiana Shoreline Erosion, IN

Feasibility Level **(12)**

New York		Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (2), NY
New York	13063	Atlantic Coast of Long Island Jones Inlet to East Rockaway Inlet, Long Beach Island, NY
New York		Fire Island to Montauk Point, NY
New York		Raritan Shoreline, NJ (Section 934 Study of Rartian and Sandy Hook Bays, Middlesex and Monmouth Counties)
New York		Port Monmouth, NJ
Philadelphia		Delaware Bay Coastline, DE and NJ
Philadelphia		Delaware Coast, Cape Henlopen to Fenwick Island,DE
Philadelphia		Brigantine Inlet to Great Egg Harbor Inlet, NJ
Philadelphia		Townsends Inlet to Cape May Inlet, NJ

Norfolk	75213	Sandbridge Beach, VA - HSDR
Savannah	13096	Glynn County, GA
Jacksonville	13045	Brevard County, FL

<u>Reconnaissance Level</u> **(17)**

New York		Raritan and Sandy Hook Bays, NJ
New York		Montauk Point, NY
New York		Marine Park Jamaica Bay, Plumb Beach, NY
New York		Lake Montauk, NY
New York		N, Shore of Long Island, NY
New York		S. Shore of Staten Island, NY
Philadelphia		Lower Cape May Meadows, NJ
Wilmington	12835	Dare County Beaches, North Portion, NC
Wilmington	12835	Dare County Beaches, South Portion, NC
Jacksonville	13069	Daytona Beach Shores, FL
Jacksonville	13136	Collier County, FL
Mobile	12836	Perdido Key Beaches, FL and AL
San Francisco	74723	Ocean Beach, CA
San Francisco		Santa Cruz Harbor and Vicinity, CA
Los Angeles	13081	Pacific Coast Shoreline, Carlsbad, CA
Los Angeles		Oceanside Shoreline, CA
Los Angeles		Malibu Coastal Area, CA

PROJECTS WHICH ARE "CONTINUING AUTHORITY TYPES" (26)

NED	00263	Compo Beach, CT
NED	00278	Silver Beach to Cedar Beach, CT
NED	00264	Cove Island, CT
NED	00262	Calf Pasture Beach Park, CT
NED	00265	Cummings Park, CT
NED	00261	Burial Hill Beach, CT
NED	10005	Guilford Point Beach (Jacobs Beach), CT
NED	00267	Gulf Beach, CT
NED	00268	Hammonasset Beach, CT
NED	00575	Sand Hill Cove Beach, CT
NED	00269	Jennings Beach, CT
NED	93117	Lighthouse Point Park, CT
NED	00272	Middle Beach, CT
NED	00274	Sasco Hill Beach, CT
NED	00272	Short Beach, CT
NED	00279	Southport Beach, CT
NED	86198	Woodmont Shore, CT
NED	00458	North Scituate Beach, MA
NED	00459	Town Beach Plymouth, MA
NED	00463	Wessagussett Beach, MA
NED	00574	Misquamicut Beach, RI
Los Angeles	74651	Imperial Beach, CA
Los Angeles	74659	San Diego (Sunset Cliffs), CA
Los Angeles	74723	Ocean Beach, CA (Navigation Mitigation)
Los Angeles	22780	Doheny Beach State Park, CA
Los Angeles		Anaheim Bay Harbor, CA (Navigation Mitigation)

PROJECTS WHICH WERE STUDIED BUT ARE NOW INACTIVE (no cost data on them) (2)

Wilmington		West Onslow Beach, NC
Los Angeles		Las Tunas Beach Park, CA

PROJECTS WHICH ARE NOW DEAUTHORIZED (but were constructed or partially constructed) (there is historical cost data on these) (10)

NED	86044	Lynn-Nahant Beach, MA
Philadelphia		Atlantic City, NJ
Philadelphia	13040	Ocean City, NJ
Philadelphia		Cold Spring Inlet (Cape May City), NJ

Philadelphia		Delaware Coast, DE
Charleston	07890	Hunting Island, SC
Jacksonville	22220	Mullet Key, FL
Jacksonville	74394	Key West, FL
Jacksonville	74975	Lido Key, FL
Jacksonville	74398	San Juan, PR

Footnote:

(1) NED stands for the New England Division Office

APPENDIX D - MODIFIED: CONGRESSIONALLY AUTHORIZED PROJECT AND STUDIES - 1995

District	CWIS	Project
PROJECTS WHICH HAVE BEEN CONSTRUCTED (57)		
NED(1)	0027	Prospect Beach, CT
NED	00275	Seaside Park, CT
NED	39027	Sherwood Island State Park, CT
NED	00461	Quincy Shore Beach, MA
NED	74976	Revere Beach, MA
NED	00464	Winthrop Beach, MA
NED	00515	Hampton Beach, NH
NED	00516	Wallis Sands State Beach, NH
NED	03450	Cliff Walk, RI
New York	05210	Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY (1)
New York	05880	Atlantic Coast of Long Island, Fire Island Inlet & Shore Westerly to Jones Inlet, NY - BEC and Navigation Project
New York	05870	South Shore of Long Island, Fire Island to Montauk Point, Moriches to Shinnecock Reach, NY
New York		South Shore of Long Island, Fire Island to Montauk Point, Southhampton to Beach Hampton Reach, Area of Georgica Pond, NY
New York		Raritan and Sandy Hook Bay, Madison and Matawan Townships, NJ

New York		Raritan Bay and Sandy Hook Bay, NJ BEC and Hurricane Project, Keansburg and East Keansburg, NJ
Philadelphia		Delaware Coast, DE - Sand Bypass
Philadelphia	76095	Cape May Inlet to Lower Township, NJ
Philadelphia	74963	Great Egg Harbor Inlet and Peck Beach, NJ
Baltimore	13056 59540	Atlantic Coast of Maryland - Ocean City, MD
Norfolk		Virginia Beach (1), VA
Wilmington	13091	Wrightsville Beach, NC
Wilmington	02710	Carolina Beach and Vicinity, NC
Wilmington		Fort Macon, NC
Charleston	13005	Folly Beach, SC
Savannah	58860	Tybee Island, GA
Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment II, Hillsboro Inlet to Port Everglades
Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment III, Port Everglades to South County Line
Jacksonville	74360	Brevard County, FL - Indialantic/Melbourne Segment
Jacksonville	74360	Brevard County, FL - Cape Canaveral Segment
Jacksonville	74365	Fort Pierce Beach, FL
Jacksonville	74364	Duval County, FL
Jacksonville	14100	Pinellas County, FL - Sand Key Segment

Jacksonville	14100	Pinellas County, FL - Long Key Segment
Jacksonville	14100	Pinellas County, FL - Treasure Island Segment
Jacksonville	74363	Dade Co, FL (Including Sunny Isles)
Jacksonville	74974	Lee County, FL - Captiva Island Segment
Jacksonville	74382	Palm Beach County, FL (62) - Boca Raton Segment
Jacksonville	74382	Palm Beach County, FL (62) - Delray Beach Segment
Jacksonville	74382	Palm Beach County, FL (62) - Jupiter/Carlin Segment
Jacksonville	13580	Palm Beach County, FL - (Palm Beach Island) Lake Worth Inlet Sand Transfer Plant (58)
Jacksonville	79207	Manatee County, FL
Mobile	74567	Harrison County, MS
New Orleans	75315	Grand Isle and Vicinity, LA
Galveston	74979	Corpus Christi Beach, TX
Galveston	74843	Galveston Seawall, TX
Buffalo		Presque Isle, PA
Buffalo	73948	Lakeview Park Cooperative, OH
Buffalo	07220	Hamlin Beach State Park, NY
Buffalo	13050	Maumee Bay State Park, OH
Buffalo	74202	Point Place, OH
Buffalo	74024	Reno Beach, OH
Anchorage	12379	Homer Spit Storm Damage Reduction, AK

Los Angeles	22740	Surfside/Sunset, CA
Los Angeles	79214	Oceanside, CA
Los Angeles	14360	Channel Islands Harbor, CA
Los Angeles	74654	Coast of California, Point Mugu to San Pedro Breakwater
Los Angeles	79100	Ventura-Pierpont Area, CA

PROJECTS UNDER CONSTRUCTION OR IN THE PLANNING STAGES: (61)

Under Construction **(12)**

NED		Roughans Point, Revere, ME
New York	05870	Fire Island Inlet to Montauk Point, Long Island, NY (Westhampton Beach)
New York	13052	Atlantic Coast of New York City from Rockaway Inlet to Norton Point (Coney Island Area), NY
New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet (Reach 1, Sea Bright to Ocean Township), NJ
Norfolk		Virginia Beach, VA
Wilmington		South of Carolina Beach, Kure, NC
Wilmington		Fort Fisher & Vicinity, NC
Charleston		Myrtle Beach, SC
Jacksonville		Martin County, FL
Jacksonville		Sarasota County, FL - Venice Segment
Chicago		Casino Beach, IL
Chicago		Indiana Shoreline Erosion, IN

Authorized/Awaiting Initiation of Construction **(6)**

Jacksonville	74361	Broward County and Hillsboro Inlet, FL - Segment I, North County Line to Hillsboro Inlet
Jacksonville	14100	Pinellas County, FL - Clearwater Beach Island Segment
Jacksonville	74382	Palm Beach County, FL (62) - South Lake Worth Inlet to Boca Raton Inlet (except Boca Raton, Jupiter/Carlin, and Delray Beach)
Jacksonville	74485	Charlotte County, FL
Jacksonville	13043	Indian River County, FL - Sebastian Segment
Jacksonville	13058	Sarasota County, FL - Longboat Key Segment

Preconstruction Engineering Design **(13)**

New York	73633	Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Reach 2 (Asbury Park to Manasquan), NJ
New York	13063	Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, NY
Norfolk		Sandbridge, VA
Wilmington		Brunswick County Beaches, Ocean Isle, NC
Jacksonville	13049	Monroe County, FL
Jacksonville	13006	Nassau County, FL
Jacksonville	13044	St. Johns County, FL
Jacksonville	13043	Indian River County, FL - Vero Beach Segment
Jacksonville	74074	Lee County, FL - Estero Island Segment

Jacksonville	74974	Lee County, FL - Gasparilla Island Segment
Mobile	01303	Panama City Beaches, FL
Chicago		Chicago Shoreline, IL
Anchorage		Dillingham Snag Point, AK

Feasibility Level **(14)**

New York	Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (2), NY
New York	Fire Island to Montauk Point, NY
New York	Raritan Shoreline, NJ (Section 934 Study of Rartian and Sandy Hook Bays, Middlesex and Monmouth Counties)
New York	Port Monmouth, NJ
Philadelphia	Delaware Bay Coastline, DE and NJ (7 Interims) 1. Broadkill Beach, DE (sch. to complete 10/96) 2. Maurice River, NJ (sch. to complete 1/97) 3. Roosevelt Inlet/Lewes Beach, DE (sch. to complete 9/97) 4. Port Mahon, DE (sch. to complete 9/97) 5. Cape May Villas & Vicinity, NJ (sch. to complete 11/97) 6. Pierces Point/Reeds Beach, NJ (sch. to complete 10/98) 7. Oakwood Beach, DE (sch. to complete 10/99)
Philadelphia	Delaware Coast, Cape Henlopen to Fenwick Island, DE (3 Interims) 1. Rehoboth Beach/Dewey Beach, DE (sch. to complete 7/96) 2. Bethany Beach/South Bethany Beach, DE (sch. to complete 7/98) 3. Fenwich Island, DE (sch to complete 7/2000)

Philadelphia		Brigantine Inlet to Great Egg Harbor Inlet, NJ (2 Interims) 1. Absecon Island, NJ (sch. to complete 12/96) 2. Brigantine Island, NJ (sch. to complete 11/98)
Philadelphia		Townsends Inlet to Cape May Inlet, NJ
Philadelphia		Barnegat Inlet to Little Egg Inlet, NJ
Philadelphia		Lower Cape May Meadows, NJ
Savannah	13096	Glynn County, GA
Jacksonville	13045	Brevard County, FL
San Francisco		Ocean Beach, CA
Los Angeles		Santa Monica Breakwater

Reconnaissance Level **(16)**

New York		Raritan and Sandy Hook Bays, NJ
New York		Montauk Point, NY
New York		Marine Park Jamaica Bay, Plumb Beach, NY
New York		Lake Montauk, NY
New York		N. Shore of Long Island, NY
New York		S. Shore of Staten Island, NY
Philadelphia		Manasquan Inlet to Barnegat Inlet, NJ
Philadelphia		Great Egg Harbor Inlet to Townsends Inlet, NJ
Wilmington	12835	Dare County Beaches, North Portion, NC
Wilmington	12835	Dare County Beaches, South Portion, NC

Mobile	12836	Parted Key Beaches, FL and AL
Los Angeles	13081	Pacific Coast Shoreline, Carlsbad, CA
Los Angeles		Oceanside Shoreline, CA
Los Angeles		Malibu Coastal Area, CA (Recon. Rpt. Complete, negotiating a FSCA prior to initiating Feasibility Stage)
Los Angeles		Silver Strand Shoreline, Imperial Beach, CA (Recon. Rpt. complete, approved to do GRR on authorized project subject to funding)
Los Angeles		City of Encinitas, CA

PROJECTS WHICH ARE "CONTINUING AUTHORITY TYPES" (26)

NED	00263	Compo Beach, CT
NED	00278	Silver Beach to Cedar Beach, CT
NED	00264	Cove Island, CT
NED	00262	Calf Pasture Beach Park, CT
NED	00265	Cummings Park, CT
NED	00261	Burial Hill Beach, CT
NED	10005	Guilford Point Beach (Jacobs Beach), CT
NED	00267	Gulf Beach, CT
NED	00268	Hammonasset Beach, CT
NED	00575	Sand Hill Cove Beach, CT
NED	00269	Jennings Beach, CT
NED	93117	Lighthouse Point Park, CT
NED	00272	Middle Beach, CT
NED	00274	Sasco Hill Beach, CT
NED	00272	Short Beach, CT
NED	00279	Southport Beach, CT
NED	86198	Woodmont Shore, CT
NED	00458	North Scituate Beach, MA
NED	00459	Town Beach Plymouth, MA
NED	00463	Wessagussett Beach, MA
NED	00574	Misquamicut Beach, RI
Los Angeles	74651	Imperial Beach, CA
Los Angeles	74659	San Diego (Sunset Cliffs), CA

Los Angeles	74723	Ocean Beach, CA (Navigation Mitigation)
Los Angeles	22780	Doheny Beach State Park, CA
Los Angeles		Anaheim Bay Harbor, CA (Navigation Mitigation)

PROJECTS WHICH WERE STUDIED BUT ARE NOW INACTIVE (no cost data on them) (2)

Wilmington	West Onslow Beach, NC
Los Angeles	Las Tunas Beach Park, CA

PROJECTS WHICH ARE NOW DEAUTHORIZED (but were constructed or partially constructed) (there is historical cost data on these) (10)

NED	86044	Lynn-Nahant Beach, MA
Philadelphia		Atlantic City, NJ
Philadelphia	13040	Ocean City, NJ
Philadelphia		Cold Spring Inlet (Cape May City), NJ
Philadelphia		Delaware Coast, DE
Charleston	07890	Hunting Island, SC
Jacksonville	22220	Mullet Key, FL
Jacksonville	74394	Key West, FL
Jacksonville	74975	Lido Key, FL
Jacksonville	19050	Virginia Key and Key Biscane, FL

PROJECTS WHICH ARE NOW DEAUTHORIZED (these projects were never constructed) (1)

Jacksonville	74398	San Juan, PR

STUDIES WHICH ARE AUTHORIZED (but not funded) (3)

Jacksonville	99999	Nassau County, South Amelia Island, FL
Jacksonville	13070	Watson Island Park, Miami Beach, FL
Jacksonville	12384	Miami Beach, Virginia Key, Barrier Island, FL

Footnote:

(1) NED stands for the New England Division Office

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APPENDIX E - PROJECT DESCRIPTIONS FOR SIX PROJECTS

Sub Appendix Number	Project
E - A	Atlantic Coast of Maryland and Assateague Island, Virginia (Ocean City, Maryland)
E - B	Carolina Beach and Vicinity, North Carolina
E - C	Tybee Island, Georgia
E - D	Grande Isle and Vicinity, Louisiana
E - E	Presque Isle Peninsula, Erie, Pennsylvania
E - F	San Gabriel River to Newport Bay, Orange County, California (Surfside/Sunset and Newport Beach)

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APPENDIX E-A
ATLANTIC COAST OF MARYLAND AND ASSATEAGUE ISLAND, VIRGINIA
(OCEAN CITY, MARYLAND)

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APPENDIX E-A

Atlantic Coast of Maryland and Assateague Island, Virginia

PROJECT DATA

1. Project name: Atlantic Coast of Maryland and Assateague Island, Virginia.

2. Location: The Atlantic coast of Maryland consists of the Maryland portion of Fenwick Island south of the Delaware-Maryland State boundary line, also known as Ocean City, and a portion of Assateague Island. The remainder of Assateague Island to the south is in the Commonwealth of Virginia. Fenwick Island and Assateague Island are separated by the Ocean City Inlet. The study area consists of the Atlantic coast of Maryland and Assateague Island. The authorized project is located on Fenwick Island along the oceanfront of Ocean City, Maryland. Ocean City is about 35 miles south of the entrance to Delaware Bay. Ocean City is a highly developed ocean resort within 150 miles of the metropolitan centers of Washington, D. C. and Baltimore, Maryland. The city is centrally located in a three-state region known as the Delmarva Peninsula, which is comprised of portions of Delaware, Maryland, and Virginia. Ocean City is bounded on the north by the Maryland-Delaware state boundary line, on the south by the Ocean City inlet, on the east by the Atlantic Ocean, and on the west by Assawoman and Isle of Wight Bays.

3. Corps of Engineers Division: North Atlantic Division.

4. Corps of Engineers District: Baltimore, Maryland.

5. Development and land use: Ocean City is a popular and highly developed ocean resort for the State of Maryland and particularly for the urban centers of Baltimore and Washington D.C. By far, the most important recreation land use is the beach. No other single material resource has had as much effect on the growth and development of the study area as the beaches and rolling surf of the Atlantic Ocean. Large multiple-unit luxury motels, hotels, and condominiums and boarding houses form a large part of the commercial land use in the study area. Other commercial usage is provided by the boardwalk, amusement centers, the central business district, shopping centers, and strip commercial developments. Commercial marinas, offering a wide range of boating facilities, are scattered along the shores of the bay area. Ocean City was established and has developed over the years without the aid of a Federal shore protection project. The city has little vacant land available, and most development since 1988 has been along the bay side of Ocean Highway, Maryland Route 528. In 1984, the auditor's office of Ocean City reported that the assessed value of all taxable real estate was a staggering $686 million. The current (1994) value of development is estimated to be over $2 billion.

6. Statement of the problem: The Atlantic coast of Maryland is subject to beach erosion and inundation and damage from Atlantic storms.

a. Beach erosion: The instability and recession of the beach due to erosion by natural coastal processes is a significant problem in the study area. The historic rate of erosion over the 130 years of existing record averages about 2.0 feet per year. The persistent rate of beach recession, together with a substantial annual net longshore transport rate of 150,000 to 204,000 cubic yards of sediment, demonstrates the dynamic nature of the littoral processes along the shores of Ocean City. The direction of predominant littoral transport in the Ocean City area is to the south. The Ocean City portion of the Atlantic shore, with its highly developed recreation facilities provides an abundance of leisure activities and contributes significantly to the economy of the State of Maryland. Storm surge and wave setup caused by ocean storms combined with astronomical high tides increase the water level offshore of Ocean City. As the water levels increase, waves generated by the storms are allowed to strike closer to oceanfront structures and facilities. It is during these conditions that wind driven waves have denuded the city beaches and damaged shorefront property. Because of erosion, the beaches are generally narrow in width, thus limiting the potential for recreation beach use in the area.

b. Island flooding: Ocean City is vulnerable to flooding from high water levels on the back bays. During severe storms, bay tides can be expected to rise as the amount of water in the bay increases. There are two major sources of water in the bay: water flowing across the island and into the bay and water entering the bay through the inlet. As ocean storm tides increase, flows through the Ocean City Inlet results in an increase in the height of tides in Isle of Wight and Assawoman Bays behind Ocean City. Bay tides are similar to ocean tides near the inlet, but the farther the bay area is from the inlet, the lower the bay tide. Relatively long duration storms are responsible for flooding of Ocean City from the bay side.

c. Storm damage: The study area is subject to severe damage from major hurricanes and northeasters. Waterfront developments in the Ocean City area are susceptible to damage from hurricanes during the months of July, August, September, and October. Serious and widespread damage has also been caused by northeasters during the period September through March. Northeasters are characterized by strong onshore winds predominantly from the northeast. Strong winds accompanying hurricanes and northeasters create storm surges and large waves. The water levels induced by storm surge allows the larger waves to pass over the offshore bar without breaking and dissipate the full energy of the wave in the surf zone and onto the beach. In addition to property damage caused by the high tides and wave attack during these severe storms, large quantities of material eroded from the beach berms and dunes are carried offshore and deposited. Hurricanes affecting the Ocean City area occurred in August 1933, September 1944, September 1960 (Donna), September 1985 (Gloria), November 1985 (Juan). The preponderance of storms that have severely impacted the Ocean City area were northeasters. During the period 1933 to 1993 at least 17 northeasters have affected Ocean City.

(1) Hurricane of 1933: The tropical storm of August 1933 eroded the beaches, caused major damage to shorefront developments, and opened a new inlet at the south end of Ocean City. Although the 1933 storm was of short duration, the impact of high winds and accompanying waves was devastating to developments along the coast.

(2) Northeaster of March 1962: The Northeaster of March 1962 was called by many, "The storm of the century." The northeaster wreaked unprecedented havoc on coastal developments along the entire eastern seaboard. The unusually high wind-driven tides superimposed on normally high spring tides, produced record breaking high tides. The extreme high tides allowed waves to reach closer to shore causing severe erosion and damage to property. The physical changes in the shoreline caused by the force of the storm required the U. S. Coast and Geodetic Service to revise many of its coast charts. The northeaster remained stationary offshore from Ocean City for a while, and then moved slowly eastward. High tides and damaging waves persisted for several days. Winds, waves, and high water from the storm pounded the Maryland, Virginia, and Delaware coasts through five consecutive high tides. Because of the storm's long duration, the recovery operation carried out by the Baltimore District Office of the Corps of Engineers was called "Operation Five High." The northeaster was more severe and damaging than any previously known storm to have impacted the area. Practically the entire barrier beach from the Maryland-Delaware line to the Maryland-Virginia line was under water at some time during the storm from wave overwash. At the inlet, on the south end of Fenwick Island where the jetty system had impounded a beach fill about 800 feet wide, damage to structures from wave action was minor. As the beach gradually narrowed north of the inlet, destruction mounted rapidly. The storm caused an estimated $11.2 million in damages to Ocean City.

(3) Recent storms: Damages to public and private property in Ocean City from Hurricane Gloria in September 1985 were estimated by the Baltimore District Commander to be about $11,900,000. Severe erosion of the beaches of Maryland was caused by the remnants of Hurricane Juan in November 1985 with estimated total damages of about $944,000. In October and November 1991, Atlantic storms hit the northeast coast, but caused little damage to the study area. A more devastating storm hit Ocean City in January 1992 causing about $300,000 in property damage. In November 1994, Hurricane Gordon moved up the Atlantic Coast as far as North Carolina before reversing its course and meandering back south. Moderate waves and tides generated from the leading edge of the hurricane caused beach erosion in the Ocean City

area. Damage to the beach berm was minor to moderate. The situation was improved after the storm by a reversal in littoral currents and wave direction which induced natural replenishment and recovery of the beach.

7. Study authorization: The mass destruction of the storms of 1933 and 1962 combined with the persistent erosion problem along the Maryland shoreline prompted local interests to request that Congress authorize the Corps of Engineers to study the storm and erosion problems. A resolution adopted by the House Public Works Committee on 19 June 1963, directed the Corps of Engineers to conduct a study of the shores of the Atlantic Ocean in Worcester County, Maryland for beach erosion control, hurricane protection and related purposes. The study was expanded by resolution of the Senate Public Works Committee adopted on 13 February 1967, to include the Virginia portion of Assateague Island.

a. Beach erosion control: The purpose of the beach erosion control portion of the study was to determine the most practicable and economical method of restoring adequate recreational and protective beaches and stabilizing the ocean shoreline.

b. Hurricane protection: The purpose of the hurricane damage reduction portion of the study was to develop a plan of improvement that would provide adequate protection against hurricane wave action and tidal flooding in the study area.

8. Project authorization: The original project was authorized by Section 501(a) of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986).

9. Project authorization document: There were no House or Senate Documents printed. The project was authorized in accordance with the report of the Chief of Engineers dated 29 September 1981.

10. Information at the time of authorization:

a. Original project description: The original project (Plan 3) recommended by the reporting officers provided for widening and raising the Ocean City beach and protecting Ocean City from a 100-year storm on the Atlantic Ocean. The project provided for two-staged construction, with the storm protection features of the plan including a 165-foot-wide beach to be constructed initially and an additional 35 feet of beach width to be construction at a later date, when needed.

(1) First stage: The first stage consisted of improving approximately 39,900 feet of beach by raising it to a berm elevation of 8.7 feet above the National Geodetic Vertical Datum, (NGVD) and widening it to 165 feet at Mean High Water (MHW); constructing a steel sheetpile bulkhead fronting the boardwalk to a height of 16 feet above the NGVD; and providing a protective system of dunes from the northern terminus of the bulkhead to the Maryland-Delaware state boundary line. The dunes were designed to have a crown elevation of 16 feet above the NGVD, and a top width of 25 feet, with side slopes of 1 vertical on 5 horizontal. The first stage also included development of a storm warning and evacuation plan, and the requirement that local interests continue participation in the National Flood Insurance Program.

(2) Second stage: The second stage provided for the construction of an additional 35-foot width of beach when needed to meet recreational beach use demand. Periodic beach nourishment and dune maintenance was to be accomplished as needed, which was estimated to be at 3-year intervals.

b. Recommended project modified by the Board of Engineers for Rivers and Harbors (BERH): The BERH noted that Plan 2 provides the same level of storm protection as Plan 3, the plan recommended by the Reporting officers. The BERH concurred in the need for and justification of the initial storm protection element of 165 feet of beach width as recommended by the reporting officers. However, the BERH did not believe that there was reasonable recreational need for the additional 35-foot beach width as recommended in Plan 3, beyond that provided by the initial 165-foot width. Therefore, the BERH recommended that the 35-foot beach addition be deleted, and Plan 2 be the recommended plan. The Chief of Engineers concurred in the views and recommendations of the BERH, and sent his report together with the reports of the BERH and the reporting officers to the Office of the Assistant Secretary of the Army.

c. Comments by the Office of Management and Budget: On 27 May 1983, the Assistant Secretary of the Army requested that the Office of Management and Budget (OMB) review the report of the Chief of Engineers. The response by OMB is as follows:

> "...concerned that the proposed 100-year protection has a high probability of being destroyed and would also be a false sense of security to local residents. In addition, the majority of the benefits are for recreation, a function more appropriately provided by State and local governments or private industry; and the project is not economically justified on flood damage reduction benefits alone. The administration is not opposed to providing incidental recreation at projects built for other purposes. However, since the recreation benefits are such a large part of the total benefits of this project, they cannot be considered and incidental part of the project. For the reasons stated above, we oppose authorization of this project."

d. Improvements by the State of Maryland: The project recommended in the report of the District Engineer dated May 1980, was designed to protect Ocean City from a 100-year ocean storm and to reduce erosion of the recreational beaches. When informed of the Administration's position on improvements for recreation, the State of Maryland notified the Assistant Secretary of the Army by letter on 6 December 1985 that it would construct a beach profile which exceeds the minimum requirements essential for erosion control.

e. Original project authorization: The original authorized project was authorized by the Water Resources Development Act of 1986. Project costs quoted in that Act are as follows:

(1) Total first costs: $58,200,000.

(2) Total Federal first costs: $26,700,000.

(3) Total non-Federal first costs: $31,500,000.

f. Project data: Project economic data, fill quantities, and unit costs for Plan 2, as estimated in the Feasibility Report dated May 1980, BERH report dated 31 March 1981, and the report of the Chief of Engineers dated 29 September 1981 (based on July 1980 price levels, a 50-year project life, and an interest rate of 7-3/8 percent) are tabulated as follows:

(1) Total first costs: $26,760,000.

(2) Total Federal first costs: $17,878,000.

(3) Total non-Federal first costs: $8,882,000.

(4) Total average annual costs: $3,580,000.

(a) Nourishment costs: $1,335,000.

(b) Maintenance costs: $64,000.

(5) Total average annual benefits: $8,070,000.

(a) Storm damage reduction: $2,401,000.

(b) Elimination of beach nourishment: $450,000.

(c) Recreation: $5,219,000.

(6) Project benefit-to-cost ratio: 2.3.

(7) Initial fill construction: 3,104,000 cubic yards.

(8) Annual erosion rate: 150,000 to 204,000 cubic yards.

(9) Annual nourishment requirement: 175,000. cubic yards.

(10) Periodic nourishment quantity: 525,000.

(11) Periodic nourishment cycle: 3 years.

(12) Fill unit costs:

(a) Initial fill: $4.35 per cubic yard.

(b) Periodic nourishment: $4.35 per cubic yard.

11. Project modifications from authorization to completion:

a. Deviation from the authorized project:

(1) Changes in project purpose: The original authorized project provided for improving approximately 39,900 feet of ocean beach fronting Ocean City. The beach fill was to meet the recreational needs of the tributary area and was designed to be an integral feature of the hurricane protection project.
The Administration opposed construction of the project as a Federal undertaking because the recreation benefits were such a large part of the total benefits of the project. The state of Maryland agreed to construct the initial beach fill (recreation) portion of the project. In March 1988, the State of Maryland awarded a contract for beach replenishment. Beach fill operations were completed in September 1988 by placing about 2.4 million cubic yards of sand at a cost of $14,200,000. In 1985 the Baltimore District conducted a brief study to reevaluate the hurricane protection portion of the Federal project. Based on the favorable findings of the study, the Federal project was revised to be a singe purpose project providing hurricane protection to Ocean City.

(2) Changes in local cooperation requirements: The terms of local cooperation for the current project are basically the same as for the authorized project except for changes in the cost-sharing provisions. The changes consisted of deleting the local cooperation requirements associated with recreation and decreasing the Federal share of costs for hurricane protective measures from 70 percent to 65 percent. The Federal share of the hurricane protection project was decreased to comply with Section 103 of the Water Resources Development Act of 1986.

(3) Changes in project scope: The beach fill included in the authorized project was to end at the Maryland-Delaware line. The fill design was modified to include a transition which extends 1,600 into Delaware. The purpose of the transition was to help stabilize the beach and to insure that the Maryland portion of the project will not be circumvented during a storm.

(4) Development of a storm warning and evacuation plan: The authorized project called for the development of a storm warning and evacuation plan. The Corps of Engineers in conjunction with the Federal Emergency Management Agency conducted a Maryland hurricane evacuation study which includes the Ocean City area. The objective of the study was to develop detailed technical information for use in updating or preparing local evacuation plans. The study results were published in a Technical data report in 1990. Details of a hurricane preparedness plan for a typical community have also been prepared by the National Weather Service in collaboration with the Corps of Engineers. The information is presented in a pamphlet entitled, "National Hurricane Research Project No.28, a Model Hurricane Plan of a Coastal Community."

b. Changes in project design:

(1) Transition beach: The beach fill included in the authorized project was to end at the Maryland-Delaware line. The fill design was modified to include a transition which extends 1,600 feet into Delaware. The purpose of the transition is to help stabilize the beach and to insure that the Maryland portion of the project will not be circumvented during a storm.

(2) Beach width: The authorized project provided for a beach fill with a constant 165-foot wide along the entire 39,900 feet of shoreline fronting both the bulkhead and the sand dune. The authorized beachfill was redesigned to consist of a 100-foot-wide fill fronting the dune and a 165-foot-wide beach fronting the bulkhead. The purpose of the modification is to produce a more uniform shore alignment and to afford a more efficient means of providing the authorized level of protection.

(3) Extension of beachfill and bulkhead: The authorized plan calls for terminating the beachfill at 8th street and the bulkhead at North Division Street. The project was modified by extending the beachfill to a point in the vicinity of 3rd Street and reducing the length of bulkhead required. The segment of bulkhead extending south of 4th Street to North Division Street was not required due to the increased width of the existing beach in that area. The beachfill is not required beyond 3rd Street because the existing beach in that area is sufficiently high and wide to meet project requirements and to provide for a smooth transition.

(4) Bulkhead design: The authorized project did not include a protective revetment feature. Following a recommendation of the Coastal Engineering Research Center, the design of the project was modified to provide for construction of a stone revetment at the toe of the bulkhead in the transition area of the bulkhead and sand dune.

(5) Beachfill section: The beachfill section of the authorized project tied into the existing bottom at a depth of about 5 feet below NGVD. Based on a reevaluation, the project design beachfill section for the hurricane protection project was modified based on an equilibrium profile parallel to the existing profile with a depth of closure at about the 21-foot depth contour. New quantity estimates were made based on this new design.

c. Modified project description: The project recommended in the Final General Design Memorandum dated August 1989 provides for the construction of a beach berm, a steel sheetpile bulkhead, and a vegetated sand dune. The project would provide 100-year level of protection to Ocean City from ocean storms.

(1) Beach berm: The protective beach berm would be created by the placement of about 3,825,000 cubic yards of beachfill along the shoreline of Ocean City including a northern transition section which extends into the State of Delaware.

(a) Beach berm fronting bulkhead: The southern limit of the beachfill fronting the boardwalk is near 3rd Street, where the existing beach is sufficiently high and wide to meet project requirements. The beachfill will undergo modification by wave attack and immediately begin to adjust to a slope which is in equilibrium with the wave and tidal forces acting upon it. The design width of the beach fronting the bulkhead is 165 feet from the construction baseline, which was established by the State of Maryland along the oceanward edge of the boardwalk, to the Mean High Water Line (MHWL). The beach also is designed to have a level berm generally averaging 100 feet in width and then sloping gradually for a distance of 65 feet to the MHWL. The berm is designed to have an elevation of 8.5 feet above the NGVD.

(b) Beach berm fronting dunes: The design width of the beach fronting the protective dunes is 100 feet from the oceanward toe of the dune to the MHWL. The beach consists of a level berm with and elevation of 8.5 feet above NGVD, generally averaging 35 feet in width and then gradually sloping for a distance of 65 feet to the MHWL. Immediately beyond the Maryland-Delaware state boundary, the beach berm and protective dune taper into the Delaware shoreline.

(2) Bulkhead: The project also provides for construction of a steel sheetpile bulkhead along the oceanward edge of the existing boardwalk from about 4th Street to 27th Street where the bulkhead ties into the dune. Stone revetment is required to protect the bulkhead from scour and undermining in the critical transition area. The bulkhead has a top elevation of 14 feet above NGVD. The bulkhead design includes encasement of the top of the sheetpile to form a concrete cap extending from the top of the bulkhead down to about one foot below the deck of the boardwalk. The cap is required for both aesthetic and safety reasons. Facilities for public access to the beach consists of stairs and ramps along the bulkhead.

(3) Dune: The shore protection project includes a dune in the area north of the boardwalk. The dune system extends from 27th street to a point about 0.3 miles north of the Maryland-Delaware state boundary line. The dune design is trapezoidal in cross section and has a crest width of 25 feet, and a height of 14.5 feet above NGVD. The slope of the ocean face of the dune is 1 vertical on 5 horizontal. The design includes sea grass plantings and sand fences to stabilize the dune.

(4) Periodic nourishment: The project also provides for periodic nourishment of the project at 4-year intervals over the 50-year project life.

d. Modified project data: The source of the data in the following subparagraphs is the Final General Design Memorandum on the Atlantic Coast of Maryland Hurricane Protection Project, dated August 1989. (Project costs are based on 1989 price levels, an interest rate of 8-7/8 percent, and a 50-year project life):

(1) Total first costs: $57,070,000. This estimate is an increase of $29,570,000 from the latest approved PB-3 at that time (20 July 1988), which was $27,500,000. The increased is based on engineering studies which tripled the estimated quantity of sand required for the project.

(2) Total Federal first costs: $36,390,000.

(3) Total non-Federal first costs: $20,680,000.

(4) Total average annual costs: $9,510,000.

(a) Nourishment costs: $3,057,000.

(b) Maintenance Costs: $109,000.

(5) Average annual benefits:

(a) Storm damage reduction: $14,380,300.

(b) Recreation: $45,300.

(c) Total benefits: $14,425,600.

(6) Benefit-to-cost ratio: 1.5.

(7) Unit fill costs:

(a) Initial fill: $7.50 per cubic yard. ($5.75 per cubic yard for dredging, plus $1.75 per cubic yard for spreading.

(b) Periodic nourishment: $7.50 per cubic yard. ($5.75 per cubic yard for dredging, plus $1.75 per cubic yard for spreading.

e. Construction of the project: The authorized project was essentially completed in September 1991, and was officially dedicated on 30 October 1991. On 30 and 31 October 1991, and again in November 1991 major Atlantic storms devastated the northeast coast. The high winds and waves accompanying the storms caused considerable damage and beach erosion along the northeast coast. However, only minor property damage occurred in Ocean City as a result of the essentially completed project. Damages prevented by the project in the Ocean City area were estimated to be about $32,000,000. On 4 and 5 January 1992, a more devastating storm hit Ocean City causing about $300,000 in property damage. Again, damages prevented by the project during that storm were estimated to be $61,000,000. While the project prevented a total of $93,000,000 in damages to Ocean City, the cumulative effect of the storms severely eroded the newly constructed dunes and beach fill. Only about 20 percent of the protective dunes remained following the January 1992 storm.

(1) First project restoration effort: Following the severe storms in the fall of 1991 and winter of 1992, plans were developed to rehabilitate the dunes and beaches. A construction contract was awarded in April 1992 for restoration of the dunes and beach berms. The restoration work was essentially completed in September 1992 at a cost of $10,800,000. With only dune planting remaining to be completed, a northeaster struck the coast in December 1992 causing additional damage to the project. Little property damage was reported in the protected area of Ocean City. However, the storm did cause erosion of the beach berm and dunes, damage the fenceline along the ocean toe of the dune, destroy vegetation planted along the oceanside of the dune, damage the majority of pedestrian crossovers, and render all but one of the vehicular/handicapped crossovers unusable.

(2) Additional project restoration efforts: Repair of damages to the project caused by the December 1992 northeaster was to be accomplished in two phases. However, several storms occurred in 1993, requiring a third phase of restoration.

(a) First phase: The first phase of the work was to restore the dunes, construct a 10-foot beach berm and revegetate the dune. A contract was awarded in February l993 and the first phase including moving about 113,000 cubic yards of beach sand was completed.

(b) Second phase: The second phase of construction to restore the remainder of the beach by moving 200,000 cubic yards of beach sand was to be accomplished in the fall of 1993 after sufficient natural accretion took place. Unfortunately, the anticipated sand accretion did not occur. Further, a number of short duration storms producing destructive wave activity occurred during the period February 1992 to May 1993. About 500,000 cubic yards of sand were lost from the foreshore and transported out of the littoral system by the storms. About 111,000 cubic yards of sand were moved to reshape and fill the vulnerable areas of the denuded beaches. In the winter of 1993, the second phase to reshape the vulnerable areas of the beach was completed at a total cost of $960,000.

(c) Third phase: As a result of the storms that occurred in 1993, a third phase of restoration was required to replace about 1,265,000 cubic yards of beach material. The dredging operation was initiated in May 1994 and was completed in October 1994 at a cost of about $8,800,000.

(3) Hurricane Gordon: In November 1994, soon after completion of the third phase dredging operation, Hurricane Gordon moved up the Atlantic Coast as far as North Carolina before reversing its course and meandering back south. The leading edge of the hurricane caused moderate winds and tides in the Ocean City area. Tides at the time were 3 feet higher than normal because of the coincidence of a full moon. Wind gusts exceeded 40 miles per hour. Although wave runup reached the toe of the protective dunes and winds blew away some of the sand fencing, only minor damage was reported. The high tides and waves did, however, erode the beach berm. Damage to the beach berm was minor to moderate, but a reversal in littoral currents and wave direction after the storm induced natural replenishment and recovery of the beach.

(4) Revegetation of dunes: A separate contract for dune revegetation was awarded in September 1994 in the amount of $101,724. The contract was delayed by action taken by the U. S. Government Accounting Office. Dune planting has been rescheduled for the period December 1994 to April 1995.

f. Completion of initial project construction: With the completion of the dune planting, the initial construction phase of the authorized project will be officially declared 100 percent complete.

12. Project nourishment and maintenance programs:

a. Nourishment program:

(1) Advance nourishment: Engineering studies conducted for the Final General Design Memorandum indicated that immediately after construction, the natural erosion processes would begin reducing the design volume. Therefore, a volume of beachfill equivalent to four years of erosion was included in the initial fill estimate. Based on an expected erosion rate of 175,000 cubic yards a year, the advance nourishment requirement for the project was estimated to be 700,000 cubic yards.

(2) Fill quantities and costs: The project fill quantities and unit costs in the following subparagraphs were estimated in the Final General Design Memorandum on the Atlantic Coast of Maryland Hurricane Protection Project, dated August 1989:

(a) Initial beach fill: 3,825,000 cubic yards.

(b) Annual nourishment required: 175,000 cubic yards.

(c) Periodic nourishment quantity: 700,000 cubic yards.

(d) Periodic nourishment cycle: 4-years.

(e) Unit cost of initial fill: $7.50 per cubic yard. ($5.75 per cubic yard for dredging plus $1.75 per cubic yard for spreading).

(f) Unit cost of periodic nourishment: $7.50 per cubic yard. ($5.75 per cubic yard for dredging plus $1.75 per cubic yard for spreading).

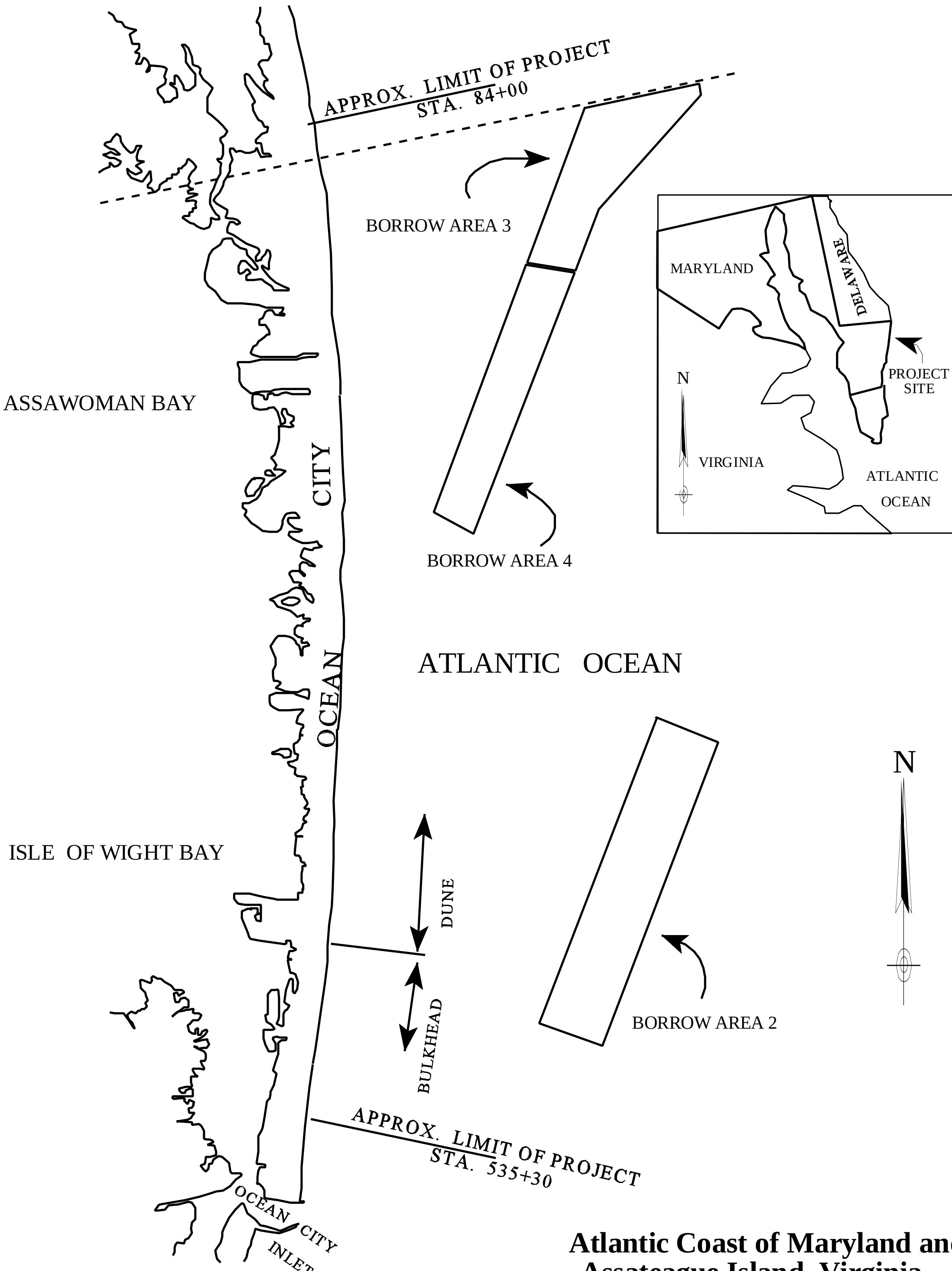
(3) Scheduled periodic nourishment: Due to the repeated damages and subsequent rehabilitation efforts made to the shore protection features of the project, no scheduled periodic nourishment has been performed to date. The District Commander estimates that periodic nourishment should occur on an average of once every 4 years. The cost of periodic nourishment is estimated to be about $3,057,000 annually.

b. Maintenance program:

(1) Maintenance costs: $109,000.

(2) Maintenance interval: Annually, or as needed.

13. Project performance: The project is performing essentially as designed. The steel sheetpile bulkhead has required minimal maintenance and repair. Given the "sacrificial" nature of the protective beach berm and dune features of the project, their rehabilitation is deemed necessary after the project has been damaged by a major storm. During major storm events, such as the northeasters of October-November 1991, January 1992, and December 1992, the project provides the intended protection to shorefront developments, but in doing so, the dunes and beach berm may be so diminished that they would not be able to provide the design level of protection for the remainder of the project life. Therefore, project restoration in addition to the routine periodic nourishment and maintenance efforts may be required to ensure project integrity.



Atlantic Coast of Maryland and Assateague Island, Virginia

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APPENDIX E-B

CAROLINAL BEACH AND VICINITY, NORTH CAROLINA

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APPENDIX E-B

Carolina Beach and Vicinity, North Carolina

PROJECT DATA

1. Project name: Carolina Beach and Vicinity, North Carolina.

2. Location: The authorized project for Carolina Beach and Vicinity is located in New Hanover County, about 15 miles southeast of Wilmington, North Carolina. The area covered by the project consists of about 5 miles of the North Carolina ocean shore along the peninsula which separates the lower Cape fear River from the Atlantic Ocean. The community of Carolina Beach is near the northern section of the project and Kure Beach is adjacent to the southern portion. These communities comprise an important summer recreational area.

3. Corps of Engineers Division: South Atlantic.

4. Corps of Engineers District: Wilmington, North Carolina.

5. Project Authorization: The original project was authorized by the Flood Control Act of 1962 in accordance with the Report of the Chief of Engineers dated 5 October l961.

6. Original project authorization document: House Document No. 418, 87th Congress, 2d Session.

7. Development and land use: Development of the study area is concentrated mainly along the ocean shore and the highways leading to the beaches. The area is well developed as a summer resort, with numerous hotels, motels, and other housing accommodations; concession stands; a boardwalk; fishing piers; amusements; and a small boat harbor. Commercial and recreational activities within the study area include fishing and businesses associated with the recreation activities of a beach resort. Over the years the facilities have been replaced and repaired as required under extensive construction and rehabilitation programs following destructive hurricanes and other ocean storms. The natural attributes of the wide beaches and the rolling surf of the Atlantic Ocean has had much to do with the growth and development of the area as a popular beach resort mecca. Carolina Beach and Kure Beach were established and have developed over the years without the aid of a Federal shore protection project.

8. Statement of the problem: The project shoreline is exposed with an unlimited fetch to ocean storms, and is constantly subject to change because of the unceasing action of the winds, waves, and currents.

a. Beach erosion: Erosion along this section of shore is a serious and continuing problem. The sand beach which is being eroded is particularly attractive to recreationists and is adjacent to seashore resort areas. In addition to the loss of the valuable and scenic beachfront, many homes, business establishments, and other improvements are subject to damage from erosion. In the years prior to construction of the project, there was a progressive increase in the use and development of oceanfront property. In many cases, little thought was given to the constant erosion of the shoreline during development. As a result, many structures which initially were considered to be well back from the ocean, over time were left with very little beach between them and the encroaching ocean waves. The persistent and gradual erosion is greatly accelerated during hurricanes and northeasters.

b. Northeasters: During its 30-year history, 1964 to 1994, the Carolina Beach project has been impacted by numerous extratropical storms or northeasters, of sufficient intensity to have caused measurable damage to shorefront development.

These storms can often be more damaging than hurricanes primarily because of the longer duration of the storm front. Two severe northeasters occurred back-to-back in December 1980 and caused significant damaged in the project area. During the period 1971 to 1980, just prior to the occurrence of the two storms, the project was allowed to deteriorate. Consequently, when the two storms struck, 7 structures experienced significant damage.

c. Hurricanes: The exposed shoreline of Carolina Beach is subject to severe damage from hurricanes and other ocean storms. Over fifty hurricanes have affected the project area during the twentieth century. Over twenty of these hurricanes were classified as major or moderate. Historical records show that hurricanes occur most frequently during the months of July, August, September, and October. Major damage in shore areas, such as, the exposed coast of North Carolina can be attributed to tidal flooding as a result of wind-driven surge and waves.

(1) Hurricane Hazel: The center of Hurricane Hazel entered the North Carolina coast on 15 October 1954 at a point very near the North Carolina-South Carolina state boundary line. The storm was large and the Wilmington Weather Bureau reported top wind gusts of 98 miles per hour. This hurricane was by far the most destructive hurricane in the history of North Carolina at that time. The destruction and devastation in the coastal areas were increased by the coincidence of the high astronomical tides and the hurricane tide. Wind driven tides and waves severely damaged oceanfront property and denuded the beaches in the Carolina Beach-Kure Beach area. The streets were covered with sand and littered with debris. Troops of the U. S. Army Corps of Engineers removed over 100,000 cubic yards of sand from Carolina Beach streets following the storm.

(2) Hurricane Connie: Hurricane Connie passed a short distance east of Carolina Beach, traveled northward, and entered the coast near Cape Lookout, North Carolina, on 12 August 1955. The Hurricane reached its greatest intensity on the 6th and 7th, with maximum winds estimated to be about 145 miles per hour. Tides along the southeastern North Carolina coast were reported 7 feet above predicted astronomical tides on the 11th, and water levels in the sounds and river mouths rose 5 to 8 feet above predicted astronomical tides on the 12th. All dunes erected after Hurricane Hazel were washed away and about a quarter of the community of Carolina Beach was inundated. Beach erosion, one of the major damages, was so extensive that during periods of high tide the waves washed up to the building line and business area of Carolina Beach.

(3) Hurricane Diane: Hurricane Diane moved northwestward and crossed the North Carolina coast on the morning of 17 August 1955. Highest winds were estimated at 125 miles per hour during the period 12-15 August, but the wind had decreased to less than 75 miles per hour at the time the storm passed inland. Major damage to the beaches resulted from the unusually high storm tides and waves.

(4) Hurricane Ione: Hurricane Ione passed approximately 60 miles off Carolina Beach and entered the coast of North Carolina west of Morehead City on 19 September 1955. The hurricane caused very little damage in the Carolina Beach area. Hurricane Ione produced extensive flooding by both salt and fresh water throughout the central coastal counties of North Carolina.

(5) Hurricane Helene: Hurricane Helene occurred on 27 September 1958, and was potentially one of the most dangerous storms to hit the Carolina coast at the time. Fortunately, it occurred at most localities during a normal tidal low. Damages were estimated to be $591,800 for Carolina Beach and $374,100 for the Cape Fear area south of Carolina Beach. Most of these damages were caused by wind, since neither tide nor wave action was exceptional.

(6) More recent hurricanes: During its 30-year history, 1964 to 1994, no hurricanes greater than category 3 have impacted the project area. Hurricanes that did impact the project area include, Hurricane David in September 1979, Hurricane Diana in September 1984, and Hurricane Hugo in September 1989. Hurricane Gordon, the most recent hurricane, passed offshore of Carolina Beach in November 1994 and traveled in a northeasterly direction up the North Carolina

coastline before it reversed direction and meandered back south. Moderate waves and tides generated by the hurricane caused only minor beach erosion in the Carolina Beach area. The existing project prevented damage to shorefront developments.

9. Study authorization:

a. Request for study: As a result of the severe damage to coastal development and beaches caused by Hurricanes Hazel, Connie, Diane, Ione, and Helene, described above, local interests requested that the Corps of Engineers study the hurricane problem in the area of Carolina Beach. The study and report which recommended implementation of the original hurricane protection project were authorized by Public Law 71, 84th Congress, First Session, approved 15 June 1955.

b. Combined studies: To expedite a solution to the severe and persistent erosion problem in the area of Carolina beach, the Cooperative Beach Erosion Control Study for Carolina Beach was combined with the Interim Hurricane Study on 12 August 1957. The purpose of the cooperative beach erosion control study was to devise effective means of restoring and preventing further erosion of the ocean shore fronting the community of Carolina Beach.

10. Information at the time of authorization:

a. Original project description: The authorized project provided for construction of a dune with a base generally bordering at or near the building line, with a crown width of 25 feet at an elevation of 15 feet above Mean Low Water (MLW), together with integral construction of a beach berm having a width of 50 feet and an elevation of 12 feet above (MLW). The protective structure would extend about 25,800 feet from the northern limits of Carolina Beach to the southern limits of Kure Beach. Grass would be planted on the dunes. The project also provided for an initial deposition of beach fill material north of Carolina Beach to serve as a feeder beach. Federal participation in the cost of beach nourishment was authorized for a period not to exceed 10 years from the year of completion of the initial fill placement.

b. Redesignation of project purpose: The BERH noted that the communities affected will remain subject to inundation by backwater during even moderate storm-induced high water surges, and that the design level, although equivalent to the most severe of record at the locality, was several feet lower than hurricane surge levels which can reasonably be expected to occur in the future. The BERH considered that the plan of improvement should be designated as one for beach improvement and stabilization and for hurricane wave protection. This redesignation of project purpose was to avoid creating a greater sense of security than warranted. The BERH agreed with the BEB in the view that an adequate storm-warning system, as well as plans and routes for evacuation of the coastal area, were essential supplements to avoid loss of life.

c. Dredging operations scheduling: The BERH agreed with the reporting officers that construction and maintenance dredging should be scheduled to avoid the spring and summer months in order to minimize adverse effects on fish and wildlife.

d. Fill quantities: The initial fill estimates required to establish the dune and beach berm, and other project related information on project operations were taken from the report of the District Engineer dated 23 September 1960. This information is provided in the following subparagraphs.

(1) Initial construction:

(a) Initial beach fill: 1,686,000 cubic yards.

(b) Initial fill for dune base: 289,000 cubic yards.

(c) Initial dune fill: 136,000 cubic yards.

(d) Initial feeder beach: 105,000 cubic yards.

(2) Annual nourishment requirement: 81,000 cubic yards.

(3) Periodic nourishment quantity: 243,000 cubic yards.

(4) Periodic nourishment cycle: 3 years, or as needed.

(5) Maintenance of high berm and dune: 18,000 cubic yards.

(6) Fill unit costs:

(a) Initial fill construction: $0.309 per cubic yard.

(b) Periodic nourishment: $0.70 per cubic yard.

e. Original estimates of project costs and benefits: The following information on project economics was taken from the report of the District Engineer dated 23 September 1960. The report of District Engineer along with reports of the Chief of Engineers, Beach Erosion Board (BEB), and the Board of Engineers for Rivers and Harbors (BERH) are contained in House Document Numbered 418, 87th Congress, 2d Session. Project first costs were computed using January 1958 price levels. Annual costs and benefits are based on a 50-year period of analysis and an interest rate of 2-5/8 percent. Non-Federal costs are based on an interest rate of 4 percent.

(1) Total first costs: $1,239,000.

(2) Total Federal first costs: $739,000.

(3) Total non-Federal first costs: $500,000.

(4) Total annual Costs: $123,110.

(a) Nourishment costs: $56,700.

(b) Maintenance Costs: $14,600.

(5) Project benefits:

(a) Storm damages prevented: $213,500.

(b) Savings in emergency costs: $5,300.

(c) Increased earning power: $23,000.

(d) Recreation: $133,900.

(e) Total project benefits: $375,700.

(6) Project BCR: 3.1.

11. Project modifications from authorization to completion:

a. Project Authorization: The original project was authorized by the Flood Control Act of 1962.

b. Project history: The original project was authorized to provide protective improvements along 25,800 feet of shoreline extending from the northern limits of Carolina Beach to the southern limits of Kure Beach. Both the Carolina Beach and Kure Beach segments of the recommended project were found to be independent and economically feasible project increments.

(1) Carolina Beach segment:

(a) Project construction: Only the Carolina Beach portion of the project, covering the northernmost 14,000 feet has been constructed. Initial construction of the Carolina Beach portion of the project was completed in April 1965 with the placement of about 3,597,000 cubic yards of borrow material obtained from the Carolina Beach Harbor area. The contract cost for the fill was $926,000 and the unit cost was $0.26 per cubic yard. Immediately following the initial placement, a considerable amount of erosion occurred along the entire length of the fill with significantly greater erosion occurring along the northern 4,000 feet of the fill. Accordingly, authority was granted to proceed with emergency measures involving additional beach nourishment and the construction of a temporary timber groin at the northern terminus of the project. The recommended emergency corrective measures were completed in March 1967 with the construction of the timber groin and the placement of 390,000 cubic yards of beachfill. The contract cost for the fill was $186,000 and the unit cost was $0.48 per cubic yard. The emergency fill placed in 1967 was completely gone within a year and the temporary groin was undergoing rapid deterioration.

(b) Special study: As a result of the continuing erosion problem, a special investigation of the Carolina Beach portion of the project was authorized to determine the causes of the inordinate erosion and to recommend a feasible long-term solution. The study and report, completed in 1970, identified the entrapment of littoral sediments in Carolina Beach Inlet as the major cause of the erosion problem. The inlet is man-made and was opened in 1952. Possible long-term solutions for the erosion problem identified in this report included inlet closure, sand bypassing from the existing inlet, and inlet stabilization with sand bypassing. Since all of these long-range plans involved the inlet, Congress directed the Wilmington District Commander to make a study of the navigational aspects of the inlet before recommending a final solution for the Carolina Beach project. The Long-term solution recommended bypassing about 480,000 cubic yards of sand every three years from a sediment trap located in the throat of the inlet. The sediment trap would serve as a renewable source of beach quality sand for nourishing the storm damage reduction project. This sand would be distributed along the north end of the fill and would serve as a source of sediment to the beaches to the south.

(c) Project completion delayed: The delay in officially completing the initial construction phase of the Carolina Beach portion of the authorized project was due, in part, to studies of the erosion problem and studies associated with possible navigation improvements for Carolina Beach Inlet.

(d) Additional emergency action: Continuation of the severe erosion along the north end of the project necessitated additional emergency action involving the construction of a 2,050-foot-long rock revetment extending southward from the north terminus of the project and the placement of about 282,000 cubic yards of beachfill. The rock revetment was not included in the original authorized project. The contract cost for the fill was $291,000, and the unit cost was $1.03 per cubic yard. The rock revetment had a design height of 12 feet (MLW) and was constructed in two stages. The first stage of the revetment along with placement of the fill was completed in December 1970. The second stage of the revetment construction was completed in September 1973.

(e) Temporary restoration: During the interim period between the two stages of revetment construction, about 734,000 cubic yards of beachfill were removed from the Cape Fear River and deposited along the entire length of the Carolina Beach portion of the project in order to restore the project to its authorized dimensions. This beachfill was completed in May 1971. The contract cost for the fill was $788,000 and the unit cost was $1.07 per cubic yard. Between the 1971 nourishment and April 1980, no additional fill material was placed on the project beaches. As a result, the severe erosion migrated to the south, leaving only the southernmost 2,000 feet of the 14,000 feet of project shoreline showing any degree of stability.

(f) Storm damage: In December 1980, the southeastern coastal area of North Carolina was struck by two severe northeasters which further aggravated the erosion at Carolina Beach, particularly along the section of the project located just south of the rock revetment. In this area, seven cottages were undermined and were condemned. Farther south, the shoreline had moved to within 25 feet of 122 other structures, making them vulnerable to damage in the event of another moderate storm. In response to the continued retreat of the shoreline along Carolina Beach, a total of 406,000 cubic yards of emergency fill was placed on the beach in April and May 1981. The contract cost for the fill was $1,052,000 and the gross unit cost was $2.59 per cubic yard. This emergency beachfill was intended to partially rebuild the severely eroded section of the project in order to provide protection against moderate storms until the entire 14,000 feet of project shoreline could be restored to authorized dimensions.

(g) Project restoration: With the adoption of a permanent plan for nourishing Carolina Beach, the project was completely restored in 1982. Total restoration of the project required the deposition of about 3,662,000 cubic yards of sand along the entire length of the Carolina Beach portion of the project. The contract cost for the fill was $8,384,000 and the unit cost was $2.29 per cubic yard. This final phase of construction completely restored the berm and dune sections from the southern end of the project to the beginning of the rock revetment. Also provided, was a 130-foot wide beach berm at an elevation of 6.5 feet above NGVD in front of the revetment.

(h) Completion of initial construction phase: With the completion of project restoration work in 1982, the initial construction phase of the Carolina Beach portion of the original authorized project, as modified, was officially declared complete.

(2) Kure Beach segment: During the design stage, the local sponsor of the Kure Beach segment indicated that they were no longer interested in supporting the project. As a result, the project was reclassified to the inactive category. Following the severe damage to coastal development and beaches caused by Hurricane David in September 1979, and Hurricane Diana in September 1984, the local sponsor indicated a renewed interest in the project. Accordingly, the Kure Beach segment was placed in the active category in June 1985. The southern portion, which includes Kure Beach is presently in the Preconstruction Engineering and Design stage and is scheduled as a new construction start in Fiscal Year 1996.

12. Project nourishment and maintenance programs:

a. Nourishment program:

(1) Local cooperation requirement: In accordance with the local cooperation agreement for the project, the community of Carolina Beach is responsible for periodic beach nourishment during the amortization period, as may be required to serve the intended purpose, except that the Federal Government will contribute, for a period of 10 years, a percentage of the annual cost thereof associated with beach erosion prevention.

(2) Periodic nourishment estimates: The cost of periodic nourishment and other related information estimated by the District Engineer in his report dated 23 September 1960 is provided in the following subparagraphs.

(a) Annual nourishment requirement: 81,000 cubic yards.

(b) Periodic nourishment quantity: 243,000 cubic yards.

(c) Periodic nourishment cycle: 3 years, or as needed.

(d) Unit cost Of nourishment: $0.70 per cubic yard.

(3) Actual periodic nourishment: The project has performed well since completion in 1982. Periodic nourishment operations were conducted in 1985, 1988, and 1991 in accordance with the 3-year nourishments cycle established as part of the long-range plan. The total volume of fill required to accomplish the three nourishment cycles was 2,724,000 cubic yards. The total cost of the periodic nourishment work was $5,993,000, and the average unit cost was $2.20. Information on the periodic nourishment work performed for the completed project is tabulated below.

Periodic Nourishment

Date	Fill Quantity (Cubic Yards)	Contract Cost ($)	Unit Cost ($/CY)
1985	764,000	1,652,000	2.16
1988	951,000	1,891,000	1.99
1991	1,009,000	2,450,000	2.43
Total	2,724,000	5,993,000	2.20

b. Extension of nourishment program: The project as originally authorized, only included Federal participation in the cost of periodic beach nourishment for a period of 10 years from the date of initiation of construction. However, due to severe and unanticipated erosion problems associated with Carolina Beach Inlet, Federal participation in the cost of periodic nourishment was extended through the 1991 nourishment cycle.

(1) Section 156 authority: Section 156 of the Water Resources Development Act of 1976 provides authority to extend the period of Federal participation in project nourishment to 15 years which begins after the initiation of construction of the project.

(2) Section 934 authority: Section 934 of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986) provides authority for Federal participation in future nourishment for a 50-year period if continuance is warranted and approved. The 50-year period begins after the date of initiation of project construction. In an effort to increase the authorized period of Federal participation in periodic nourishment of the Carolina Beach project, the District Engineer prepared a reevaluation report under Section 934. The report was completed in February 1993. The report recommendations were favorable towards extending Federal participation in periodic beach nourishment from the date of initiation of construction, 1964, through the year 2014. The recommended extension was approved.

c. Justification of extension of nourishment program: The following information on project economics was taken from the Section 934 Reevaluation Report dated February 1993. The project area has not been directly affected by a major hurricane since its initial construction in 1964. Had the area experienced a major hurricane, damages prevented by the project for this singular event, could greatly increased the total dollar value of the storm damages prevented, as listed below. Recreation benefits listed below are based on a $0.53 increase in the value of a recreational beach experience resulting from the improved project beaches. Project construction costs were computed using 1992 price levels. Annual costs and benefits are based on using an 8-1/4 percent rate of interest over the remaining project life of 20-years.

(1) Total Construction cost: $12,610,000.

(2) Total Annual Costs: $2,709,000.

(a) Nourishment costs: $1,333,000.

(b) Maintenance Costs: $1,376,000.

(3) Project benefits:

(a) Storm damages prevented: $4,901,000.

(b) Benefits during construction: $200,000.

(c) Recreation: $228,000.

(d) Total project benefits: $5,329,000.

(4) Project BCR: 1.97.

d. Proposed future nourishment: Beachfill placed in 1991 along the major portion of Carolina Beach is performing as anticipated and is providing adequate storm protection. However, based on current erosion rates, it is anticipated that periodic nourishment will be necessary in Fiscal Year 1995. The 1995 fill requirements are estimated to be 889,000 cubic yards in place on the beach. This volume consists of the material necessary to restore the authorized project dimensions based on May 1994 survey information plus anticipated losses that will occur prior to construction. The borrow area measure, or the actual volume to be dredged from the borrow area is 20 percent greater than the in-place volume, or 1,066,000 cubic yards. The total cost of the 1995 periodic nourishment is estimated to be about $3,575,000, of which $2,324,000 would be the Federal share.

e. Maintenance program: In accordance with the local cooperation agreement for the project as presented in the report of the District Engineer dated 23 September 1960, the community of Carolina Beach is responsible for maintenance of the beach berm and dune. Maintenance costs estimated in the 23 September 1960 report are provided in the following subparagraphs.

(1) Maintenance fill volumes:

(a) Dune (nourishment): 2,000 cubic yards.

(b) 12-foot berm: 16,000 cubic yards.

(2) Maintenance costs:

(a) Dune (nourishment): $1,400.

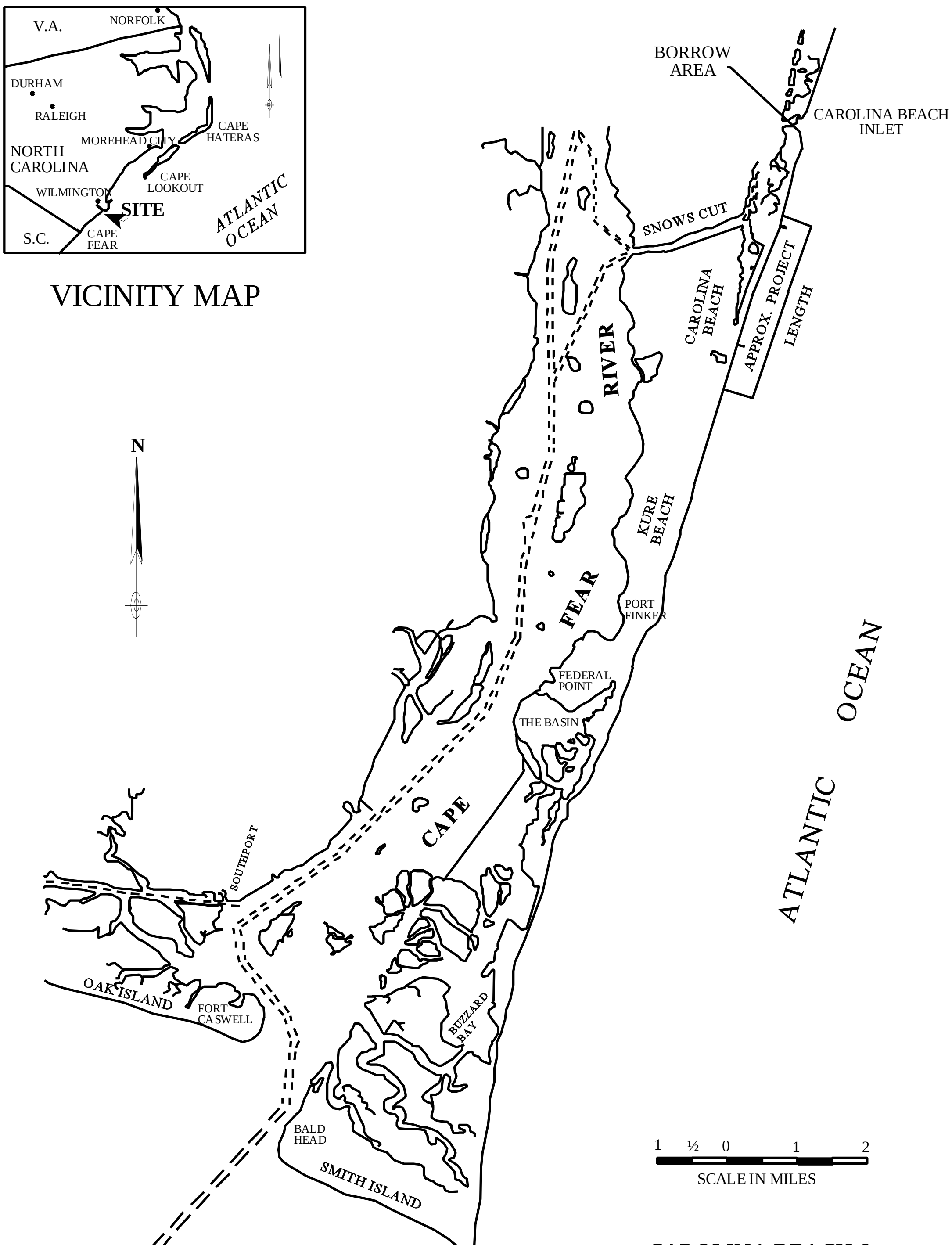
(b) Dune Vegetation: $2,000.

(c) 12-foot berm: $11,200.

(3) Maintenance interval: As needed.

(4) Additional maintenance requirements: The original authorized project was modified to provide for emergency construction of a 2,050-foot-long rock revetment extending southward from the north terminus of the project. Maintenance and repair of the rock revetment is a local responsibility. Accordingly, this responsibility was documented in the "Maintenance Manual" provided to the local sponsor following the official completion of the initial construction of the Carolina Beach portion of the project in 1982. Since its completion in 1973, the revetment has been repaired only once, in 1986 at a cost of about $25,000. Presently (1994), the revetment is in good condition with some slight slumping of the armor stone along the southern end of the revetment. Officials of Carolina Beach are aware of this problem.

13. Project performance: The project is performing essentially as designed. Since its completion in 1972, the rock revetment has required only minor repair. Given the "sacrificial" nature of the protective beach berm and dune features of the project, their rehabilitation is deemed necessary after the project has been damaged by a major storm. During a major storm event, the project provides the intended protection to shorefront developments, but in doing so, the dunes and beach berm may be so diminished that they would not be able to provide the design level of protection for the remainder of the project life. Therefore, project restoration in addition to the routine periodic nourishment and maintenance efforts may be required to ensure project integrity.



CAROLINA BEACH & VICINITY

PROJECT LOCATION MAP

APPENDIX E-C

TYBEE ISLAND, GEORGIA

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APPENDIX E-C

Tybee Island, Georgia

PROJECT DATA

1. Project name: Tybee Island, Georgia

2. Location: Tybee Island is located directly south of the Savannah Harbor entrance about 17 miles east of the City of Savannah, Georgia. The developed portion of the island is bordered on the north by the south channel of the Savannah River, on the east by the Atlantic Ocean, and on the south and west by Tybee Creek and other small tidal creeks.

3. Description: Tybee Island is about 3.5 miles long from its northerly tip to the mouth of Tybee Creek and has an average width of about one-half mile. The ocean shore of the island is about 15,000 feet long and its beaches are open to the public for recreation purposes for its entire length. Tybee Island was first used as a recreation area in the early 1800's. The island was established and has developed over the years without the aid of a Federal shore protection project. The island grew into a popular resort in 1887 with the opening of the railroad from Savannah, Georgia. Development and beach use accelerated after the highway from Savannah to Tybee Island was constructed in 1933. The island is heavily developed as a residential and tourist area as it is one of only four beaches in Georgia that is accessible by car. The beach areas are highly developed and provide practically every recreational service and convenience, including picnic areas, life guards service, parking areas, and concession facilities. Behind the beach lies a line of sand dunes, a number of which have been removed during the years to make room for improvements. Those that remain are from 10 to 20 feet high. The ground elevation on the island varies from 10 to 18 feet above Mean Low Water (MLW) and slopes westward to salt marshes. A reinforced concrete seawall extending along the entire oceanfront of the island was constructed in 1941 as part of a WPA project. The seawall stabilized the land form, served as a barrier against erosion and recession, and reduced inundation from storm surge and waves. The principal concentration of business activities on the island is located near the south end of the beach. The only highway access to the island is via U. S. Highway 80 from Savannah.

4. Corps of Engineers Division: South Atlantic.

5. Corps of Engineers District: Savannah, Georgia.

6. Statement of the problem: Recreation is a critically important and growing activity for the tourism based economy of Tybee Island. Local interests desire a project to prevent further beach erosion in order to maintain an adequate beach area for recreational purposes. The ocean shoreline of Tybee Island is subject to continual erosion and damage from ocean storms.

a. Beach erosion: The wide, sandy beach is composed of fine to medium sand and shell fragments which are easily moved by currents and wave action. Currents that move along-shore are created from wave action and astronomical and storm tides. The littoral currents are influenced by tidal flooding of the Savannah River and Tybee Creek estuaries located to the north and south, respectively. The forces resulting from the littoral currents and wave action from northeasters are the prime movers of beach sands to, around, and from the beach. This process continues to reshape or shift the shore of the island. Erosion has also caused lowering and loss of the beach fronting the existing seawall as well as the loss of land along the northerly beach area. Although erosion control measures have been ongoing since 1882, erosion and recession of the beaches continue.

b. Storm damage: High surges and large waves accompanying major storms and hurricanes cause inundation and wave damage to shore installations. These infrequent events are also responsible for the erosion of the valuable recreational beach. The last major storm to hit Tybee Island was Hurricane Dora in 1964. Remnants of storm waves from Hurricane Hugo caused erosion of the beach in September 1989. Hurricane Gordon, the most recent hurricane, passed well offshore of Tybee Island in November 1994 and traveled in a northeasterly direction up the Atlantic Coast before it reversed direction and meandered back south. There were no reports of significant erosion damage to the project or destruction of shorefront facilities on the island due to the storm.

7. Study authorization: The persistent erosion problem and storm damage along the ocean shoreline of Tybee Island prompted local interest to request that Congress authorize the Corps of Engineers to study the storm and erosion problems. Resolutions adopted by the Senate and House Public Works Committee on 29 April 1963 and 19 June 1963, respectively, directed the Corps of Engineers to conduct a study of the shores of Tybee Island in the interest of beach erosion control, hurricane protection and related purposes.

8. Project authorization: The original project for Tybee Island was authorized by Senate and House Public Works Committee resolutions adopted 22 June 1971 and 23 June 1971, respectively, under authority of Section 201 of the Flood Control Act of 1965 (Public Law 89-298, 27 October 1965).

9. Project authorization document: Information on the authorized project for Tybee Island is contained in House Document numbered 92-105, 92nd Congress, First Session.

10. Information at the time of authorization:

a. Original project description: The original project recommended by the reporting officers provided for construction of a terminal groin about 800 feet long at the north end of Tybee Island. An additional 1,200-foot extension of the rubblemound groin was deferred, as were two additional intermediate groins. Both intermediate groins are designed to b e 480 feet in length and located at critical points along the improved beach. The deferred groin improvements were authorized as part of the original project to be added at a later date, if needed. The project also provided for the initial restoration of about 8,300 feet of beach from the vicinity of 9th Street to the terminal groin located at the northern end of the island. The restored beach would have a level berm 60 feet wide at elevation 11 feet above Mean Low Water (MLW). Construction of the initial beach fill includes a 3-year advance nourishment feature. Annual periodic nourishment requirements are estimated to be 100,000 cubic yards, and will be provided at 3-year intervals to maintain the authorized project dimensions. Therefore, each nourishment cycle will require 300,000 cubic yards of fill material. Federal participation in periodic nourishment was authorized for a period of 10 years.

b. Recommended project modified by the Board of Engineers for Rivers and Harbors (BERH):

(1) The BERH recommended that the project be extended about 5,000 feet southward from 9th street to the vicinity of 18th street to provide a project for the entire ocean shoreline of Tybee Island. The length of the protected beach was thereby increased from 8,300 feet to 13,300 feet. The BERH indicated that the extension would not result in a significant change in project cost but would provide for maintaining the existing protective and recreational beach. The Chief of Engineers concurred in the views and recommendations of the BERH.

(2) The BERH also recommended that access to the beach and adequate parking should be provided in for the northernmost 4,000 feet of the proposed project, and that lands for these purposes should be provided prior to initiation of construction. The Chief of Engineers concurred in the views and recommendations of the BERH. General Design Memorandum, Supplement No. 1, dated 20 February 1974 presented the public parking and access requirements for the original authorized project.

c. Project economics: Economic data and other information on the original project as documented in the Survey Report dated 5 January 1970, BERH report dated 18 June 1970, and the report of the Chief of Engineers dated 3 November 1970 are tabulated in the following subparagraphs. The data are based on 1970 price levels, a 50-year project life, and an interest rate of 4-7/8 percent.

(1) Total first costs:

(a) With 2,000-foot groin extension: $1,078,000.

(b) Without 2,000-foot groin extension: $823,000.

(2) Total Federal first costs:

(a) With 2,000-foot groin extension: $529,000.

(b) Without 2,000-foot groin extension: $404,000.

(3) Total non-Federal first costs:

(a) With 2,000-foot groin extension: $549,000.

(b) Without 2,000-foot groin extension: $419,000.

(4) Total average annual costs: $137,000 (based on the condition without the 2,000-foot groin extension).

(a) Nourishment costs: $89,800.

(b) Maintenance Costs: $2,600.

(5) Total average annual benefits: $319,400.

(a) Land enhancement: $6,500.

(b) Reduced maintenance: $8,400.

(c) Recreation: $304,500.

(6) Benefit-to-cost ratio: 2.3

d. Fill quantities and costs: Project fill quantities and unit costs estimated in the Survey Report dated May 1980, BERH report dated 31 March 1981, and the report of the Chief of Engineers dated 29 September 1981 are tabulated in the following subparagraphs.

(1) Initial beach fill construction: The initial beach fill required for beach restoration was estimated to be 760,000 cubic yards which includes a 3-year advance nourishment amount of 300,000 cubic yards. The total estimated cost of the fill was $410,400.

(2) Annual nourishment requirement: 100,000 cubic yards.

(3) Periodic nourishment quantity: 300,000 cubic yards.

(4) Periodic nourishment cycle: 3-years.

(5) Unit cost of initial fill: $0.54 per cubic yard.

11. Project modifications from authorization to completion:

a. Completion of original authorized project features:

(1) North terminal groin:

(a) Estimated cost: The north terminal groin in the original authorization document was to be about 800 feet long, with an additional 1,200-foot extension deferred until needed. The cost of the terminal groin was estimated to be $293,000, including contingency, engineering and design, and supervision and overhead costs.

(b) Actual cost: Construction of the north terminal groin was completed in June 1975. Changes in the detail design of the north groin were made prior to construction. The changes were recommended in General Design Memorandum, Supplement No. 2, dated 15 October 1974. The completed groin as modified by the GDM Supplement extends 800 feet seaward and 225 feet landward of the old 1912 seawall location. The total cost of the north terminal groin was $876,000.

(2) Restored beach:

(a) Estimated cost: The cost of restoring the beach was estimated in the original authorization document to be $530,000, including contingencies, engineering and design, and supervision and overhead costs.

(b) Actual cost: Hydraulic placement of fill for restoration of the beach at Tybee Island began in July 1975. The beach fill which was completed in March l976, extends about 13,800 feet. This length of beach is somewhat longer than the 13,300 feet recommended in the BERH report, dated 18 June 1970. The improved beach extends from 18th street near the southern end of the island to the north groin. The beach fill required about 2,270,000 cubic yards of sand to complete at a cost of $2,628,000.

(3) Total cost of originally authorized project:

(a) Estimated first costs: The total first cost of initial construction of the project, excluding the deferred extension of the terminal groin, was estimated in the original authorization document to be $823,000, including contingencies, engineering and design, and supervision and overhead costs.

(b) Actual cost of construction: With the placement of the initial beach fill in March 1976, construction of the project, as originally authorized, was complete. The total cost of construction was $3,504,000.

b. Modifications to the original authorized project:

(1) Beach berm: A beach berm width of 60 feet was recommended in the original authorization document. The beach berm was later changed by the District Commander to a berm width of 40 feet. The berm elevation of 11 feet above MLW remained unchanged.

(2) Terminal groins: General Design Memorandum, Supplement No. 3, dated 19 February 1981 proposed that the authorized project be modified to include the addition of a terminal groin at the south end of the project and modification of the north terminal groin. The combined work was completed in February 1987 at a cost of about $607,000.

(a) South Groin: Construction of the south terminal groin was included in a contract awarded in June 1986. Work on the south groin was completed in February 1987 The south groin was constructed between 18th and 19th streets and extends 620 feet seaward from the existing seawall.

(b) Modification of north groin: The north groin was modified in 1986 during construction of the south groin. Portions of the north groin were restored to the original design elevation, and one area was raised in order to reduce the amount of sand moving northward out of the project area.

c. Completion of initial construction phase: The original authorized project for beach erosion control on Tybee Island, as modified, includes the north and south terminal groins and about 13,800 feet of beach between the groins, as measured along the concrete seawall. With the completion of work on the north and south groins in February 1987, the initial construction phase of the originally authorized project, as modified, was officially declared complete.

d. Changes in original project first costs:

(1) Original authorization: $823,000.

(2) Actual costs incurred: $3,504,000.

e. Cost of project modifications:

(1) Original authorization: None anticipated.

(2) Actual costs incurred: $607,000.

f. Total Annual Costs:

(1) Nourishment costs:

(a) Original authorization: $90,000 annually for 10-years. This amount is based on the estimated nourishment requirement of 100,000 cubic yards per year.

(b) Actual costs incurred: $1,989,000. This does not include the placement of 918,000 cubic yards of dredged material deposited on the beach in 1993 from deepening the Savannah Harbor Navigation Channel, for which there was no charge to the project.

(2) Maintenance Costs:

(a) Original authorization: $2,600.

(b) Actual costs incurred: The north groin was constructed in 1975 and modified in 1986. The south groin was completed in 1986. No maintenance of these structures has been was required since the project was completed.

g. Significant policy change: The most significant current policy change which affects economic justification is the requirement that storm damage reduction benefits must account for at least 50 percent of total project benefits for the determination of economic feasibility. In the 1970 survey report (authorization document), recreation benefits accounted for more than 95 percent of total project benefits. Since the original project was justified wholly upon recreation benefits, no structural features were included in the project design for storm damage prevention.

h. Current estimates of benefits: In the economic analysis conducted for the Section 934 Reevaluation Report on Tybee Island dated October 1994, benefits accruing the beach improvement were reevaluated. Alternatives to the authorized project were investigated with the objective of increasing the storm damage reduction potential of the project. These alternatives included increasing the height and width of the beach berm to provide increased protection from ocean storms. Storm damage reduction and recreation benefits were updated in a December 1994 "Supplemental Documentation". The current benefit information provided in the following subparagraphs was taken from that document.

i. Changes in project benefits:

(1) Storm damage reduction:

(a) Original authorization: None

(b) Section 934 Report: $ 589,000.

(2) Recreation:

(a) Original authorization: $305,000.

(b) Section 934 Report: $6,618,000.

(3) Other benefits:

(a) Original authorization: $14,000.

(b) Section 934 Report: none.

(4) Total average annual benefits:

(a) Original authorization: $319,000.

(b) Section 934 Report: $7,207,000.

(5) Project BCR:

(a) Original authorization: 2.3.

(b) Section 934 Report: 7.4.

12. Project nourishment and maintenance programs:

a. Original authorized nourishment program: The original project authorization provided for initial beach construction to include a 3-year advance nourishment feature. The beach fill was completed in March l976. Annual periodic nourishment was to be scheduled at 3-year intervals to maintain authorized project dimensions. Each nourishment cycle required 300,000 cubic yards of fill material. Federal participation in periodic nourishment was authorized for a period of 10 years. No work was carried out under this 3-year nourishment program until the 1987, when the first periodic nourishment was completed.

(1) First periodic nourishment: A contract was awarded in January 1987 for the first periodic nourishment. The first nourishment was almost eleven years after the initial beach restoration work which was completed in March 1976. Not all segments of the authorized beach improvement project required nourishment. During the nourishment operation, sand fill was placed only on those beach areas that did not experienced natural accretion. A total of 1,300,000 cubic yards of sand was placed on the authorized project beach. The nourishment work was completed in April 1987 at a cost of $1,989,000.

(2) Disposal of dredged material. In 1993, dredged material from deepening the Savannah Harbor Navigation Channel was pumped by hydraulic pipeline dredge onto the beach at Tybee Island. The District Commander and the Georgia Ports Authority determined that it was less costly to dispose of a portion of the dredged material on Tybee Island than to dump at sea. An estimated 918,000 cubic yards sand were deposited on the beach. There was no cost to the local sponsor since disposal on Tybee Island resulted in a savings to the Georgia Ports Authority. Because the dredged material had a greater percentage of fines and the slurry mix was lean, losses during placement was estimated to be about 52 percent. A large amount of the dredged material was not retained on the dry beach above the Mean High Water Line and flowed into the nearshore area. When the dredging operation reached a point where it became more economical to transport the dredged material to ocean disposal, beach fill had only been placed along 4,610 feet of beach immediately south of the north terminal groin. The overall result was a major improvement in the condition of the beach. However, the beach that was improved was not restored to authorized dimensions. In early 1995, the Georgia Ports Authority received funding from the State to construct a groin field on the South Tip Beach, which is not part of the authorized Federal project, and to provide some additional beach nourishment. This work included placement of sand on the South Tip Beach and on the project beach for about 2,000 feet north of the south terminal groin.

b. Extension of authorized nourishment period:

(1) Federal interest: Federal participation in periodic nourishment of the Tybee Island project was originally authorized for a period of 10 years.

(2) Section 156 authority: Section 156 of the Water Resources Development Act of 1976 provides authority to extend the period of Federal participation in project nourishment to 15 years which begins after the initiation of construction of the project.

(3) Section 934 authority: Section 934 of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986) provides authority for Federal participation in future nourishment for a 50-year period if continuance is warranted and approved. The 50-year period begins after the date of initiation of project construction.

(4) Section 934 Reevaluation Report: A Section 934 Reevaluation Report on Tybee Island was completed in October 1994. In that report, the Savannah District Commander found that there was a Federal interest in nourishment efforts for Tybee Island and endorsed the extension of Federal authorization from 15 years to 50 years. The report was

approved by Headquarters in June 1995, however, extension of Federal participation in periodic nourishment was not authorized at that time.

c. Proposed changes to the nourishment program: The Section 934 Reevaluation Report includes a proposal to change the nourishment program established for the original authorized project. The changes would increase nourishment fill quantities and future nourishment cycles. Information on the changes proposed in the report are provided in the following subparagraphs.

(1) Annual nourishment requirement:

(a) Original authorization document: The annual nourishment requirement, including allowances for loss of fines in dredging and the effects of the groins, was estimated in the original authorizing document to be 100,000 cubic yards. The total volume of fill require per 3-year cycle was 300,000 cubic yards.

(b) Section 934 Report: A study of littoral processes on Tybee Island conducted for the Section 934 Reevaluation Report developed a new erosion rate of 78,000 cubic yards annually. Using a 52 percent loss factor resulted in a total annual nourishment requirement of 119,000 cubic yards. Also, a fill quantity of 830,000 cubic yards per cycle is recommended.

(2) Initial nourishment quantity:

(a) Original authorized project: During the initial nourishment operation for the original project, a total of 1,300,000 cubic yards of sand was required to restore the beach to authorized dimensions. The nourishment work was completed in April 1987.

(b) Section 934 Report: In his Section 934 Reevaluation Report the District Commander proposes an "initial nourishment" to begin in December 1996. The initial nourishment under the 934 authority would be followed by nourishments in years 2003, 2010, and 2017. The total volume of fill material required for the initial nourishment operation to be performed in 1996 is estimated to be 1,128,000 cubic yards. Subsequent periodic nourishment operations would require 830,000 cubic yards per cycle.

(3) Initial nourishment cost:

(a) Original authorization: $1,989,000. (Following an 11-year period of no nourishment.)

(b) Section 934 Report: $5,498,000 (Includes 7 years of advance nourishment).

(4) Periodic nourishment cycle:

(a) Original authorization: The original authorizing document recommended 3-year nourishment cycles to stabilize and maintain the improved beach at Tybee Island.

(b) Section 934 Report: Future nourishment as proposed in the Section 934 Reevaluation Report is to be accomplished in 7-year cycles.

(5) Fill unit cost:

(a) Original authorization: $0.54 per cubic yard for initial construction and for subsequent periodic nourishments.

(b) Section 934 Report: $2.13 per cubic yard for initial periodic nourishment, and $2.94 thereafter for subsequent nourishment operations.

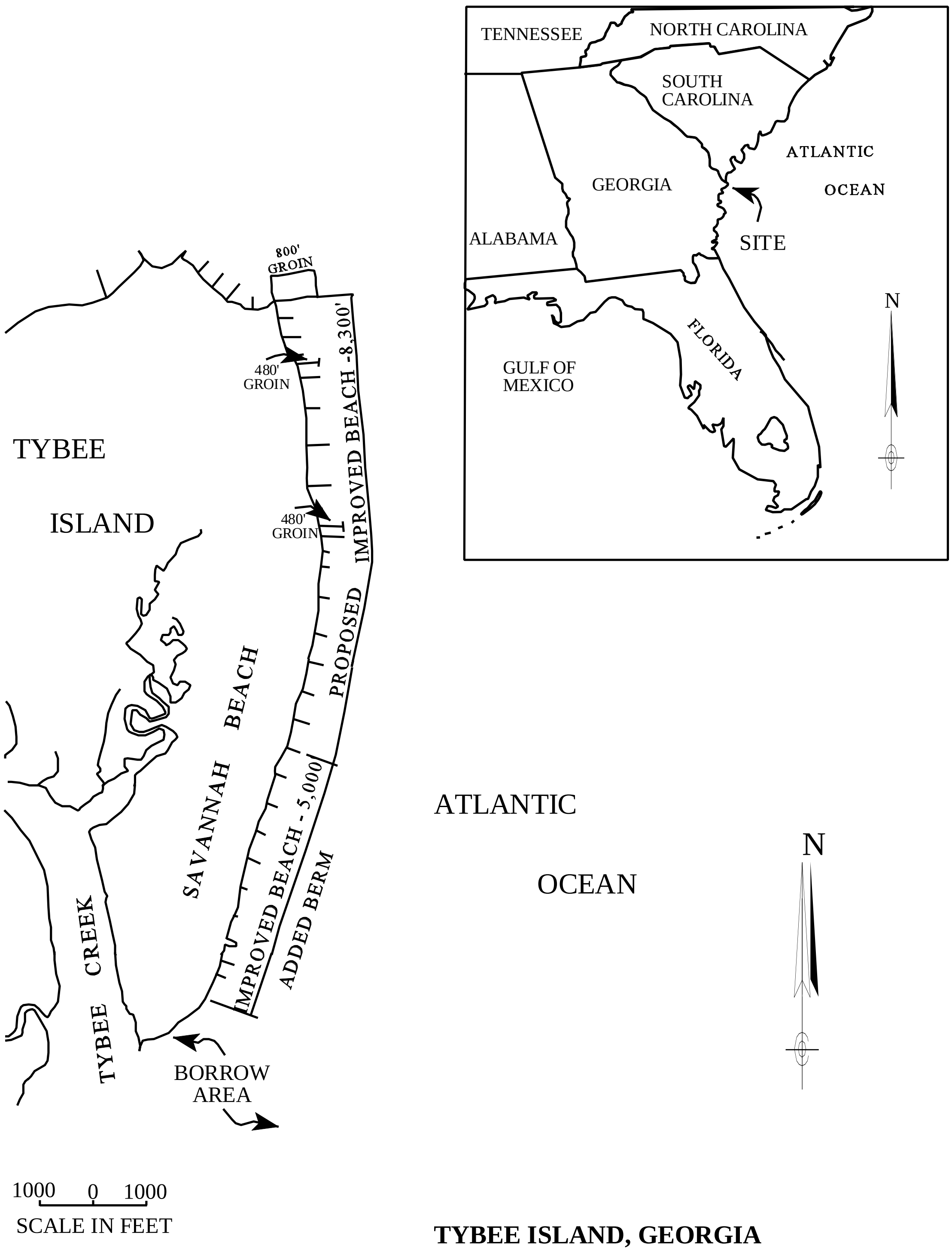
d. Maintenance program:

(1) Maintenance costs:

(a) Original authorization: $2,600 annually.

(b) Actual costs incurred: None.

13. Project performance: The project is performing essentially as designed. No maintenance has been required on the north and south groins since their final completion in 1987. Given the "sacrificial" nature of the protective beach berm feature of the project, its rehabilitation is deemed necessary after the project has been damaged by a major storm. During a major storm event, the project provides the intended protection to shorefront developments, but in doing so, the beach berm may be so diminished that it would not be able to provide the desired protection for the remainder of the project life. Therefore, project restoration in addition to the routine periodic nourishment and maintenance efforts may be required to ensure project integrity.



TYBEE ISLAND, GEORGIA
BEACH EROSION CONTROL AND HURRICANE PROTECTION
PLAN OF IMPROVEMENT

APPENDIX E-D

GRAND ISLE AND VICINITY, LOUISIANA

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APPENDIX E-D

Grand Isle and Vicinity, Louisiana

PROJECT DATA

1. Project name: Grand Isle and Vicinity, Louisiana.

2. Location: The authorized project for Grand Isle is located along the Gulf of Mexico in Jefferson Parish, Louisiana. It is about 50 miles south of New Orleans and 45 miles northwest of the Southwest Pass of the Mississippi River. Grand Isle is one of the many low irregular barrier islands separated by bays, lagoons, and bayous which forms a part of the gulf shoreline of Louisiana.

3. Corps of Engineers Division: Lower Mississippi Valley.

4. Corps of Engineers District: New Orleans.

5. Project Authorization: The original project was adopted by Public Works Committee resolutions dated September 23, 1976 and October 1, 1976, under authority of Section 201 of the Flood Control Act of 1965 (Public Law 89-298, 27 October 1965).

6. Original project authorization document: House Document numbered 94-639, 94th Congress, 2d Session. Referred to Public Works Committee for printing on 29 September 1976.

7. Development and land use: Historically, Grand Isle developed as a base of operations for large offshore petroleum and sulfur industries and as a commercial fishing center. It is also a significant recreation and sportfishing area for residents of Louisiana and nearby states. Grand Isle offers one of the few valuable recreation beaches in the State of Louisiana. It provides opportunities for excellent fishing and boating. In the face of continuing demand for such facilities, recreation beach-orientated economic activity on the island is expected to continue at a rapid pace. Of the 2,340 acres on the island, 640 acres are in residential development, 210 in industrial development, and 213 in commercial, Government, and public establishments. There is a state-owned park with about 126 acres of beach area. Grand Isle was established and has developed over the years without the aid of a Federal shore protection project. The remainder of the vacant land that is available on the island is low and swampy.

8. Statement of the problem: Past history of the Grand Isle indicates that beach erosion and inundation and damage from hurricanes have caused major problems dating back to the mid 1800's.

a. Beach erosion: Erosion of the Gulf shore of Grand Isle is a serious and continuing problem. The sand beach which is being eroded is particularly attractive to recreationists and is adjacent to the most heavily developed area on the island. In addition to the loss of the valuable and scenic beachfront, many homes, business establishments, and other improvements are subject to damage from erosion of the island. Louisiana State Highway 1, the only access to the mainland, is also subject to damage from erosion.

b. Hurricane damage: The Grand Isle area has experienced many hurricanes causing serious damage and loss of life. The most damaging hurricanes have approached Grand Isle from the south, southeast, and southwest. Hurricanes have caused widespread flooding and damage to the entire area by penetration of the hurricane surge inland across Grand Isle. Flooding has been experienced from both the gulf side and the bay side of the island. Hurricanes passing west of Grand Isle produce high stages and large waves along the gulf side of the island, causing inundation of the entire island. The force of the large waves is a significant cause of damage on the island. The Standard Project and Probable Maximum Hurricanes would produce stages of 10 feet and 17 feet, Mean Sea Level, respectively.

(1) Hurricane Flossy: On 24 September 1956, Hurricane Flossy struck the area of causing tidal flood damage on Grand Isle. High winds and waves forced water behind the island through Barataria Bay and into Caminada Bay. Grand Isle was inundated from the bay side to depths of 4 to 8 feet.

(2) Hurricane Carla: On 9-13 September 1961, Hurricane Carla passed inland about 400 miles west of Grand Isle. Carla was one of the most severe gulf hurricanes of the century and caused high tides and attendant extensive damage and inundation of low-lying areas along Coastal Louisiana. Storm induced tides ranged from about 3.5 to 7.5 feet. Louisiana Highway 1, which serves as the only vehicle escape route for residents of Grand Isle, was inundated from 9 to 13 September at several locations.

(3) Hurricane Hilda: Hurricane Hilda crossed the Louisiana coast about 100 miles west of Grand Isle during the evening of 3 October 1964. With winds of 98 miles per hour, Hilda caused heavy damage to offshore and coastal oil installations in the vicinity of Grand Isle and generated surge heights of about 4 to 5.5 feet. The hurricane caused considerable damage to the beach at Grand Isle.

(4) Hurricane Betsy: Hurricane Betsy was the most destructive storm of record at the time for the Louisiana Coast and one of the great hurricanes of the century. Betsy struck just west of Grand Isle on the night of 9 September 1965. Winds of 100 mile per hour with gusts up to 160 miles per hour were reported at Grand Isle while the island experienced a maximum surge height of 8.8 feet. The entire Island was inundated and virtually all buildings were either swept away, demolished, or severely damaged by the onrushing surge and waves. The entire beach and adjacent sand dunes were swept back over the island by the high surge and waves. The coastal highway was covered with 3 feet of sand in some places and was severely eroded in others.

(5) Recent hurricanes: In November 1994, Hurricane Gordon passed through the Florida Straits before traveling northeastward up the Atlantic Coast. The storm did not impact the project area.

9. Study authorization:

a. Request for a study authorization: As a result of inundation and property damage caused by Hurricanes Flossy and Carla, local interests requested that Congress authorize the Corps of Engineers to study the storm and erosion problems. The House Public Works Committee adopted a resolution on 26 September 1963 requesting that studies be made of the shores of Grand Island in the interest of beach erosion control, hurricane protection, and related purposes.

b. Additional study authorization: Reacting to the severe erosion damage and destruction of property on Grand Island caused by the hurricanes described above, the House Public Works Committee adopted a resolution on 5 May l966. The resolution called for a review of reports on Grand Isle to determine whether any modifications with respect to hurricane protection at Grand Isle were advisable, particularly in light of damages suffered by the recent hurricane, "Betsy."

10. Prior projects: Prior to 1951, no major efforts were made to control beach erosion on Grand Isle. Remedial measures attempted during the period 1951 to 1968 were constructed by the U. S. Coast Guard, State of Louisiana, and local interests. These measures all proved to be unsuccessful in resolving the erosion problem. In 1970, the Corps of Engineers designed and constructed a stone revetment that tied about 1,400 feet of shoreline fronting the U. S. Coast Guard station into an existing eastern jetty. In 1972, the State completed construction of a 2,600 foot long groin and placed sandfill on its landward side.

11. Information at the time of authorization:

a. Original project description: The original hurricane and beach erosion control project for the protection and enhancement of Grand Isle was authorized by resolutions of the Senate and House Public Works Committees in accordance with the plans and conditions set forth in House Document Numbered 94-639, 94th Congress, 2d Session. The authorized project provided for construction of a sandfill berm and dune extending the length of Grand Isle's gulf shore. The dune and berm would provide protection from damages caused by gulf waves driven by hurricanes that occur with an average frequency of once every 50 years. The project also included a stone jetty about 2,600 feet long at Caminada Pass to stabilize the western end of the island. The dune has a crown width of 10 feet and a top elevation of 11.5 feet, Mean Sea Level (MSL). Protective vegetation was planted on the dune. Federal participation in periodic beach nourishment was limited to a ten-year period. The project would not provide protection from back bay flooding. The reporting officers recommended that local interests be allowed a credit, limited to $1,000,000, applicable to their share of the project costs for emergency works completed by the State of Louisiana in July 1972. The emergency improvements consisted of a rubblemound jetty and placement of sandfill on its landward side. This work, although completed prior to authorization, was accomplished in accordance with the recommended plan of improvement.

b. Initial fill quantities and unit costs of the original project: The total volume of initial fill to establish the dune and beach berm was estimated by the District Engineer in his report dated 31 October 1972 to be 2,540,000 cubic yards. Of this amount, 640,000 cubic yards were placed by local interests prior to authorization of the project. The emergency work was required to prevent serious and imminent damage to property on the island. The unit cost of the fill placed by the local sponsor was $0.93 per cubic yard. The unit cost for subsequent filling operations to construct the beach berm and dune to project dimensions was estimated by the reporting officers to be $1.65 per cubic yard.

c. Original project costs and benefits: The following information on project economics was taken from an Addendum to the report of the Chief of Engineers dated 29 September 1975. The report of the Chief of Engineers along with the Addendum is contained in House Document numbered 94-639, 94th Congress, 2d Session. Project first costs were computed using 1974 price levels. Annual costs and benefits are based on a 50-year period of analysis and an interest rate of 5-7/8 percent.

(1) Total first costs: $10,600,000.

(2) Total Federal first costs: $5,700,000.

(3) Total non-Federal first costs: $4,900,000.

(4) Total average annual costs: $833,000.

(a) Nourishment costs: $115,000.

(b) Post hurricane replenishment: $45,000.

(c) Dune and jetty maintenance: $12,000.

(5) Project benefits:

(a) Storm damages prevented: $538,000.

(b) Erosion prevention: $374,000.

(c) Intensified land use: $237,000.

(d) Recreation: $634,000.

(e) Total average annual benefits: $1,783,000.

(6) Project BCR: 2.1.

12. Project modifications from authorization to completion:

a. Project authorization: The project was authorized by Congress in 1976.

b. Phase I and Phase II General Design Memoranda: A Phase I, General Design Memorandum was prepared in June 1979 and a Phase II, General Design Memorandum was prepared in June 1980. The following information was taken from those reports.

Project Costs and Benefits ($)

Project Costs	Phase I	Phase II
Total first costs:	10,900,000	13,800,000
Federal:	6,760,000	8,310,000
Non-Federal:	4,140,000	5,490,000
Total average annual Costs:		
Nourishment costs:	457,000	415,000
Nourishment cycle:	4 years	4 years
Project benefits:		
Storm damage reduction:	659,000	781,000
Erosion prevention:	429,000	511,000
Intensification:	67,000	73,000
Recreation:	605,000	605,000
Area redevelopment:	128,000	200,000
Total average annual benefits:	1,888,000	2,170,000
Project BCR:	1.5	1.5

c. Project Construction: A construction contract was awarded on 25 July 1983 for construction of the 7-mile long beach berm and dune. the dredging contract was essentially completed on 26 August 1985. About 2,970,000 cubic yards of hydraulic fill were placed at a total cost of $8,967,000. The unit cost of the fill was $3.02. Prior to official completion of the initial construction phase of the project and its acceptance by local interests, the project was damaged by Hurricanes Danny, Elena, and Juan. The damages to the project involved the loss of approximately 6,000 feet of dune, and partial loss of about feet of dune. While the project was severely damaged, it prevented major destruction of property on Grand Isle. No structural damage was experienced during Hurricanes Danny and Elena and only minor damage was sustained from Hurricane Juan. The New Orleans District Commander estimated that the damages prevented by the project was about $12,000,000. Additional damage to the project occurred during Hurricane Bonnie in 1986, Hurricanes Gilbert and Florence in 1988, and Hurricanes Chantal and Jerry in 1989. The project area was not impacted by Hurricane Gordon as it passed through the Florida Straits in November 1994, and headed northeastward up the Atlantic Coast.

d. Project restoration: Repair and restoration of the project was accomplished under two contracts.

(1) First contract: The first contract was completed on 5 February 1988 and provided for a 200-foot extension of the east jetty, a 500-foot extension of the west jetty, and removal of 408,000 cubic yards of sand from the cuspate bar for use in the repair of the eroded beach at the eastern end of the island. The cost of this contract was $1,745,000.

(2) Second contract: The second contract which was awarded on 21 March 1990, provided for repair of the dune and beach berm. About 1,422,000 cubic yards of sand was placed by this contract. The work under the contract was completed on 4 September 1991 and the project was turned over to the local sponsor on 1 October 1991. The cost of this contract was $10,934,000. As of 30 September 1993, the actual cost of the project totaled $31,600,000. This total includes $12,600,000 Federal costs and $19,000,000 non-Federal costs.

e. Project modification: On 24 August 1992, Hurricane Andrew caused major damages to the dune and beach berm. The Fiscal Year 1992 Supplemental Appropriations Act authorized $5,500,000 to repair the erosion damage to the beach berm and dune and to construct a series of segmented breakwaters located offshore and generally parallel to the shore. Since this work was authorized and funded under the Flood Control and Coastal Emergencies Appropriations, it is not included in the official project cost estimate.

(1) Restoration of beach berm and dune: A contract was negotiated to repair the beach and dune at a total cost of $2,491,000. Work under the contract consisted of depositing about 310,000 cubic yards of sand fill along the shore. The beach fill operation was completed on 24 March 1994.

(2) Construction of segmented breakwaters: A second contract to construct the segmented rubblemound breakwaters was awarded on 21 September 1994. The contract provides for construction of 23 segmented breakwaters to be constructed offshore and parallel to the beach. The breakwaters are about 200 feet in length and spaced 350 feet apart. The cost of the work under this contract is $2,296,000. Construction of the breakwaters is scheduled for completion in early 1995.

f. Completion of initial project: With the completion of the segmented breakwaters in 1995, the initial construction phase of the project will be officially declared complete.

13. Project nourishment and maintenance programs:

a. Authorization of nourishment program: In his Review Report dated 31 October 1972, the New Orleans District Engineer recommended that the Federal Government contribute $11,000 annually towards the cost of periodic beach nourishment of project features associated with beach erosion prevention for an initial period of 10 years. The Board of Engineers for Rivers and Harbors and the Chief of Engineers concurred in the recommendation, and nourishment was authorized for a period not to exceed 10 years. The following information was taken from the Review Report dated 31 October 1972.

(1) Nourishment costs: $93,000 annually.

(2) Nourishment Cycle: 5 years.

b. Extension of authorized nourishment period:

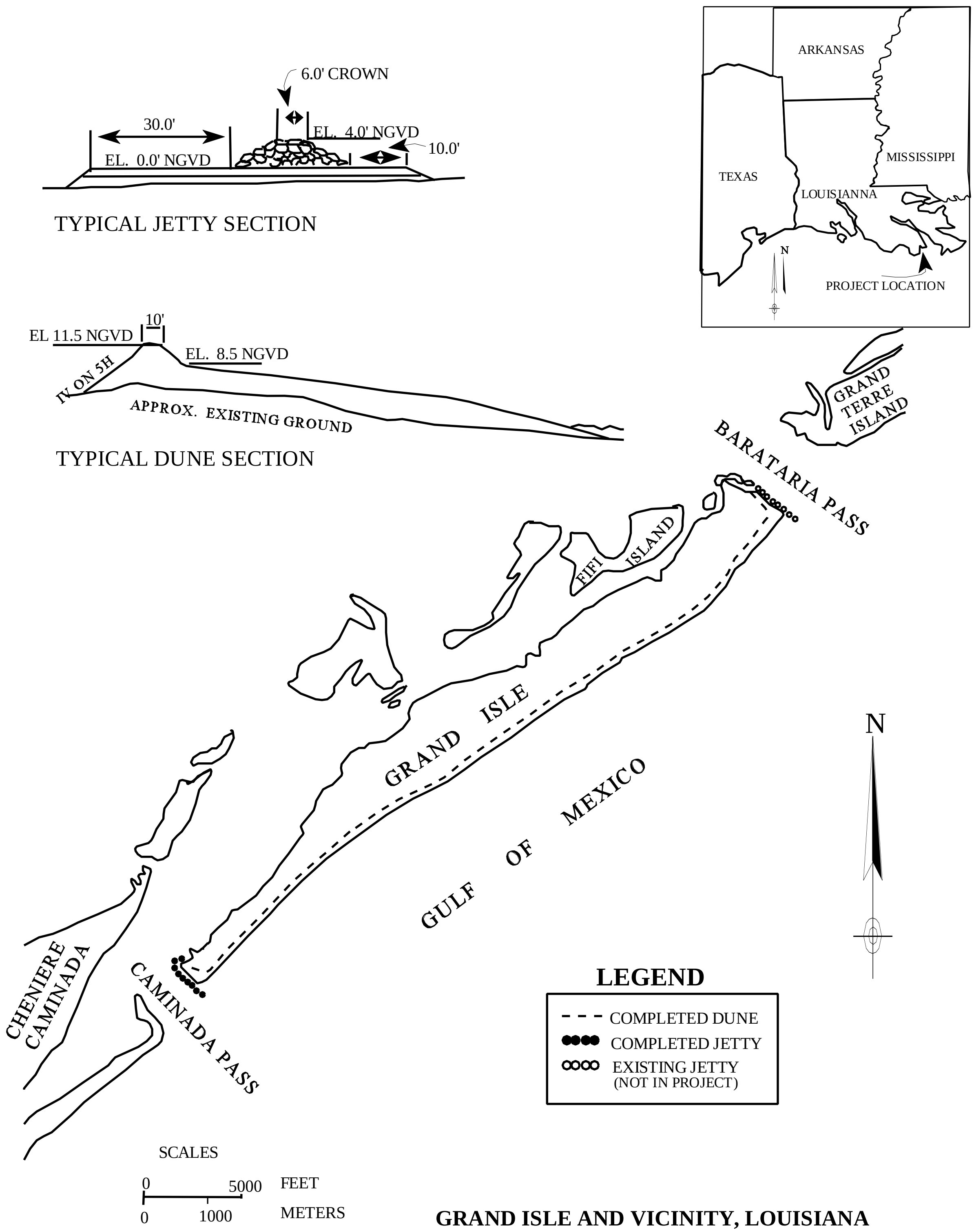
(1) Section 156 authority: Section 156 of the Water Resources Development Act of 1976 provides authority to extend the period of Federal participation in project nourishment to 15 years which begins after the initiation of construction of the project. The nourishment period for the Grand Isle project was increased from 10 years to 15 years.

(2) Section 934 authority: Section 934 of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986) provides authority for Federal participation in future nourishment for a 50-year period if continuance is warranted and approved. The 50-year period begins after the date of initiation of project construction. No Section 934 Reevaluation Report has been prepared for the Grand Isle project to determine if there was a Federal interest in extending nourishment efforts for Grand Isle and to endorse extension of Federal authorization from 15 years to 50 years.

c. Scheduled periodic nourishment: Because of the repeated damages and subsequent repairs made to the authorized erosion prevention features of the project, no scheduled periodic nourishment has been performed to date. The District Commander estimates that periodic nourishment should occur on an average of once every 4 years. The cost of periodic nourishment is currently estimated to be $1,900,000 annually.

d. Maintenance program: Because of the repeated damage and subsequent repair and rehabilitation of the project using available emergency appropriations, no scheduled maintenance of the project has been performed. It is anticipated that only minor maintenance would be required annually, or as needed.

14. Project performance: The project is performing essentially as designed. However, the "sacrificial" nature of the protective dunes and beach berm features of the project, requires their rehabilitation after the project has been damaged by a major storm. During storm events, the project would provide the intended level of protection to shorefront developments, but in doing so, the dunes and beach berm may be so diminished that they would not be able to provide the desired protection for the remainder of the project life. Therefore, emergency project restoration in lieu of routine periodic nourishment and maintenance efforts may be required to ensure project integrity.



GRAND ISLE AND VICINITY, LOUISIANA

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APPENDIX E-E

PRESQUE ISLE PENINSULA, ERIE, PENNSYLVANIA

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APPENDIX E-E

Presque Isle Peninsula, Erie, Pennsylvania

PROJECT DATA

1. Project name: Presque Isle Peninsula, Erie, Pennsylvania.

2. Location: The authorized project for the Presque Isle Peninsula is located on the south shore of Lake Erie in the vicinity of Erie, Pennsylvania. The project area is 78 miles southwest of Buffalo, New York and 102 miles east-northeast of Cleveland, Ohio.

3. Corps of Engineers Division: North Central.

4. Corps of Engineers District: Buffalo, New York.

5. Project authorization:

a. The original cooperative beach erosion control project for the Presque Isle Peninsula was authorized by the 1954 River and Harbor Act (Public Law 83-780, 3 September 1954).

b. The offshore breakwater modification: The segmented offshore breakwater project was authorized by Section 501(a) of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986).

6. Project authorization documents:

a. Original project document: House Document Numbered 231, 83d Congress, 1st Session.

b. Offshore breakwater modification: No House or Senate Documents were printed. The project was authorized in accordance with the Report of the Chief of Engineers dated 2 October 1981.

7. Presque Isle Peninsula: The peninsula is a curved sand spit projecting in a northeasterly direction from its narrow connection with the mainland shore. A landlocked bay, about 5 miles long and somewhat less than 2 miles wide, located between the peninsula and the mainland is know as Presque Isle Bay, or Erie Harbor. Virtually all of the 3,200 acres of the peninsula is owned by the Commonwealth of Pennsylvania and is developed as a park. The State park and recreation area is the year-round destination for about five million visitors a year. The beaches have had a long history of serious erosion. Preservation of the peninsula is of vital importance to Erie Harbor and Presque Isle State Park. The peninsula is under constant attack by wind and waves. Numerous shoreline protective measures have been constructed over the years with little success. Remnants of old groins, revetments, bulkheads, and other protective works along the shoreline bare testimony of failed projects constructed over the years.

8. Storms and breaches: Past history of the Presque Isle peninsula indicates that erosion has been a major problem dating back to the early 1800's. The peninsula has been particularly susceptible to damage by reason of strong easterly currents, high water levels, and wave action accompanying storms from the west and southwest. At such times, the highway along the neck becomes impassable and frequently suffers damage from scour and deposition of sand on the pavement. During the period of record, the neck of the peninsula was beached in 1828, 1833, 1873, and 1917. The severe damage to the peninsula and its developments was caused by a series of storms occurring in December 1942, December 1943, November 1944, and December 1944.

9. Study authorization: As a result of property damage and loss of valuable recreation beach caused by the severe and persistent erosion problem on the Presque Isle Peninsula, the Commonwealth of Pennsylvania made a formal application on 25 June 1947 for the Corps of Engineers to study the problem and develop a plan of improvement to reduce erosion and preserve the peninsula. The application was approved by the Chief of Engineers on 5 August 1947, in accordance with authority conferred by the provisions of Section 2 of the River and Harbor Act of 3 July 1939.

10. Information at the time of authorization:

a. Original project description: A cooperative beach erosion control project for the protection and improvement of Presque Isle Peninsula was originally authorized by the 1954 River and Harbor Act in accordance with the plans and conditions set forth in House Document Numbered 231, 83d Congress, 1st Session. The project provided for construction of a seawall, bulkhead, and groin system along the neck of the peninsula, and removal of a portion of the Lighthouse Jetty and adjacent bulkhead. The project also provided for restoration of the beaches on the lakeward perimeter of the peninsula by placement of 2,500,000 cubic yards of sand fill. The Federal share was one-third of the total first cost of the project. Construction of the project was completed in 1959.

b. Original project costs and benefits: The following information on project economics was taken from the report of the District Engineer, dated 31 October 1951, contained in House Document numbered 231, 83d Congress, 1st Session. Unit prices are based on July 1948 price levels. Annual costs and benefits were calculated using a 50-year period of analysis and interest rates of 3 percent Federal and 3-1/2 percent non-Federal.

(1) Total first costs: $5,724,000.

(2) Total Federal first costs: $1,899,000.

(3) Total non-Federal first costs: $3,825,000.

(4) Average annual costs:

(a) Nourishment costs: Initial project construction included the placement of 1,000,000 cubic yards of material on a feeder beach. Additional beach replenishment was required to maintain the beach project. The annual cost of nourishment which was based on replacement of the feeder beach after 20 years, was estimated to be about $57,500.

(b) Nourishment cycle: 20 years, or as needed.

(c) Maintenance costs: $5,000.

(d) Total average annual costs: $274,900.

(5) Average annual benefits:

(a) Direct damages prevented: $30,000.

(b) Reduction of future maintenance: $50,000.

(c) Recreation: $250,000.

(d) Total average annual benefits: $330,000.

(6) Benefit/cost ratio: 1.2.

c. Modification of the original project by the Beach Erosion Board (BEB): The BEB believed that the feeder-beach method of shore restoration would result in lower costs than the complete plan which included groins and bulkheads. The BEB considered that the groin and bulkhead structures would not be essential, if the supply of beach material were restored to the eroded areas. Therefore, the BEB recommended that these structures be eliminated from the recommended plan. The Chief of Engineers concurred. The first costs and annual costs of the project, as modified by the BEB, were estimated using January 1952 price levels. Project benefits were not changed and remain at July 1948 price levels. The revised economic analysis of the project as taken from the BEB report dated 23 April 1952 is provided in the following subparagraphs.

(1) Total first costs: $5,259,000.

(2) Total Federal first costs: $1,753,000.

(3) Total non-Federal first costs: $3,506,000.

(4) Total average annual costs: $310,000.

(5) Total average annual benefits: $330,000.

(6) Benefit/cost ratio: 1.07.

11. Project modifications from authorization to completion:

a. Authorization of periodic nourishment: When the cooperative beach erosion project was authorized in 1954, it was recognized that periodic beach nourishment with sand fill would be required to preserve the full protective and recreational function of the project. However, sand losses were greater than estimated. To control the erosion to the point where the protective structures and the State Park facilities would not be threatened, a modification to the project was required. Project modification was authorized by the 1960 River and Harbor Act (Public Law 86-645, 14 July 1960) in accordance with the recommendations contained in House Document numbered 397, 86th Congress, 2d Session. The Act authorized Federal participation in beach nourishment to the extent of one third of the cost for a period of 10-years. Later, the 1962 River and Harbor Act increased the Federal share of project cost to 70 percent.

b. Extension of nourishment program: The nourishment authorization under the 1960 River and Harbor Act expired in 1971. The 1974 Water Resources Development Act (Public Law 93-251, 7 March 1974) reinstated and extended Federal participation in the costs for beach nourishment. The cost to the Federal Government was not to exceed $3,500,000 for a period of five years. The 1976 Water Resources Development Act (Public Law 94-587, 22 October 1976) extended Federal participation in the cost of nourishment during the preconstruction period in anticipation of a project which would provide permanent protection to the peninsula. Nourishment was authorized to continue indefinitely or until a permanent structural solution was constructed. The protective beach berm was maintained under that authority from 1979 to 1990, when the first construction funds for the project modification were received.

c. Offshore breakwater plan:

(1) Phase I, General Design Memorandum: The final Phase I, General Design Memorandum completed in November 1980, recommended modification of the existing Federal shore protection project at Presque Isle Peninsula. The

recommended improvements were authorized for construction by Section 501(a) of the Water Resources Development Act of 1986. The Act specified a total construction cost, "of $34,800,000, with an estimated Federal first cost of $18,900,000 and an estimated non-Federal first cost of $15,900.000." The modification provided for construction of 58 offshore rubblemound breakwater segments, initial placement of sand fill to create a beach berm, removal of existing shore protection structures, and annual beach replenishment. The benefits used to justify construction of the recommended improvements were predominantly attributed to recreational beach use. The total average annual recreation benefits based on a 50-year project life, 7-3/8 percent interest rate, and October 1980 price levels were estimated to be $3,459,000.

(2) Phase II, General Design Memorandum: The Phase II, General Design Memorandum, Detailed Project Design, Presque Isle Peninsula, Erie, Pennsylvania, dated April 1986, recommended modification of the existing Federal shore protection project at Presque Isle Peninsula. The modification plan was similar to the plan recommended in the Phase I, General Design Memorandum. The modification plan provided for construction of 58 offshore rubblemound breakwater segments, initial placement of 200,000 cubic yards of sand fill to create a beach berm with an average width of 75 feet and a crest elevation of 10 feet above Low Water Datum (LWD), removal of existing shore protection structures, and annual beach replenishment of 38,000 cubic yards. The breakwaters are each 150 feet long with a crest elevation of 8 feet above LWD. Spacing between breakwater segments is 350 feet. The short, detached segments are design to limit wave energy reaching the shoreline and thus, reduce the rate of erosion. Staged construction of the modification improvements over a 12-year period produced the greatest net benefits and was recommended.

d. Offshore breakwater project costs and benefits: The following information was taken from the economic studies prepared for the Phase II, General Design Memorandum, Detailed Project Design, Presque Isle Peninsula, Erie, Pennsylvania. Project costs and benefits are based on a 50-year period of analysis, an interest rate of 8-5/8 percent, and a 12-year staged construction program. Unit prices are at January 1986 price levels.

(1) Project first costs:

(a) Total first costs: $33,000,000.

(b) Total Federal first costs: $22,000,000.

(c) Total non-Federal first costs: $11,000,000.

(2) Average annual costs:

(a) Nourishment costs: $385,000 annually.

(b) Nourishment cycle: Annually, or as needed.

(c) Maintenance costs: $60,000 annually.

(d) Total average annual costs: $2,126,000.

(3) Average annual benefits:

(a) Nourishment costs savings: $2,397,000.

(b) Harbor dredging savings: $240,000.

(c) Decreased road maintenance: $107,000.

(d) Decreased structure maintenance: $4,000.

(e) Land loss costs: $13,000.

(f) Recreation beach use: Since the current nourishment program provides sufficient beach area to meet the long-term recreation needs of Presque Isle State Park, no recreation benefits were used to justify the project.

(g) Total average annual benefits: $2,761,000.

(4) Benefit/cost ratio: 1.3.

e. Staged construction: In the economic studies for the Phase II, General Design Memorandum, consideration was given to a 2-year traditional construction period, and 12-year and 24-year staged construction programs. Based on the results of the studies, the 12-year construction period was found to be the most cost effective schedule for construction and maximized net discounted benefits. The local sponsor indicated its preference to construct the project over the 12-year period. However, Congress and the Administration indicated a strong preference for the most rapid construction that could effectively be completed. In February 1988, the Buffalo District Commander was directed to construct the project in the traditional manner. Construction funds were received in Fiscal year 1990 and the offshore breakwater project was completed in November l992. The initial beach fill was 373,000 cubic yards as compared with 200,000 cubic yards estimated in the Phase II, General Design Memorandum. While 58 breakwaters were authorized, only 55 were constructed. The remaining 3 breakwaters were deferred until needed.

f. Offshore breakwater project costs and benefits: The following information was taken from the economic studies prepared for the Phase II, General Design Memorandum, Detailed Project Design, Presque Isle Peninsula, Erie, Pennsylvania. Project costs and benefits are based on a 50-year period of analysis, an interest rate of 8-5/8 percent, and a 2-year traditional construction period. Unit prices are at January 1986 price levels.

(1) Project first costs:

(a) Total first costs: $21,340,000.

(b) Total Federal first costs: $13,850,000.

(c) Total non-Federal first costs: $7,490,000.

(2) Average annual costs:

(a) Nourishment costs: $385,000 annually.

(b) Nourishment cycle: Annually, or as needed.

(c) Maintenance costs: $60,000 annually.

(d) Total average annual costs: $2,560,000.

(3) Average annual benefits:

(a) Nourishment costs savings: $2,397,000.

(b) Harbor dredging savings: $342,000.

(c) Decreased road maintenance: $167,000.

(d) Decreased structure maintenance: $6,000.

(e) Land loss costs: $21,000.

(f) Recreation beach use: Since the current nourishment program provides sufficient beach area to meet the long-term recreation needs of Presque Isle State Park, no recreation benefits were used to justify the project.

(g) Total average annual benefits: $2,933,000.

(4) Benefit/cost ratio: 1.15.

12. Project nourishment and maintenance programs:

a. Beach nourishment program: When the cooperative beach erosion project was authorized in 1954, it was recognized that periodic beach nourishment with sand fill would be required. The beaches along the shore of Presque Isle State Park have been maintained by periodic nourishment since the project was authorized in 1954. The purpose of the nourishment program is to control erosion of the unique peninsula. Although the nourishment program was originally considered a temporary solution, Congress authorized nourishment as a continuous erosion control program until a "permanent solution" was constructed.

b. Beach nourishment operations:

(1) Period prior to construction of offshore breakwaters: Beach nourishment operations authorized by the 1960 Act were undertaken in 1960-1961, 1964-1965, 1965-1966, 1968-1969, and 1971 at a total cost of $2,178,000. The Federal share of the nourishment costs was $1,329,000 and the remaining $849,000 was the responsibility of the local sponsor. The nourishment authorization under the 1960 River and Harbors Act expired in 1971. The 1974 Water Resources Development Act reinstated and extended Federal participation in the costs for beach nourishment. The cost to the Federal Government was not to exceed $3,500,000 for a period of five years. Nourishment of the beaches was undertaken in 1975, 1976, 1977, 1978, and 1979 at a total cost of about $5,000,000, of which $3,500,000 were Federal funds. The non-Federal cash contribution was $1,500,000. The 1976 Water Resources Development Act extended Federal participation in the cost of beach nourishment during the preconstruction period in anticipation of a project which would provide permanent protection to the peninsula. The protective beach berm was maintained under that authority from 1979 to 1989.

(a) Periodic Beach nourishment, 1975-1985: The volumes and costs of beach fill placed on the beaches along the Presque Isle Peninsula for the 11-year period, 1975 to 1985 are tabulated below. The approximate conversion between tons and cubic yards of fill material is 1 cubic yard = 1.5 tons.

Year	Tons Placed
1975	186,700

1976	182,900
1977	287,000
1978	173,000
1979	216,000
1980	215,900
1981	235,800
1982	283,700
1983	194,100
1984	222,300
1985	312,200

Total tons placed: 2,509,600.

Total cost of fill: $11,613,000.

Average unit cost of fill: $4.63 per ton.

(b) Periodic beach nourishment, 1986-1992: The volumes and costs of beach fill placed on the beaches along the Presque Isle Peninsula for the 5-year period, 1986 to 1990 are tabulated below.

Year	Tons Placed	Contract Cost
1986	258,432	$1,472,765
1987	228,896	1,499,931
1988	238,203	1,349,902
1989	268,718	1,399,677
1990	170,229	909,324
	1,164,478	$6,631,599

Total tons placed: 1,164,478.

Total cost of fill: $6,631,599.

Average unit cost of fill: $5.69 per ton.

(2) Period after construction of offshore breakwaters:

(a) Estimated amounts: The offshore breakwater project was constructed during the period October 1990 to November 1992. The total cost of construction was $23,800,000. The cost of periodic beach nourishment necessary to maintain the protective beach berm to project dimensions with the segmented offshore breakwaters in place was estimated to be $385,000 annually. The estimated cost of nourishment is based on an annual fill requirement of 55,000 tons of suitable beach sand.

(b) Actual amounts: The tonnages and contract costs for placing the initial beach fill during construction of the offshore breakwaters, and for periodic nourishment are tabulated below. The fill tonnages and costs for 1991 include initial filling during construction which consisted of 232,000 tons at a cost of $1,814,787. The tonnage and contract cost shown for 1992 represents initial filling during breakwater construction.

Year	Tons Placed	Contract Cost ($)
1991	301,813	2,289,733
1992	315,930	2,470,573
1993	92,607	670,260
1994	81,563	649,896
	791,913	6,080,462

Total tons placed: 791,913.

Total cost of fill: $6,080,462.

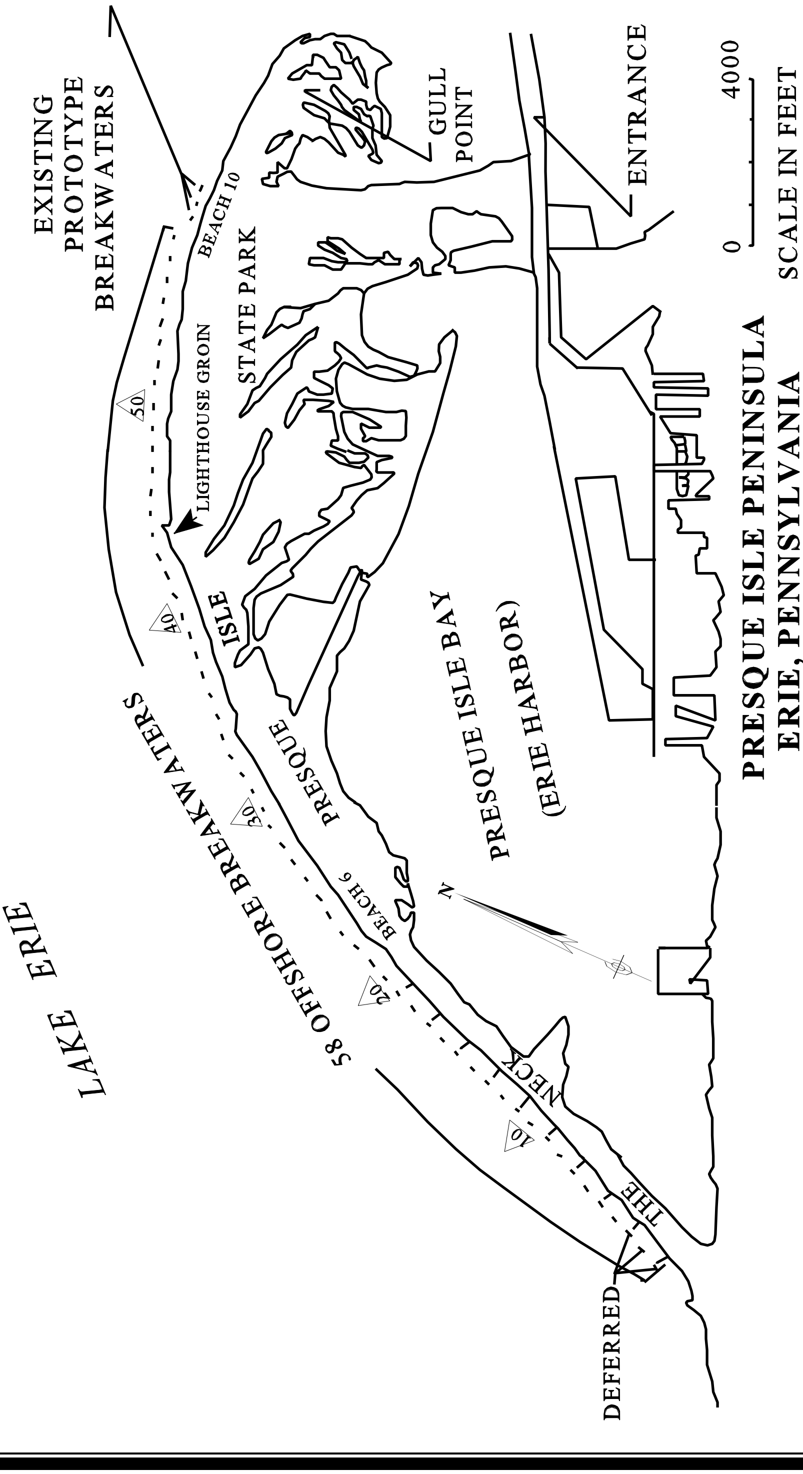
Average unit cost of fill: $7.68 per ton.

c. Maintenance program: The maintenance program for the offshore breakwater project includes the repair, rehabilitation, and replacement of the segmented offshore breakwaters when needed during the project economic life. The estimated maintenance cost for the segmented breakwaters is given below.

(1) Maintenance costs: $60,000 annually.

(2) Maintenance interval: As needed.

13. Project performance: The project is performing essentially as designed. The segmented breakwaters are performing well, and no significant maintenance problems are anticipated. Given the "sacrificial" nature of the protective beach feature of the project, its rehabilitation is deemed necessary after the project has been damaged by a major storm. During a major storm event, the project provides the intended protection to shorefront developments, but in doing so, the beach berm may be so diminished that it would not be able to provide the desired protection for the remainder of the project life. As a result, emergency restoration in lieu of periodic nourishment may be required to assure project integrity.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APPENDIX E-F

SAN GABRIEL RIVER TO NEWPORT BAY, ORANGE COUNTY, CALIFORNIA
(SURFSIDE-SUNSET AND NEWPORT BEACH)

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APPENDIX E-F

San Gabriel River to Newport Bay, Orange County, California

(Surfside-Sunset and Newport Beach),

PROJECT DATA

1. Project name: San Gabriel River to Newport Bay (Surfside-Sunset and Newport Beach), Orange County, California.

2. Location: Orange County is in Southern California immediately south of Los Angeles County. The Pacific Ocean shoreline of Orange County extends generally southeastward for about 42 miles from the northern boundary of Orange County, at the mouth of the San Gabriel River, to the southern boundary near the mouth of San Mateo Creek.

3. Description: The portion of the county shoreline covered by this report is about 17 miles long from the mouth of San Gabriel River to the entrance to Newport Bay. The principal shore communities in the study area are Seal Beach, Huntington Beach, and Newport Beach.

a. San Gabriel River to Anaheim Bay segment: This segment of shoreline is about 1.5 miles in length and extends from the Orange County-Los Angeles County boundary line at the mouth of San Gabriel River to the entrance to Anaheim Bay. The shoreline from the downcoast jetty of the river to the upcoast jetty at the entrance to Anaheim Harbor is a continuous, publicly owned beach broken only by the Seal Beach pier and groin.

b. Anaheim Bay to Newport pier segment: This segment is about 12.5 miles in length. The shoreline is nearly continuous sand beach extending from the downcoast jetty of Anaheim Bay Harbor to the Newport pier. The southern limit of the segment is marked by the encroachment of a submarine canyon whose terminus lies in close proximity to the Newport pier. The entire stretch of shoreline in this segment is considered a single littoral unit along which sand may pass unrestrictedly from one end to the other, according to the vagaries of wave action.

c. Newport pier to entrance to Newport Bay segment: This shoreline is 2.8 miles in length and is essentially a continuation of Newport Beach, but is considered as a littoral unit owing to the obstruction and loss of littoral material into the submarine canyon. This part of the beach is separated from Newport Bay by a narrow spit, with the lower end closed by the upcoast jetty at the entrance to Newport Harbor.

4. Corps of Engineers Division: South Pacific.

5. Corps of Engineers District: Los Angeles, California.

6. Project Authorization: The original beach erosion control project for the coastline of Orange County was authorized by the River and Harbor Act of 1954, Public Law 83-780, 83d Congress, 2d Session.

7. Original project authorization document: House Document numbered 349, 83th Congress, 2d Session.

8. Statement of the problem: Beach sand reaches the problem area along the shore of Orange County by littoral transport from that contributed to the shore by flood runoff from the San Gabriel and Santa Ana Rivers. After construction of flood control measures on the San Gabriel and Santa Ana Rivers, together with construction of the jetties at Anaheim Bay (U. S.

Naval Weapons Station, Seal Beach) and the construction of the Long Beach offshore breakwaters, changes were noted in the littoral movement of material within the entire study area. Changes noted were starvation of beach segments, reduced sources of natural beach material, wave approach direction to the shores, and a reversal of direction of littoral movement of material along the shore. The overall construction program affected the beaches of the study area in different ways. Some beaches benefited from the changed conditions while others suffered. Erosion was especially severe along the shore fronting the communities of Surfside and Sunset Beach, where wave action has caused loss of land and property damage.

9. Study authorization: As a result of property damage and loss of valuable recreation beach caused by severe and recurring erosion, the State of California made a formal application to the Chief of Engineers for a cooperative study of the problems of beach erosion and shore protection. A cooperative study of the shore segment between the mouth of the San Gabriel River and the Newport Bay entrance was approved on 26 February 1957, in accordance with authority conferred by the provisions of Section 2 of the River and Harbor Act of 3 July 1930, as amended and supplemented. The report was also made in accordance with Public Law 85-500, Section 112, Eighty-fifth Congress, approved 3 July 1958.

10. Information at the time of authorization:

a. Project description: The original authorized beach erosion control project authorized by the River and Harbor Act of 1954 (House Document numbered 349, 83rd Congress, 2d Session) provided for the initial deposition of 200,000 cubic yards of sand fill along the eastern shore of Seal Beach, construction of a groin about 700 feet long at Seal Beach, and the initial placement of 1,000,000 cubic yards of beach fill along the shore at Surfside to act as a feeder beach. The Federal share of the project first costs was 100 percent for protection of Federally owned shores and one-third of the first costs of protecting the other publicly owned portions of the shore in Orange County. Information from House Document numbered 349, 83rd Congress, 2d Session is tabulated in the following subparagraphs.

b. Fill quantities:

(1) Initial beach fill construction:

(a) East Seal Beach: The initial fill required to establish the protective beach in the East Seal Beach segment was estimated to be 200,000 cubic yards of suitable beach sand.

(b) Surfside: The initial fill required to establish a feeder beach in the Surfside area was estimated to be 1,000,000 cubic yards of suitable beach sand.

(2) Annual nourishment requirement:

(a) East Seal Beach: Annual nourishment requirement for East Seal Beach shore was estimated to be 10,000 cubic yards.

(b) Surfside: Annual nourishment requirement for Surfside and downcoast beaches was based on an annual loss of 150,000 cubic yards of material. The annual nourishment requirement was determined to be 200,000 cubic yards if the fill material is taken from the marshlands behind the local beaches.

(3) Periodic nourishment quantity:

(a) East Seal Beach: 100,000 cubic yards.

(b) Surfside: 1,000,000 cubic yards.

(4) Periodic nourishment cycle:

(a) East Seal Beach: 10 years.

(b) Surfside: 5 years.

c. Fill unit costs:

(1) East Seal Beach:

(a) Initial construction: $0.35 per cubic yard.

(b) Periodic nourishment: $0.40 per cubic yard.

(2) Surfside:

(a) Initial construction: $0.30 per cubic yard.

(b) Periodic nourishment: $0.40 per cubic yard.

d. Project costs: Project costs are based in 1952 price levels and interest rate of 3-1/2 percent.

(1) Total first costs: $486,000.

(2) Total Federal first costs: $148,400.

(3) Total non-Federal first costs: $337,600.

(4) Total Annual Costs: $106,170.

(a) Nourishment costs: $84,000.

(b) Maintenance Costs: $2,000.

e. Project average annual benefits:

(1) Loss of land and improvements: $136,000.

(2) Loss of recreation beach: $7,500.

(3) Highway and railroad relocation savings: $10,000.

(4) Total project benefits: $153,500.

f. Project BCR: 1.5.

11. Project modifications from authorization to completion:

a. Local cooperation problem: Construction of the improvements authorized for East Seal Beach was completed by local interests in 1959. The completed work included a 750-foot long groin, and placement of 250,000 cubic yards of sand on the beach. The Federal share of the cost was $286,300. The original document estimated the required fill quantity for East Seal Beach to be 200,000 cubic yards at an estimated cost of $70,000. This portion of the project appears to be successful. Virtually no maintenance of the groin has been required and the protective beach has reached a state of stabilization requiring only minimal maintenance. However, disagreements in cost sharing with local interests resulted in a deferment of the Sunset-Surfside Beach portion of the project and a request by local interests to modify the project.

b. Project modification by the Congress: The original beach erosion control project was modified by Section 101 of the River and Harbor Act of 1962, (Public Law 87-874, 23 October 1962) under the project title of "Orange County, California". The project modification was authorized in accordance with the plan presented in House Document numbered 602, 87th Congress, 2d Session in lieu of the existing uncompleted project for the shore area downcoast of Anaheim Bay (Surfside-Sunset Beach). The project modification provided for construction of a protective beach berm in the vicinity of Surfside-Sunset Beach about 500 feet wide and 9,200 feet long to be created by artificial placement of about 3,000,000 cubic yards of suitable sand on the beach, and an offshore rubblemound breakwater about 2,600 feet long at Newport Beach. The project also provided for periodic nourishment of the Surfside-Sunset Beach berm by transferring sand from the impoundment area of the new breakwater. The authorized Federal participation in the cost of the project was not to exceed 67 percent. Information on the project as modified by the 1962 River and Harbor Act and as presented in House Document numbered 602, 87th Congress, 2d Session is provided in the following subparagraphs.

(1) Initial beach fill quantity: The initial fill required to establish the protective beach berm (500 feet wide and 9,200 feet long) in the vicinity of Surfside-Sunset Beach was estimated to be 3,000,000 cubic yards of suitable beach sand.

(2) Annual nourishment requirement: The estimated annual nourishment requirement of 350,000 cubic yards to maintain the protective beach berm in the Surfside-Sunset Beach area was based on an annual movement of 300,000 cubic yards of material out of the beach segment by littoral processes and 50,000 per year from windblown sand losses, losses offshore, and losses into the submarine canyon.

(3) Periodic nourishment quantity: 1,750,000 cubic yards.

(4) Periodic nourishment cycle: 5 years, or as needed.

(5) Fill unit costs:

(a) Initial construction: $0.575 per cubic yard.

(b) Periodic nourishment: $1.29 per cubic yard.

(6) Total first costs: $4,250,000.

(7) Total Federal first costs: $2,845,000.

(8) Total non-Federal first costs: $1,405,000.

(9) Total annual costs: $613,000.

(a) Nourishment costs: $450,000.

(b) Maintenance costs: $21,000.

(10) Project average annual benefits:

(a) Direct damages prevented: $1,896,000.

(b) Recreation: $280,000.

(c) Incidental damage prevented: $45,000.

(d) Total project benefits: $2,221,000.

(11) Project BCR: 3.6.

c. Project modification by the Chief of Engineers: On 13 September 1963, using his discretionary authority, the Chief of Engineers authorized a modification of the existing project as a result of a request by local interests and a re-evaluation of basic data.

(1) The project was modified by, extending the south limit of the project to the west jetty at the entrance to Newport Harbor, relocating the proposed breakwater near the mouth of the Santa Ana River, extending the south jetty at the Santa Ana River, constructing additional structures and fills between the Santa Ana River and Newport Pier at such time and location as required, and increasing the volume of sand to be placed on the Surfside-Sunset Beach shore from 3,000,000 cubic yards to 4,000,000 cubic yards.

(2) The total first cost of the work under the modified project was estimated to be $10,900,000 using 1971 price levels. The Federal share of the first costs totals $7,300,000 and the non-Federal share was $3,600,000. Subsequent estimates of the modified project first costs made using 1976 price levels totalled $15,100,000, of which $10,100,000 was Federal and $5,000,000 was non-Federal.

d. Current status of the modified project: The overall project was designed to be constructed in stages. The construction work pertaining to stages 1, 4A, 7, 8, and 9 of the modified project is located in the Surfside-Sunset Beach area. Stage 6 is near the mouth of the Santa Ana River, and Stages 2, 3, 4B, and 5 are located in the Newport Beach area. The estimated first cost of the project in 1993 was $50,000,000, of which $33,500,000 was Federal and $16,500,000 was non-Federal. The Design Memoranda for the various stages of construction merely state that an economic analysis of the project is furnished in the project document (House Document numbered 602, 87th Congress, 2d Session). The benefit-to-cost ratios that were provided for the various stages of construction were updated versions of the overall project BCR taken from the 1962 project document. The updating was accomplished using price levels current at the time.

(1) Stage 1 Construction: Stage 1 Construction which was completed in June 1964 at a total cost of $2,082,000, provided for the placement of 4,000,000 cubic yards of sand on the a feeder beach in the Surfside-Sunset Beach area. The sand was dredged from the U. S. Naval Weapons Station, Seal Beach. The Feeder beach which is abut 500 feet wide and 9,200 feet long serves to nourish and stabilize the remaining downcoast shoreline to the Santa Ana River.

(2) Stage 2 Construction: Stage 2 Construction was accomplished in the Newport Beach area under two contracts at a total first cost of $700,000, of which $469,000 (67 percent) was the Federal share. The first contract was completed in February 1968. The work consisted of placing 494,000 cubic yards of sand on the beach between 32nd and 50th Streets and constructing a steel sheet-pile groin, 250 feet long near 40th Street. The second contract, completed in November 1968 provided an additional 246,000 cubic yards of sand in the area between 32nd and 50th Streets. The contract also provided for the construction of a steel sheetpile groin about 191 feet long near 44th Street and another, 60-feet long, near 48th Street.

(3) Stage 3 Construction: Stage 3 Construction was completed in the Newport Beach area at a cost of $600,000 including a Federal share of $402,000. Construction of rubblemound groins near 36th, 48th, 52nd, and 56th Streets with lengths of 507, 340, 340, and 570 feet, respectively, was completed in November 1969. The area from the mouth of the Santa Ana River to 36th Street in Newport Beach was filled with a total of 900,000 cubic yards of sand hauled from the Santa Ana River Channel under the emergency authority of Public Law 99, 84th Congress. The sand was removed from the Santa Ana River for flood control purposes and deposited on the protective beach with no cost to the beach erosion control project. The work was completed in February 1970.

(4) Stage 4A Construction: Stage 4A Construction in the Surfside-Sunset Beach area provided for the placement of 2,300,000 cubic yards of material dredged from the U. S. Naval Weapons Station, Seal Beach. This phase of construction, similar to stage 1, was to restore the 500-foot wide by 9,200-foot long feeder beach in the Surfside-Sunset Beach area. The work was completed in May 1971 at a total cost of $905,000.

(5) Stages 4B and 5 Construction: Stages 4B and 5 Construction in the Newport Beach area provided for the encasement of the two steel sheet-pile test groins constructed earlier near 40th and 44th streets with rock to lengths of 480 and 470 feet, respectively. Two additional rubblemound groins were constructed near 28th and 32nd Streets with lengths of 600 and 540 feet, respectively. Construction of a 590-foot rubblemound groin at 62nd Street was deferred pending a demonstrated need. In addition to the rubblemound groin construction, 358,000 cubic yards of sand were placed on the beach to restore eroded areas and to provide nourishment for the downdrift beaches. The work was completed in March 1973 at a total cost of $831,000.

(6) Stage 6 Construction: Stage 6 Construction provided for the construction of an offshore breakwater immediately upcoast from the mouth of the Santa Ana River to act as a sand trap to halt further downcoast movement of beach material. The trapped material was to be pumped upcoast to restore the feeder beach system. Stage 6, which also provides for the extension of the south jetty at the mouth of the Santa Ana River, has been deferred pending a demonstrated need.

(7) Stage 7 Construction: Stage 7 Construction provided for the placement of 1,644,000 cubic yards of material dredged from local offshore borrow areas on the beach fronting Surfside-Sunset Beach. This phase of construction, similar to Stages 1 and 4A, was to restore the feeder beach in the Surfside-Sunset Beach area. The work was completed in June 1979 at a total cost of $3,040,000.

(8) Stage 8 Construction: Stage 8 Construction consisted of replenishing the feeder beach in the Surfside-Sunset Beach area. This stage of construction was similar to Stages 1, 4A, and 7. The original contract for Stage 8 called for placing a base fill of 1,500,000 cubic yards of beach material borrowed from a nearshore site. The original contract was modified to include the dredging an additional 762,000 cubic yards of material from the adjacent approach channel of the U. S. Naval Weapons Station, Seal Beach, and disposal of the material onto the feeder beach in the Surfside-Sunset Beach area. The modified contract also provided for the placement of an additional 21,000 cubic yards of material onto the beach. The total volume of beach fill was about 2,283,000 cubic yards. The total contract cost for the dredging work was $5,293,000. The Surfside-Sunset Beach replenishment portion of the contract cost totalled $4,477,000, of which, the

Federal share was $3,009,000. The remainder of the contract cost appears to have been borne by the harbor maintenance program of the U. S. Navy. Completion of Stage 8 Construction was accomplished in 1985.

(9) Stage 9 Construction: Stage 9 Construction provided for another replenishment of the feeder beach in the Surfside-Sunset Beach area. The total volume of beach fill was about 1,822,000 cubic yards. The material was obtained from the nearshore borrow sites and deposited on the feeder beach at a contract cost of $6,923,000. The work was completed in 1990.

(10) Completion of initial project construction: Stage 6 construction has been deferred pending a demonstrated need. Therefore, the initial construction phase of the authorized project cannot be officially declared complete.

12. Project nourishment and maintenance programs:

a. Original authorized nourishment program: The original project authorization required that all maintenance costs be borne by local interests. These costs included the annual maintenance cost of the Seal Beach groin and the periodic cost of replenishment fills to be placed on the shores of Seal Beach and Surfside subsequent to the initial fills. Annual periodic nourishment was to be scheduled at 10-year intervals for East Seal Beach and 5-year intervals for Surfside to maintain authorized project dimensions. Each nourishment cycle for East Seal Beach and Surfside required 100,000 and 1,000,000 cubic yards of fill material, respectively. Federal participation in periodic nourishment was not authorized at that time.

b. Modification of original authorized nourishment program:

(1) Federal participation in periodic nourishment: Federal participation in periodic nourishment of the existing project was authorized by Section 101 of the River and Harbor Act of 1962. The 1962 Act authorized Federal participation in the cost of periodic nourishment for a period of 10 years. The Federal share of the cost of nourishment operations was not to exceed 67 percent.

(2) Extension of period nourishment program:

(a) Section 156 authority: Section 156 of the Water Resources Development Act of 1976 provides authority to extend the period of Federal participation in project nourishment to 15 years which begins after the initiation of construction of the project.

(b) Section 934 authority: Section 934 of the Water Resources Development Act of 1986 (Public Law 99-662, 17 November 1986) provides authority for Federal participation in future nourishment for a 50-year period if continuance is warranted and approved. The 50-year period begins after the date of initiation of project construction.

c. Beach nourishment operations:

(1) East Seal Beach: The initial beach fill of 250,000 cubic yards authorized for East Seal Beach was placed in 1959 and appears to be successful. The beach has reached a state of stabilization and has required only minimal replenishment to maintain project dimensions.

(2) Surfside-Sunset Beach: A total of 4,000,000 cubic yards of sand was placed in the Surfside-Sunset Beach area to form a feeder beach. The work was completed in June 1964 at a cost of $2,082,000. The sand was dredged from the U. S. Naval Weapons Station, Seal Beach. The Feeder beach which is abut 500 feet wide and 9,200 feet long serves to nourish and stabilize the remaining downcoast shoreline to the Santa Ana River.

(a) First periodic nourishment: The first periodic nourishment of feeder beach in the Surfside-Sunset Beach area was completed about seven years after the initial beach fill was placed. The replenishment work was completed in May 1971 at a total cost of $905,000. Restoration of the feeder beach required the placement of 2,300,000 cubic yards of beach sand.

(b) Second periodic nourishment: After about eight years of continued erosion, the feeder beach in the Surfside-Sunset Beach area required another nourishment operation to ensure the integrity of the protective and recreational features of the project. The replenishment work was completed in June 1979 at a total cost of $3,040,000. The effort to restore the feeder beach required the placement of 2,300,000 cubic yards of beach sand.

(c) Third periodic nourishment: Periods of accelerated erosion during the 6 years following the 1979 nourishment operation seriously eroded the feeder beach in the Surfside-Sunset Beach area. The original contract for the beach nourishment operation completed in 1985 for the feeder beach called for placing a base fill of 1,500,000 cubic yards of beach material borrowed from a nearshore site. The original contract was modified to include the dredging an additional 762,000 cubic yards of material from the adjacent approach channel of the U. S. Naval Weapons Station, Seal Beach, and disposal of the material onto the feeder beach in the Surfside-Sunset Beach area. The modified contract also provided for the placement of an additional 21,000 cubic yards of material onto the beach. The total volume of beach fill was about 2,283,000 cubic yards. The total contract cost for the dredging work was $5,293,000. The Surfside-Sunset Beach replenishment portion of the contract cost totalled $4,477,000, of which, the Federal share was $3,009,000. The remainder of the contract cost appears to have been borne by the harbor maintenance program of the U. S. Navy.

(d) Forth periodic nourishment: Erosion during the 5 years following the 1985 beach replenishment work depleted the feeder beach in the Surfside-Sunset Beach area to the point where another nourishment operation was required. The total volume of beach fill needed to restore the beach was about 1,822,000 cubic yards. The material was obtained from the nearshore borrow sites and deposited on the feeder beach at a contract cost of $6,923,000. The work was completed in 1990.

(e) Since 1990, no further nourishment of the feeder beach in the Surfside-Sunset Beach area has been required.

(3) Newport Beach: Recurring severe erosion of West Newport Beach, the segment between the Santa Ana River and the Newport Pier presents the potential for loss of land, property damage, and reduced recreational beach area. On 13 September 1963, the Chief of Engineers using his discretionary authority, approved the construction of additional structures and fills between the Santa Ana River and Newport Pier at such time and location as required. The initial beach fill authorized for Newport Beach was accomplished under two contracts. The first contract which was completed in February 1968, consisted of placing 494,000 cubic yards of sand on the beach between 32nd and 50th Streets. The second contract, completed in November 1968 provided an additional 246,000 cubic yards of sand in the area between 32nd and 50th Streets. The contract costs for the first and second beach fill operations were estimated to be $474,000 and $221,000, respectively. The actual costs for the first contract was $317,000.

(a) First periodic nourishment: First periodic nourishment of the beach fill in the Newport Beach area: The area from the mouth of the Santa Ana River to 36th Street in Newport Beach was filled with a total of 900,000 cubic yards of sand hauled from the Santa Ana River channel under the emergency authority of Public Law 99, 84th Congress. The sand was removed from the Santa Ana River for flood control purposes and deposited on the feeder beach with no cost to the beach erosion control project. The work was completed in February 1970.

(b) Second periodic nourishment: Severe and persistent erosion required additional fill material to nourishment of the beaches fronting Newport Beach. About 358,000 cubic yards of sand were placed on the beach to restore eroded areas and to provide nourishment for the downdrift beaches. The work was completed in March 1973 at a total cost of $201,000.

(c) Since completion of the 1973 beach nourishment work, no further nourishment of the beaches at Newport Beach has been required.

d. Annual nourishment quantities:

(1) East Seal Beach: 10,000 cubic yards.

(2) Surfside-Sunset Beach: 200,000 cubic yards.

(3) Newport Beach: 52,000 cubic yards.

e. Periodic nourishment quantities:

(1) East Seal Beach: 100,000 cubic yards.

(2) Surfside-Sunset Beach: 1,000,000 cubic yards.

(3) Newport Beach: 156,000 cubic yards.

f. Periodic nourishment cycles:

(1) East Seal Beach: 10 years.

(2) Surfside-Sunset Beach: 5 years.

(3) Newport Beach: 3 years.

g. Annual nourishment costs:

(1) East Seal Beach:

(a) Estimated cost: $4,000.

(b) Actual cost incurred: None.

(2) Surfside-Sunset Beach:

(a) Estimated cost: $450,000.

(b) Actual cost incurred: $512,000.

(Based on total costs of $15,345,000 for replenishment of initial beach fill over a 30-year period. This does not include the cost of about 800,000 cubic yards of sand from navigation maintenance work deposited at no cost to project.)

(3) Newport Beach:

(a) Estimated cost: $130,000.

(b) Actual cost incurred: No nourishment has been required since completion of the beach nourishment work in the 1973.

13. Unit cost of beach fill:

a. East Seal Beach: Estimated in the original authorization document using 1952 price levels.

(1) Initial fill: $0.35 per cubic yard.

(2) Periodic nourishment: $0.40 per cubic yard.

b. Surfside-Sunset Beach:

(1) Original authorization: Based on 1952 price levels:

(a) Initial fill: $0.30 per cubic yard.

(b) Periodic nourishment: $0.40 per cubic yard.

(2) House Document 602, 87th Congress, 2d Session: Based on 1961 price levels:

(a) Initial fill: $0.575 per cubic yard.

(b) Periodic nourishment: $1.29 per cubic yard.

(3) Stage 1 Construction: Based on 1964 price levels:

(a) Initial fill: $0.52 per cubic yard.

(b) Periodic nourishment: None estimated.

(4) Stage 4a Construction: Based on 1971 price levels:

(a) Initial fill: $0.40 per cubic yard.

(b) Periodic nourishment: None estimated.

(5) Stage 7 Construction: Based on 1978 price levels:

(a) Initial fill: $1.80 cubic yard. (Borrow area A)

$2.10 cubic yard. (Borrow area B)

(b) Periodic nourishment: None estimated.

(6) Stage 8 Construction: Based on 1985 price levels.

(a) Initial fill: $1.97 per cubic yard

(b) Periodic nourishment: None estimated.

(7) Stage 9 Construction: Based on 1990 price levels.

(a) Initial fill: $3.77 per cubic yard.

(b) Periodic nourishment: None estimated.

14. Maintenance program costs:

a. East Seal Beach:

(1) Estimated cost: $2,000.

(2) Actual cost incurred: None required.

b. Surfside-Sunset Beach:

(1) Estimated cost: None estimated.

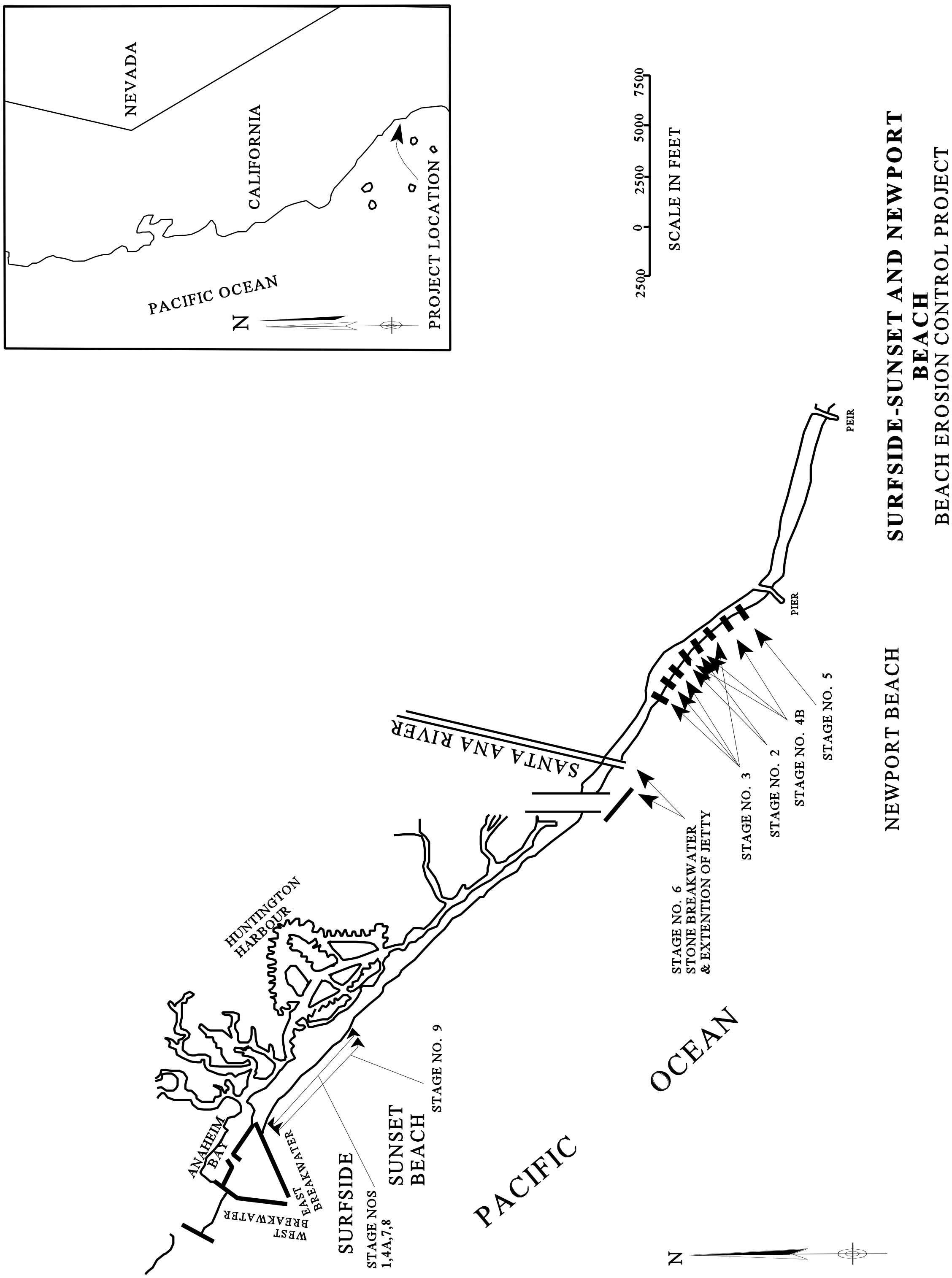
(2) Actual cost incurred: None required.

c. Newport Beach:

(1) Estimated cost: $2,000.

(2) Actual cost incurred: None.

15. Project performance: The project is performing essentially as designed. The groins have required minimal maintenance and repair. Given the "sacrificial" nature of the feeder beach in the Surfside-Sunset Beach area and other protective beach features of the project, their replenishment is deemed necessary after the project has been damaged by unusual tides and wave action caused by ocean storms. During a major storm events, the project beaches provide the intended protection to shorefront developments, but in doing so, they may be so diminished that they would not be able to provide the desired protection for the remainder of the project life. Therefore, project restoration in addition to the routine periodic nourishment and maintenance efforts may be required to ensure project integrity.


NEVADA
CALIFORNIA
PACIFIC OCEAN
PROJECT LOCATION
N
SCALE IN FEET
2500 0 2500 5000 7500
SURFSIDE-SUNSET AND NEWPORT BEACH
BEACH EROSION CONTROL PROJECT
PEIR
PIER
NEWPORT BEACH
STAGE NO. 5
STAGE NO. 4B
STAGE NO. 2
STAGE NO. 3
SANTA ANA RIVER
STAGE NO. 6
STONE BREAKWATER
& EXTENTION OF JETTY
HUNTINGTON HARBOUR
OCEAN
PACIFIC
STAGE NO. 9
SUNSET BEACH
SURFSIDE
STAGE NOS
1,4A,7,8
EAST BREAKWATER
WEST BREAKWATER
ANAHEIM BAY
N

APPENDIX F - SURVEY ADMINISTERED TO BEACHFRONT HOMEOWNERS

1. Circle the type of building that most closely matches your residence.

a. single family detached b. rowhouse or duplex c. mobile home
d. Low-rise multiple family (under 4 stories) e. Multifamily (4+stories)

2. Does your property join the shoreline or a sand dune barrier?

___ a. Yes ___ b. No

3. How far is your residential structure from the high water shoreline?
___ (approximate distance in feet)

4. ___ Number of bedrooms (in your unit) ___ Number of bathrooms

5. How many years have you owned this housing unit ___ years

6. Is your property subject to flooding and/or erosion?

___ a. Yes ___ b. No ___ c. Do not know

7. Are you currently participating in the National Flood Insurance program?

___ a. Yes ___ b. No c. ___ Do not know

8. Do you know how much you pay for flood insurance on this housing unit?

___ a. Yes, you know ___ b. Do not know ___ c. Not insured

9. How important is the cost of insurance in making decisions about this unit?

___ a. No effect on decisions b. ___ Very small effect

___ c. Moderate effect d. ___ Large effect on decisions

10. Has erosion or wave action caused significant damage to your property or to nearby property?

___ a. Yes ___ b. No ___ c. No not know

1. If nearby property, how far away is the affected property? ___ (feet)

11. If your answer to the previous question was yes, what effect would these flooding or erosion problems have on the sales price or ease of sale if you attempted to sell your property?

___ a. No effect b. ___ Very small effect

___ c. Moderate effect c. ___ Large effect

12. Have you considered selling this property in the last five years?

___ a. Yes ___ b. No ___ c. Do not know

13. In this area, the primary beach season (when the beach is most heavily used and rents are high) lasts about __ weeks. The average weekly rent for this unit during the primary beach season is approximately $__ per week.

14. In this area, the secondary beach season lasts about ___ weeks. The average weekly rental for this unit during the secondary beach season is approximately $__ per week.

15. During the average primary week that you are in residence here, how may times do you and/or your family visit the local beach? __ Please give the name of this local beach _________.

16. Do your believe that the character of the local beach is threatened by flooding and/or erosion?

___ a. Yes ___ b. No

17. Regarding your answer to the previous question, please indicate WHY you DO or DO NOT believe that flooding and/or erosion is a threat to the local beach. Please list all important reasons.

18. Do you know if any measures were taken by public agencies to reduce damages to the beach or to your residence?

___ a. Yes ___ b. No ___ c. Do not know

If you answered yes, what agency or agencies took the measures?
____

and what measures were taken?

19. Has your community done anything to combat the erosion problem?

___ a. Yes ___ b. No ___ c. Do not know

If you answered yes, what specific things have been done?

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13. ABSTRACT (Maximum 200 words)
This report presents the results of a study performed by the Army Corps of Engineers in response to a request by the Office of Management and Budget for the Army to analyze the effectiveness of the Federal shore protection program. This report defines the scope of the shore protection program over the period 1950-1993 in terms of the number and types of protective measures, lineal distances of protected shorelines, actual costs and costs updated to 1993, quantities of sand used in restoration and nourishment, and benefits. The report compares estimated against actual costs, quantities of sand and benefits; provides an analysis of Federal programs that are involved in risk management in the coastal zone; the environmental effects of shore protection projects; a discussion of the level of protection afforded by beach projects; and the question of whether or not shore protection projects induce development. Future costs of constructed protects as well as an estimate of projected costs for projects which have a possibility of being constructed in the next fifteen years.

14. SUBJECT TERMS
shore protection, beach restoration and nourishment, sand quantities, costs, benefits, federal projects, erosion control, environmental effects, induced development, risk management, level of protection

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