NEW JERSEY SHORE PROTECTION MASTER PLAN



STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF COASTAL RESOURCES

OCTOBER 1981

VOLUME 2 - BASIS AND BACKGROUND

NEW JERSEY SHORE PROTECTION MASTER PLAN

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State of New Jersey

Brendan Byrne
Governor

Department of Environmental Protection
Jerry Fitzgerald English
Commissioner

Division of Coastal Resources
David N. Kinsey
Director

CN 401
Trenton, New Jersey 08625

Prepared With The Assistance Of:

Dames & Moore
6 Commerce Drive
Cranford, New Jersey 07016

Contract Number DBC-P168
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CHAPTER I

INTRODUCTION

The New Jersey Shore Protection Master Plan was developed through a series of preliminary and draft working documents as well as public workshops and hearings. At appropriate stages of the study program, significant public and government agency comments were reviewed and incorporated. The Master Plan represents the culmination of this process.

As discussed in the Commissioner's cover letter in Volume 1, the New Jersey Shore Protection Master Plan is presented in three volumes to facilitate its use. Volume 1 presented The Plan itself along with a summary discussion of the physical, socioeconomic, and environmental setting along the New Jersey shore. Volume 1 also includes a discussion of the studies and coordination activities which will continue to take place during implementation of the Master Plan.

Volume 2 is the Basis and Background for proposals put forth in Volume 1. Much of the information contained herein is taken from the Draft Shore Protection Master Plan (September 1980). Public comments on the Draft Master Plan and the DEP responses to the comments are presented in Volume 3.

As discussed in Volume 1, Section 1.B.2, the New Jersey shoreline was divided into 16 reaches; including 13 oceanfront reaches between Sandy Hook and Cape May Point, two bay reaches (Raritan Bay and Delaware Bay), and a Delaware River reach. The reach approach is the method whereby consistent shore protection engineering plans are developed within areas affected by similar coastal processes. The reach concept in the engineering design process endeavors to reduce the potential for any one shore erosion control program to produce adverse effects in adjacent shore areas (e.g., down-drift effects). Shore protection is thereby provided for an entire coastal compartment, irrespective of political subdivision boundaries, rather than for only local erosion problem areas as has been the traditional practice in New Jersey. The 16 shoreline reaches, which are presented in Volume 1, Figure I.B-1 and Table I.B-3, form the basic, discrete planning units for the shore protection plans developed and evaluated in the Master Plan as well as the basis for discussion of shore erosion, socioeconomic, and environmental characteristics discussed in the subsequent chapters of this volume.

To guide the reader through Volume 2, the component chapters are reviewed below.

In order to provide an understanding of the behavior of the operative shoreline processes and the effects of implementing applying the various alternative solutions to erosion, Chapter II includes a discussion of the physical, socioeconomic, and environmental setting along the New Jersey shore. Chapter III provides an overview of past and present State and Federal programs and policies influencing shore protection, coastal development, and resource use. New directions in Federal policies are also discussed in Chapter III.

The various alternative approaches to shore erosion management, including both engineering and non-engineering techniques and concepts, are presented and discussed in Chapter IV. A comparative evaluation of selected engineering alternatives, land management alternatives (i.e., land use regulations and acquisition) and the

no action alternative is provided in Chapter V. A detailed presentation of the alternative engineering plans and estimated costs for New Jersey is presented in Chapter VI. The cost benefit analyses, which is the basis for the engineering alternative priority analysis discussed in Volume 1, Section II.B.1.d, is presented in Chapter VII with example calculations. As background for the engineering analysis presented in Chapter VI, a cost-comparison of beach nourishment schemes is provided in Chapter VIII.

The State's contingency response sequence to erosion emergencies is reviewed in Chapter IX. An overview of various methodologies for delineation of coastal erosion hazard areas, including the erosion setback scheme evaluated in Chapter V, is provided in Chapter X.

A discussion of existing and pending State legislation relating to shore protection is presented in Chapter XI. A glossary of terms is provided to aid the reader to understand the engineering, socioeconomic, and environmental terminology used throughout the document. A bibliography of shore protection references is also provided for the interested reader.

CHAPTER II

STATUS OF THE NEW JERSEY SHORE

In order to assess the extent of the problem of erosion along the shoreline of New Jersey, and evaluate the most suitable alternatives for addressing the problem, this chapter presents a shore erosion severity status report. A brief history of the New Jersey shore, a discussion of beach access, and a socioeconomic and environmental profile of the New Jersey shore are also presented as background for the decision making processes. A discussion of the coastal processes affecting the New Jersey shore and a brief summary of erosion conditions and the socioeconomic and environmental setting are presented in Volume 1, Chapter I.

A. SHORE HISTORY – IN BRIEF

Although few Indians were permanent residents of the New Jersey shore, they were probably frequent summer visitors, coming to fish, hunt, gather shellfish and make shell wampum. The first arrival of Europeans occurred in 1609 when Henry Hudson's ship sailed along the New Jersey shore from Delaware Bay and anchored in Sandy Hook Bay. Gradual encroachment by Europeans drove the Indians away from the shore areas. By as early as 1775 only about two hundred full blooded Indians remained on the coastal plain of the State (Wilson, 1964).

Settlements directly on the sea held little attraction for early European arrivals who preferred the mainland rather than the barrier islands. Settlers typically sought protection from heavy winter storms by settling one to two miles inland. The early shore settlers farmed, raised cattle, gathered oysters for market, or relied on fur trade, whaling or salt production for income. The southern barrier islands, including Five Mile Beach, Seven Mile Beach, and Ludlam Island were used for cattle raising as early as the 1690s. Many of the first settlers were also attracted to the shore, as the Indians were, by plentiful oyster beds on Raritan Bay, Barnegat Bay, Little Egg Harbor, Delaware Bay, and the mouths of enumerable rivers and creeks emptying into salt water bays and inlets connecting them with the open ocean. Town Bank in Cape May County and Long Beach Island in Ocean County were first settled by whalers whose efforts appeared to have been reasonably profitable until the Revolutionary War.

During the 1800's the shore residents depended increasingly on privateering, fishing, and developing resorts for their livelihood. Development of major shore resorts including Cape May, Atlantic City, Ocean City, Long Branch, and Asbury Park in the late 1800's and early 1900's was stimulated by the arrival of railroads to the shore areas. The speed with which resort growth occurred is reflected in the fact that as late as 1850, there were no permanent residents on Ludlam Island (Sea Isle City), but by 1900, it was reported to have thirty hotels and three hundred cottages (Wilson, 1964).

With the sale of bay and ocean riparian grants by the State in the 1800's and 1900's, the industrial age, and the appearance of the automobile, the New Jersey shore saw a steady wave of growth and development. The Raritan Bay and Delaware River saw increasing industrial development while the Atlantic shore communities continued to draw increasing summer crowds and permanent development from the metropolitan areas. The two World Wars and the Korean crisis caused further expansion of military installations and supporting development in the four Atlantic shore counties.

Paralleling the growth in coastal population and wealth was an ever increasing demand for leisure and recreation. With the increased facilities for travel, such as better roads and the automobile, the people of New Jersey and neighboring states were drawn to the shore areas by the appeal of the beaches, sea breezes, boating, fishing, and other water related activites. Since the turn of the century many thousands of acres of national wetlands and sand dunes have been transformed into resort and residential developments; usually with little consideration of the importance of these resources in coastal protection and without considering the dynamic nature of the shore zone natural migrational trend of the local shoreline. During that same period, the advance in population and wealth of oceanfront municipalities between Sandy Hook and Cape May Point has been far greater than the growth in wealth and population for the State as a whole.

As development expanded along the State's shores it resulted in action that violated some of the fundamental processes which built and maintained beaches naturally. As was discussed in Volume 1, Chapter I, some of the natural coastal processes so destructive to structures erected by man, are manifestations of nature working to build up beaches and dunes. Unfortunately, one of the first activities of developers building along the beaches has been to level or disturb the adaptive dune environments which provide the most aesthetically pleasing, natural protection against shoreline erosion and storm damage. Once the natural dunes were destroyed, and erosion control structures constructed in their place, beach erosion problems were often accelerated. The continued erosion has often jeopardized the security of life and property in areas adjacent to the beaches. Ironically, without wide, stable, attractive beaches, shorefront recreation opportunities tend to decline. Examination of existing erosion conditions along the New Jersey ocean reaches shows a close relationship between beach erosion severity and gradual beach abandonment by the public.

Beach erosion was an early recurring menace to the State's shore recreation industry — narrowing valuable beaches and damaging or undermining boardwalks and dwellings — especially during major storms. Comparison of early shoreline charts by the Coast and Geodetic Survey and more recent shoreline maps by the Army Corps of Engineers, show continual though erratic erosion and accretion of shorelines accompanied by localized changes in shoreline orientation over the past 125 years of record. The net tendency has been considerably balanced on the side of erosion.

At the turn of the century civic authorities began to realize the need for protection measures such as jetties, groins, seawalls, and breakwater to protect the valuable shore recreation industry. All of these measures represented major capital expenditures, requiring State, County, and local cooperation. Since the turn of the century, most attempts to cope with the phenomena of erosion have focused on short-term technological stop-gap methods (band aid approach) to protect valuable structures and property, instead of considering the major natural causes of shoreline change.

B. DISCUSSION OF CRITICAL EROSION AREAS

Based on the methodology presented in Volume 1, Section I.C.2, the shoreline erosion conditions were classified according to severity. By virtue of the predominant erosional and accretional trends, and the magnitude of existing and potential erosion damage, developed shoreline areas were classified into one of the following categories:

- o Category I — Critical Erosion
- o Category II — Significant Erosion
- o Category III — Moderate Erosion
- o Category IV — Non-Eroding

Based on that assessment of erosion conditions, and as summarized in Volume 1, Section I.C.2, portions of 10 reaches (8 ocean and 2 bay reaches) have been classified as Category I — critical erosion areas. In the following sections, each reach having critical erosion areas is briefly discussed in terms of the magnitude of erosion and existing structures. To facilitate orientation, where appropriate, the discussion of critical erosion areas is presented by municipalities within the affected reaches. For completeness, all areas located within a reach containing a Category I area are discussed. Aerial and ground-level photographs, taken during field reconnaissance in 1979, are provided in Figures II.B-1 through II.B-25 to supplement the discussion in erosion conditions.

1. Reach 1 - Raritan Bay

Raritan Bay is characterized by an irregular shoreline and a wave climate without long period energy. Consequently, storm erosion depletes the shore by depositing material offshore and not having available means to replenish the beach by natural processes. Shoreline erosion occurred during earliest recorded periods with a rate of recession as high as 8 feet per year at some locations. Largely due to extensive construction of shore erosion control structures and beach filling, more recent trends are not as great. Bayshore currents are weak and the east to west net littoral drift appears relatively small as indicated by a deficiency of significant sand trapping in existing groins, some constructed as early as 1929.

Most areas east of the Atlantic Highlands Yacht Harbor have very narrow beaches or are stabilized with rip rap. Since completion of the Yacht Harbor breakwater in 1940, adjacent beaches do not seem to have been materially affected. This part of the reach has been classified as Category III. The Keansburg area is characterized by a wide artificial beach and developed dunes where adequate setback distance is provided for structures, roads and utilities. This location has been classified as Category III. Although Keansburg has a fairly wide beach, it is exposed to storm wave activity and could experience localized erosion problems in the future. Erosion along the community of Union Beach has left buildings located close to the mean high water line (see Figure II.B-1, photo A). Because of the threat involved with this type of situation, the segment has been classified as Category I. An inspection of this area indicated that although bulkhead structures are in use, they are in varying states of disrepair. The community of Keyport has conditions similar to those at Union Beach although not as severe. This portion of the shoreline has also been

classified as Category I. Portions of the Aberdeen bayshore have been stabilized by an extensive seawall consisting of stone, concrete, gabions and earth fill. This recent construction is in good condition and plans to provide supplemental beach fill and dunes are currently being implemented. Therefore, this area of the reach has been classified as Category III. The community at Morgan Beach is characterized by a moderately wide beach that is subject to erosion scarping. Since this beach has been artificially filled under a Federal Program and could require renourishment at a future date, it has also been classified as Category III.

2. Reach 2 - Sandy Hook to Long Branch

Sandy Hook, a part of the Gateway National Recreation Area, is a sand spit which was built out into the Raritan Bay by the northerly littoral drift of sediment derived from the shoreface to the south. The spit system is the result of the complex interrelationship between waves, current, shore protection structures and sediment supply in the various ocean and bay beach segments. Historically, the Hook has alternately been attached to and separated from the mainland at the Navesink Highlands and the barrier beach at Sea Bright.

The narrowest southern portion of Sandy Hook is vital for access and utilities. In response to sediment starvation along and updrift of the massive stone seawall there, the southern-most ocean beach has been subjected to extensive erosion and storm damage in recent years. Due to the immediate threat to buildings, roads and utilities along the narrow southern portion of the Hook, this area has been classified as Category I. Because there is no immediate or near term erosion threat to buildings or infrastructure elsewhere on Sandy Hook, the remaining ocean beaches are Category III or IV depending on whether they are eroding or accreting.

In the area of Sea Bright there are two types of shoreline. The northern-most area is characterized by seawall directly on the oceanfront, and the southern areas has numerous groins which are filled to various levels of capacity (Figure II.B-2, photo A). The most apparent problems are lack of maintenance on the seawall and the absence of adequate beach. The seawall protects the community and its failure would endanger property, infrastructure and perhaps human life. Although the seawall is functioning as rubble structures are expected to, erosion of sand from the toe and over steepening of the offshore profile appear to be creating excessive settlement. The lack of a protective beach is allowing direct wave attack and damage to the structure during winter storms. Due to these factors the northern area has been classified as Category I. In the area of the groin field, the erosion is not as severe as in front of the exposed seawall. Beaches exist and are satisfactory for some recreational use, however, they are much steeper now than they were in years past. Because no buildings are in immediate danger, and because the groins are nearly full, the southern area has been classified as Category II.

At Monmouth Beach the northern part of the seawall has no protective beach in front of it. The situation is similar at the southern end of Monmouth Beach. Some of the groins have accumulated small fillets of sand on their downdrift sides, but these accumulations can provide only limited and highly localized protection for the seawall (Figure II.B-2, photo B). Because the structural and functional characteristics of the the seawall in this location are very similar to that of Sea Bright, it has been classified as Category I.

3. Reach 3 - Long Branch to Shark River Inlet

This is an area where there is an obvious lack of available sediment in the nearshore zone to be intercepted by the existing groins. These groins are variable length, constructed of stone and are nearly exposed at the root in most cases (see Figure II.B-3 and II.B-4 photos). The critical portion of Long Branch begins at Lake Takanasee and extends southward through Deal, Allenhurst and Loch Arbour. A large vertical bulkhead exists from Lake Takanasee to the south. Locally the toe of the bulkhead is protected by rubble. Most of the locations where the bulkhead exist are also areas of significant erosion. From Lake Takanasee south, Long Branch is classified as Category I; Long Branch from Lake Takanasee north is classified Category II.

Along the Deal shoreline a number of significant problems exist. First, most of the sand that would normally be in littoral transport through Deal is held in place by the long groin that separates Deal from Allenhurst. Throughout Deal, several groins exist which are acting as total littoral barriers. This area is characterized by high rates of shoreline recession and eroding bluffs. Overall, the area is sediment starved and the material which is available in the littoral zone, is not being effectively contained by the existing groins (see Figure II.B-4, photo B). In several places there is either a bulkhead or seawall behind which homes are perched just above the mean high water line (see Figure II.B-5, photo A). These conditions, in conjunction with lack of sediment transport, are the reason that this area is identified as Category I.

Loch Arbour and Allenhurst have a very small shoreline and essentially act as a single unit. Both municipalities have shorefront located between two long groins. The southern-most groin is extremely long. Because of its length it causes a large indentation or erosional pattern in Loch Arbour itself. To the north, in Allenhurst, a large sand fillet exists indicating depositions due to the large groin separating Allenhurst from Deal. The recession of the shoreline is significant in Loch Arbour compared with the adjoining beach at Asbury Park. This area is classified as Category I. An additional reason for classifying Deal, Loch Arbour and Allenhurst as Category I is because of the location of several buildings in the immediate vicinity of the high water line. Any storm surge of significance may cause property damage. Also, heavy wave activity in this vicinity could cause extensive recession at the shoreline and subsequent undermining of buildings and infrastructure.

As illustrated in Figure II.B-6 (photo A), Bradley Beach is immediate updrift of Shark River Inlet and as such is deprived of sediment in the littoral zone. Three stone groins and numerous dilapidated wooden groins are present in this area. The stone groins would be more effective if sufficient sand was present in the littoral system. The mean high water line has receded back to the boardwalk and threatens to go further. Because of the lack of sand and littoral transport, and the large retreat of the high water line, the Bradley Beach area is classified as Category I.

4. Reaches 4, 5, and 6 — Shark River Inlet to Barnegat Inlet

No Category I areas have been designated in Reaches 4, 5, and 6. General shoreline conditions are illustrated in Figure II.B-6, photo B and Figures II.B-7, II.B-8, II.B-9, and II.B-10.

5. Reach 7 - Long Beach Island

Although no area along Long Beach Island has been classified as a Category I areas, a few areas of significant erosion (Category II) occur in this reach and are discussed below. In particular, three areas along the island have experienced significant erosional beach loss and threat to private dwellings and infrastructures during recent storms, such as occurred during the winter 1977-1978. These areas include portions of Ship Bottom, Brant Beach, and Beach Haven Borough. (Refer to photos, Figures II.B-11 and II.B-12.)

In addition, a significant area of erosion occurs downdrift of the terminal groin at the southern end of Long Beach Township (Holgate) due to sediment starvation (see Figure II.B-12, photo B). Overwashing and breaching of the terminal groin have also been a threat despite various attempts to stabilize the situation. Since no imminent danger to dwellings or infrastructure exists, and because sufficient setback occurs between the erosion and the nearest buildings and roads, the area has been classifed as Category II.

6. Reach 8 - Pullen Island and Brigantine Island

Pullen Island is part of the Brigantine National Wildlife Refuge and is the only remaining undeveloped and protected barrier island on the Atlantic Coast of New Jersey (see Figure II.B-13, photos A and B). Although Pullen is under a constant state of dynamic migration, since migration of the ocean or inlet beaches are of no threat to development, it has not been classified.

The developed northern portion of Brigantine Island has been classified as Category I because of the low, narrow beach and poor condition of groin structures. Existing development is very close to high water and storm waves pose considerable threat to the buildings located there (see Figure II.B-13, photo B). At the apex of the island, where the shoreline alignment changes, the beach is somewhat wider and is characterized by dunes that appear to be stable (see Figure II.B-14, photos). However, storm activity would likely have wave runup at the toe of these dunes and could cause considerable erosion and pose a threat to developed areas adjacent to the beach. Therefore, this section of Brigantine has been classified as Category II. The remaining portion of the island to the south is influenced by the north jetty of Absecon Inlet. Sand is accumulating to the north of the inlet jetty forming a wider protective beach. This area is classified as non-eroding (Category IV).

7. Reach 9 - Absecon Island

Based on the severity of the erosion problem and the potential for danger to private property and the infrastructure, Longport is the only area classified as Category I in Reach 9. As illustrated by photos in Figure II.B-16, from the northeast end of Longport to the southern terminal groin a continuous unbroken line of seawalls and bulkheads exists. The beach is extremely low and narrow, extending in places only to a 50 foot width. The primary problem along this stretch is a lack of sand control in the littoral zone due to the ineffective groins that currently exist. If the erosion condition remains unchecked, it is quite probable that during a storm, damage could occur to roads and utilities as well as personal property. Other areas in Reach 9 consists of Atlantic City, Ventnor City and Margate City. These areas are classified as Category II or III depending on the local condition of beaches and shore protection structures.

The heavily developed Absecon Inlet shore at the north end of Reach 9 is stabilized with revetments and groins which currently have little or no protective beach (see Figure II.B-15, photo A). The situation here is analogous to the inlet shores at the northern end of Reaches 12 and 13. A Corps of Engineer inlet stabilization program authorized in 1954 was completed except for the eastern portion of the revetment along the inlet frontage and placement of protective beach fill (USACOE, Philadelphia District, April 1964). Due to the incomplete nature of the inlet protection program, during large storm events, erosion damage to private properties and infrastructure are possible along the vulnerable area. The inlet shore has been classified as Category III.

8. Reach 10 - Pecks Beach (Ocean City)

This entire ocean shore of this reach has been identified as Category I. The island typically has very narrow or moderate beach widths (refer to photos on Figure II.B-18). Historically, the beaches have been narrower than at the present; probably because the city is currently conducting an annual beach nourishment program along its ocean beach to alleviate local erosion conditions. Although the island has extensive bulkhead structures and small dunes locally, the progressive beach erosion is encroaching upon the developed areas. If left unchecked, severe damage to buildings, roads and utilities could result.

In January 1979 the southerly migration of Great Egg Harbor Inlet channel caused significant erosion and minor damage to private property and the revetment on the inlet beach at the north end of Ocean City (see Figure II.B-17, photo B). To mitigate this problem, starting in the Spring of 1979, the State implemented an emergency program involving beach filling supplemented with two controlling timber and stone groins. The inlet shore is now classified as Category II.

9. Reach 11 - Ludlam Island

The Ludlam Island reach consists of Upper Township (Strathmere and Whale Beach) and Sea Isle City. This barrier island is generally uniform in the width of beach from inlet to inlet, except for the bulbous ends at the north end (see Figure II.B-19). Throughout the entire reach, the beach width varies from 0 feet to 20 feet. Several groins are located along a section of shoreline in Sea Isle City, but they do not maintain large fillets of sand. Numerous buildings are precariously located within 20 feet of the mean high water line. Private structures, roads, and utilities are in many places located close enough to the mean high water that they could be damaged during moderate storms. Therefore, the entire reach is classified as Category I, exclusive of the bulbous northern end of the island considered as Category II and the inlet shore on Corson Inlet which is Category III. Since adequate structures do not presently exist to retain beach fill placed by the State to stabilize the Corson Inlet south shore, future migration trends of the inlet channel could again threaten buildings there (refer to Figure II.B-19, photo A).

10. Reach 12 - Seven Mile Beach

The Seven Mile Beach consists of Avalon and Stone Harbor. A portion of Avalon fronts along Townsends Inlet and is continuously protected with bulkheads and revetments along that shore frontage (see Figure II.B-20, photo A). Along the easternmost portion of the inlet shore, there is little or no beach along a revetment constructed there for erosion control. The top of the bulkhead and revetment are approximately 12 feet above mean low water and occasionally are overtopped by storm waves. In the future, the southwestwardly migration of the Townsend Inlet main channel could undermine the revetment and threaten development. For these reasons, the inlet shore has been categorized as III.

The southern portion of Avalon is characterized by narrow beach widths and property fronted by a narrow dune. Historically, this dune has been eroded by storm waves and contigency provision should be allocated for maintaining this dune through major storms. Presently, it appears that this dune system is serving as an effective natural storm erosion barrier.

The municipality of Stone Harbor has a very narrow beach and a continuous line of timber bulkheading fronting all of the development (see Figure II.B-21, photo A). Historical data indicates that this area is undergoing steady erosion which will threaten the landward areas in the near future if allowed to continue. At the southern end of Stone Harbor, a breach of the terminal groin would separate the southern tip of the island from the remainder of the reach (see Figure II.B-21, photo B). Sediment starvation, combined with refraction and diffraction around the terminal groin, has produced an acute downdrift erosional recession area analogous to that which has developed at Long Beach Township (Holgate) in Reach 7. Because of the narrow beach and proximity of development to the high water line, the southern end of Stone Harbor is classified as Category I.

11. Reach 13 - Five Mile Beach

Reach 13 has no Category I erosion areas. The central portion of the reach involving Wildwood City and Wildwood Crest is classified as Category II as is a portion of the Hereford Inlet shore in North Wildwood. The remaining portions of the reach are classified as Category III or IV depending on whether they are eroding or non-eroding. The beaches along the northern portion of this reach are the widest of any along the New Jersey shore (see Figure II.B-23, photo A).

Along most of Hereford Inlet there are shore erosion control structures including discontinuous revetments, bulkhead groins in varying conditions of disrepair. Most of the structures were constructed to protect specific roads and developed areas (see Figure II.B-22, photo B). Due to the lack of adequate protective beaches and structures, the eastern portion of the inlet shore was classified as Category II. Along the western portion of the inlet shore structures are in better condition and the area is classified as Category III.

12. Reach 14 - Cape May Inlet to Cape May Point

This reach consists of Coast Guard Receiving Area, Cape May City, Cape May Point, Cape May Point State Park and Lower Township. Severe erosion has occurred at the Coast Guard Area, Lower Township and Cape May Point State Park areas. Also, Cape May City has little or no beach along its seawall structure (see Figure II.B-23, photo B and II.B-24, photo A). The seawall is in fair to poor condition due to poor filtration design, undermining problems, overtopping and displaced stone. The western portion of Cape May City has a narrow to moderate beach with stone groins which are presently functioning adequately. As illustrated in Figure II.B-24 (photo B), Cape May Point has a narrow beach and low dune with stone groins in various alignments. Evidence from aerial and ground observations indicates that this area is continually eroding and is thus considered an area of very delicate stability.

The region from the Cape May Inlet (formerly known as Cold Spring Inlet) to Cape May City at Ocean Avenue has been classified as Category I because of the accelerated erosion and deteriorated condition of the seawall. The beach at the western portion of Cape May City has been classified Category II because of the dependence on the condition at the upcoast beaches. Sand starvation in this area could lead to immediate problems such as potential flanking of the terminal groin at the western end of the city. Despite the erosion of Lower Township and Cape May Point State Park, these areas have been classified as Category III because sufficient setback distance exists between erosion forces and the developed areas or infrastructure. Cape May Point has been classified as Category II because of the very delicate equilibrium that exists between erosion and protective structures as well as evidence of past erosional trends.

13. Reach 15 - Delaware Bay

The Delaware Bay reach extends from Cape May Canal northward to Stow Creek. The bayshore is primarily eroding salt marsh (mud) with narrow sandy beaches occurring primarily along the southern portion of the reach in Cape May County. Operative erosional processes include low energy, short period waves and tidal currents. Most of the eroding beaches are small, occurring only along small isolated commercial and recreational developments. The predominant bay shore erosion control structures include timber bulkheads, timber groins, cinder block bulkheads, and steel sheet pile bulkheads.

Along Lower Township the shorefront appears to be in relatively stable condition. Numerous groins are effective in maintaining the integrity of the shoreline. Along this portion of shoreline, minor bluffs of 10 feet relief exist. For the Villas area, considerable erosion as indicated on the aerial photographs, was documented by observations in the field (refer to Figure II.B-25, photo A). Existing structures appear insufficient to maintain a beach since the amount of natural sand in the littoral zone is very small along this portion of the coastline. At Pierces Point and Reeds Beach a small number of private cottages are being threatened by erosion (Figure II.B-25, photo B). Moores Beach is a very similar situation to that of Reeds Beach.

The classification of the Delaware Bay shoreline is as follows: Lower Township from Cape May Point to Villas has been classified as Category III; the area between Villas and Miami Beach is Category II; the small isolated developed areas in Middle Township, Maurice River Township, and Downe Township are classified as Category I; and north of Moores Beach to the end of the reach, the undeveloped bayshore is classified as Category III.

14. Reach 16 — Delaware River

Dominant erosional processes along the tidally influenced portions of the Delaware River (south of Trenton) include tidal currents, flood stage waters, and waves generated by passing ships. At some locations navigational dredging of channels may also be contributing to river bank erosion. In general, much of the developed section of the river are eroding to some degree. An adequate assessment of the magnitude of the erosion problem along the entire river is not possible due to a paucity of historical aerial photographs and published erosion data such as is available for the ocean beaches. For this reason, erosion categories comparable with those applied to the ocean reaches could not be utilized for the Delaware River Reach. However, erosion at several locations has resulted in undermining and subsequent damage to shore parallel erosion control structures including bulkheads and seawalls. Most recently the following areas have reported significant erosion or structural damage:

Gloucester County
- Paulsboro Borough

Salem County
- Carneys Point Township (Upper Penns Neck)
- Pennsville Township
- Penns Grove Borough
- Fort Mott State Park.

FEBRUARY 1979



PHOTO A - (REACH 1)

UNION BEACH AT SPRUCE STREET. VIEW EAST ALONG RARITAN BAY SHORE. DECAYING BULKHEADS PROTECT BUILDINGS HERE FROM WAVE DAMAGE.

JANUARY 1979



PHOTO B - (REACH 2)

THE LACK OF BEACH AND THE PRESENCE OF DEEP WATER IN FRONT OF THIS SEAWALL AT SEABRIGHT ALLOWS DIRECT WAVE ATTACK AND SUBSEQUENT STRUCTURAL DAMAGE, ESPECIALLY DURING WINTER STORMS.

DAMES & MOORE

FIGURE II.B-1

JANUARY 1979



PHOTO A - (REACH 2)

VIEW OF SEABRIGHT LOOKING NORTH ALONG OCEAN AVENUE TO SANDY HOOK. EROSION IS LESS SEVERE TO THE SOUTH WHERE A FUNCTIONAL GROIN FIELD HAS HELPED TO RETAIN THE BEACH.

JANUARY 1979

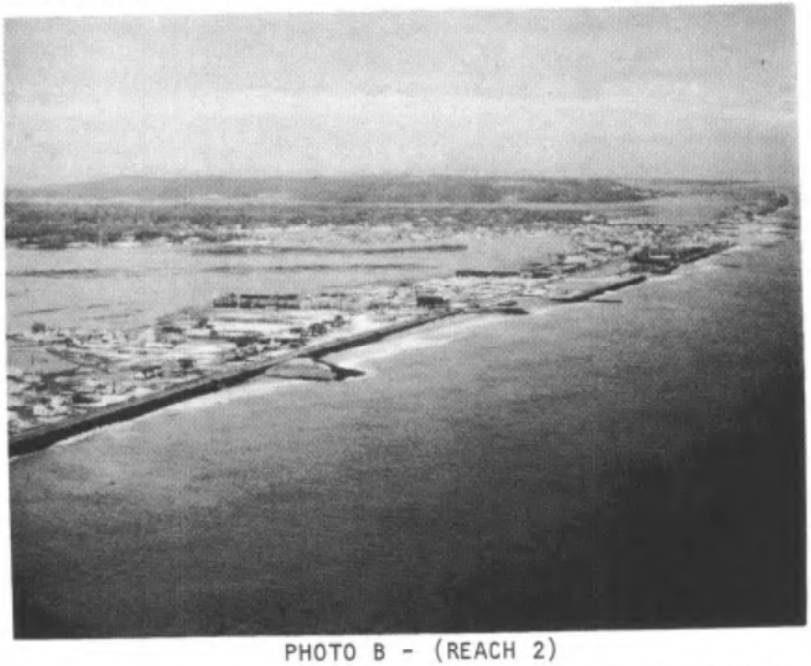

PHOTO B - (REACH 2)

SEAWALL AT MONMOUTH BEACH AND SEABRIGHT. HIGHLANDS AND SANDY HOOK ARE VISIBLE TO THE NORTH. AGAIN NOTE LACK OF BEACH IN FRONT OF SEAWALL.

DAMES & MOORE

FIGURE II.B-2

JANUARY 1979



PHOTO A - (REACH 3)

FUNCTIONAL T-GROINS ALONG SOUTH LONG BRANCH SHORE.
VIEW IS TOWARD NORTHWEST.

JANUARY 1979



PHOTO B (REACH 3)

VIEW NORTH ALONG TIMBER BULKHEAD AT SOUTH LONG BRANCH. HARBOR ISLAND SPA IS IN BACKROUND. TYPICALLY THE BULKHEADS ARE THREATENED BY DIRECT STORM WAVE ATTACK.

DAMES & MOORE

FIGURE II.B-3

JANUARY 1979



PHOTO A - (REACH 2)

NORTH LONG BRANCH AND MONMOUTH BEACH HAVE AN ASSORTMENT OF FUNCTIONAL SHORE PROTECTION STRUCTURES BUT LACK AN ADEQUATE BEACH.

JANUARY 1979



PHOTO B - (REACH 3)

VIEW OF DEAL AND LONG BRANCH TO NORTH. OVERALL THIS AREA IS SEDIMENT STARVED AND EXISTING GROINS ARE NOT EFFECTIVELY CONTAINING THE REMAINING LITTORAL MATERIAL.

DAMES & MOORE

TT-14

FIGURE TT.B-4

FEBRUARY 1979



PHOTO A - (REACH 3)

VIEW SOUTH ALONG A STONE REVETMENT AT SNYDER AVENUE, DEAL. HOMES PERCHED JUST ABOVE THE STONE ARE SUSEPTIBLE TO STORM WAVE DAMAGE.

JANUARY 1979



PHOTO B - (REACH 3)

ASBURY PARK LOOKING NORTH. NOTE BREAKWATER PROTECTION OF THE CONVENTION CENTER.

DAMES & MOORE

FIGURE II.B-5

JANUARY 1979



PHOTO A - (REACH 4 AND 3)

VIEW OF SHARK RIVER INLET.NOTE THE WIDE BEACHES AT BELMAR LEFT (SOUTH) OF THE INLET. AVON-BY-THE-SEA AND BRADLEY BEACH TO THE NORTH OF THE INLET ARE EXPERIENCING LITTORAL STARVATION.

JANUARY 1979



PHOTO B - (REACH 4)

SPRING LAKE AND BELMAR AT LAKE COMO. NOTICE NOTCHED GROIN AT CENTER OF PHOTO.

DAMES & MOORE

FIGURE II.B-6

FEBRUARY 1979



PHOTO A - (REACH 4)

VIEW SOUTH OF SEA GIRT BEACHES NEAR TRENTON AVENUE. RIP RAP HAS BEEN PLACED TO PROTECT PRIVATE HOMES ALONG THIS BEACH.

JANUARY 1979

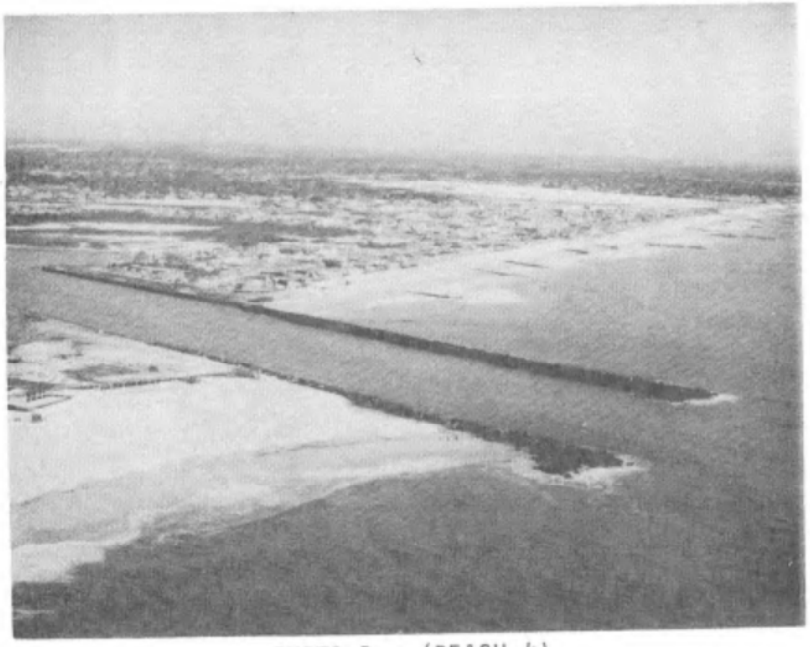

PHOTO B - (REACH 4)

VIEW OF MANASQUAN INLET. MANASQUAN BEACHES NORTH OF INLET ARE EXPERIENCING LITTORAL STARVATION. WIDE BEACHES HAVE ACCRETED ON THE SOUTH SIDE OF THE INLET.

JANUARY 1979



PHOTO A - (REACH 5)

VIEW OF POINT PLEASANT BEACH. MANASQUAN INLET JETTIES IN THE UPPER RIGHT CORNER OF THE PHOTO ARE BLOCKING A MAJOR PORTION OF THE NORTHERLY LITTORAL DRIFT.

JANUARY 1979



PHOTO B - (REACH 6)

SOUTH MANTOLOKING BEACH AND BRICK TOWNSHIP HAVE WIDE BEACHES AS COMPARED TO THOSE ALONG THE NORTHERN MONMOUTH COUNTY OCEAN SHORELINE.

JANUARY 1979



PHOTO A - (REACH 6)

LAVALLETTE AND DOVER TOWNSHIP (NORMANDY BEACH). NOTE SAND FENCING CONSTRUCTED IN VARIOUS CONFIGURATIONS TO AID IN DUNE STABILIZATION.

JANUARY 1979



PHOTO B - (REACH 6)

SEASIDE PARK AMUSEMENT PIERS. NOTE THE GENERAL ABSENCE OF GROINS AND THE UNIFORMITY OF BEACH WIDTH IN THIS AREA.

DAMES & MOORE

FIGURE II.B-9

JANUARY 1979



PHOTO A - (REACH 6)

NATURAL DUNE AREA ALONG ISLAND BEACH STATE PARK. TO THE NORTH IS BERKELEY TOWNSHIP (SOUTH SEASIDE PARK).

JANUARY 1979



PHOTO B - (REACH 7)

VIEW NORTH ACROSS BARNEGAT INLET. PIPELINE ALONG BEACH WAS USED TO NOURISH THE BEACHES TO THE SOUTH OF INLET IN 1979.

DAMES & MOORE

FIGURE II.B-10

JANUARY 1979



PHOTO A - (REACH 7)

HARVEY CEDARS IN THE VICINITY OF TEMPORARY INLET BREACHES AND HEAVY DAMAGE DURING MARCH 1962 STORM.

JANUARY 1979



PHOTO B - (REACH 7)

NORTH VIEW ALONG LONG BEACH ISLAND FROM BRANT BEACH (LONG BEACH TOWNSHIP) TOWARD SHIP BOTTOM. CONSIDERABLE STORM EROSION OCCURED ALONG THIS SECTION DURING THE WINTER OF 1977-1978.

DAMES & MOORE

FIGURE II.B-11

JANUARY 1979



PHOTO A - (REACH 7)

LONG BEACH TOWNSHIP. NOTE NEW CONSTRUCTION ALONG THE DUNE AT THE CENTER OF THE PHOTO.

JANUARY 1979



PHOTO B - (REACH 7)

TERMINAL GROIN AT HOLGATE. BEACH HAVEN IS LOCATED TO RIGHT. THIS AREA WAS THE LOCATION OF A TEMPORARY BREACH AND EXTENSIVE DAMAGE DURING THE STORM OF MARCH 1962.

DAMES & MOORE

FIGURE II.B-12

JANUARY 1979



PHOTO A - (REACH 8)

BRIGANTINE INLET AND THE UNDEVELOPED PULLEN ISLAND (LITTLE BEACH). BEACH HAVEN INLET IS JUST TO THE NORTH (RIGHT). THIS UNDISTURBED ISLAND AND INLET SYSTEM ARE UNDER A CONSTANT STATE OF DYNAMIC MIGRATION.

JANUARY 1979



PHOTO B - (REACH 8)

BRIGANTINE AND NORTH BRIGANTINE STATE NATURAL AREA. BRIGANTINE INLET IS IN VIEW AT THE UPPER RIGHT CORNER OF PHOTO. BEACHES ALONG THIS AREA ARE LOW AND NARROW AND EXISTING GROINS ARE IN POOR CONDITION.

DAMES & MOORE

FIGURE II.B-13

JANUARY 1979



PHOTO A - (REACH 8)

VIEW NORTH ALONG BRIGANTINE ISLAND. ANCIENT PEAT DEPOSITS ARE EXPOSED ALONG SOME PORTIONS OF THIS LOW, ERODING BEACH.

JANUARY 1979



PHOTO B - (REACH 8)

VIEW OF BRIGANTINE ACROSS ABSECON INLET. ATLANTIC CITY IS IN FOREGROUND. DUE TO THE INFLUENCE OF THE INLET JETTY, THE BEACH ALONG THE SOUTHERN END OF BRIGANTINE ISLAND IS ACCRETING.

DAMES & MOORE

FIGURE II.B-14

JANUARY 1979



PHOTO A - (REACH 9)

VIEW WEST ALONG SOUTH SHORE OF ABSECON INLET, ATLANTIC CITY. NOTE THE LACK OF BEACH IN FRONT OF THE INLET FACE STRUCTURES.

FEBRUARY 1979



PHOTO B - (REACH 9)

VIEW OF NARROW BEACH ALONG BOARDWALK AT VERMONT AVENUE, ATLANTIC CITY.

DAMES & MOORE

FIGURE II.B-15

FEBRUARY 1979



PHOTO A - (REACH 9)

TIMBER BULKHEAD ALONG LONGPORT SHORE AT 16th AVENUE. REMNANTS OF OLDER BULKHEAD ARE VISIBLE IN THE FOREGROUND.

FEBRUARY 1979



PHOTO B - (REACH 9)

DETERIORATING CONCRETE SEAWALL AT LONGPORT. VIEW IS NORTH TOWARD MARGATE CITY.

DAMES & MOORE

FIGURE II.B-16

JANUARY 1979



PHOTO A - (REACH 9 AND 10)

VIEW NORTH ACROSS GREAT EGG HARBOR INLET. OCEAN CITY IS IN FOREGROUND, ABSECON ISLAND IS TO NORTH.

JANUARY 1979



PHOTO B - (REACH 10)

SOUTH SHORE OF GREAT EGG HARBOR INLET, OCEAN CITY. BEACH FILL AND GROINS WERE PLACED AFTER THIS PHOTO WAS TAKEN TO STABILIZE THE EROSION PROBLEMS.

DAMES & MOORE

FIGURE II.B-17

JANUARY 1979



PHOTO A - (REACH 10)
VIEW NORTH ALONG PECK BEACH (OCEAN CITY)

FEBRUARY 1979



PHOTO B - (REACH 10)

VIEW SOUTHWEST ALONG LOW, NARROW BEACH AT
11th AVENUE, OCEAN CITY

DAMES & MOORE

FIGURE II.B-18

JANUARY 1979



PHOTO A - (REACH 10 AND 11)

CORSON INLET. STRATHMERE STATE NATURAL AREA IS IN FOREGROUND AND CORSON INLET (OCEAN CREST) STATE PARK IS TO THE NORTH OF INLET.

JANUARY 1979



PHOTO B - (REACH 11)

VIEW NORTH ALONG LUDLAM ISLAND, SEA ISLE CITY. ALTHOUGH BEACHES APPEAR GENERALLY UNIFORM IN WIDTH, NUMEROUS BUILDINGS ARE LOCATED WITHIN 20 FEET OF THE MEAN HIGH WATER LINE.

DAMES & MOORE

FIGURE II.B-19

JANUARY 1979



PHOTO A - (REACH 12)

TOWNSEND INLET SOUTH SHORE AT AVALON. VIEW IS TO NORTHWEST. NOTE LACK OF SAND IN GROINS ALONG INLET SHORE.

JANUARY 1979



PHOTO B - (REACH 12)

SEVEN MILE BEACH AT AVALON. NOTE DEVELOPMENT SET BEHIND NATURALLY PROTECTIVE DUNE AREA.

DAMES & MOORE

FIGURE II.B-20

JANUARY 1979



PHOTO A - (REACH 12)

SEVEN MILE BEACH AT STONE HARBOR. A CONTINUOUS LINE OF TIMBER BULKHEADING IS FRONTED ONLY BY A NARROW, ERODING BEACH.

JANUARY 1979



PHOTO B - (REACH 12)

VIEW OF TERMINAL GROIN AT SOUTHERN END OF STONE HARBOR. THE ACUTE DOWNDRIFT EROSIONAL RECESSION AREA SOUTH OF THE TERMINAL STRUCTURE IS ANALOGOUS WITH THAT WHICH HAS FORMED AT HOLGATE AT THE SOUTHERN END OF REACH 4.

DAMES & MOORE

JANUARY 1979



PHOTO A - (REACH 12)

UNDEVELOPED PORTION OF STONE HARBOR BOROUGH AT SOUTHERN TIP OF SEVEN MILE BEACH. HEREFORD INLET EBB TIDAL SHOAL IS VISIBLE IN FOREGROUND.

JANUARY 1979



PHOTO B - (REACH 13)

VIEW WEST ALONG THE SOUTH SHORE OF HEREFORD INLET AT NORTH WILDWOOD. INLET SHORE STRUCTURES INCLUDE DISCONTINUOUS REVETMENTS, BULKHEADS, AND GROINS IN VARYING CONDITIONS OF DISREPAIR.

JANUARY 1979



PHOTO A - (REACH 13)

FIVE MILE BEACH AT NORTH WILDWOOD. BEACHES ARE MORE THAN 1200 FEET WIDE IN THIS AREA. ALONG THE SOUTHERN PORTION OF THIS REACH, THE BEACH AVERAGES ABOUT 300 FEET IN WIDTH.

JANUARY 1979



PHOTO B - (REACH 14)

CAPE MAY, JUST SOUTH OF CAPE MAY INLET. NOTE THE GENERAL LACK OF BEACH FRONTING THE SEAWALL AND THE CLOSE PROXIMITY OF BUILDINGS TO THE WALL.

DAMES & MOORE

FIGURE II.B-23

FEBRUARY 1979



PHOTO A -(REACH 14)

SEAWALL UPCOAST OF OCEAN AVENUE, CAPE MAY CITY. VIEW IS TO THE EAST.

JANUARY 1979

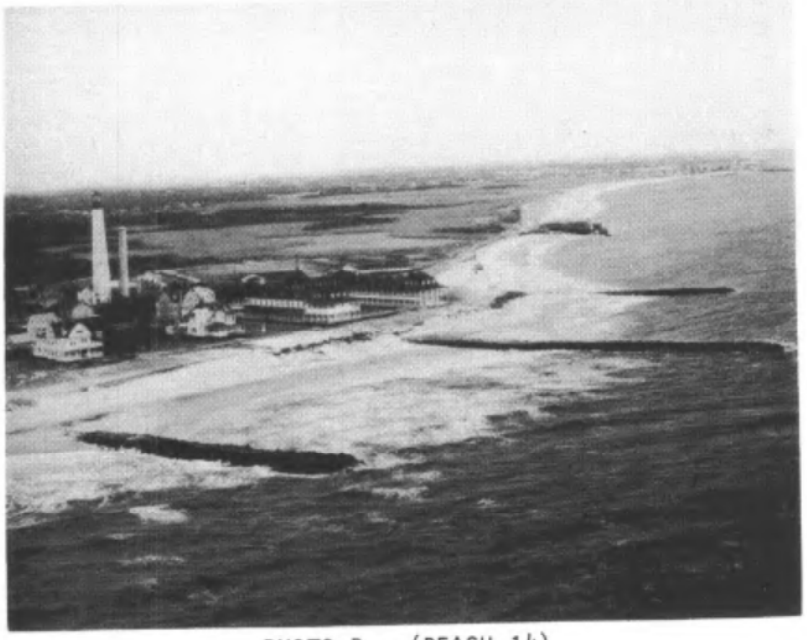

PHOTO B - (REACH 14)

GROIN FIELD AND NARROW ERODING BEACH AT CAPE MAY POINT.

DAMES & MOORE

FIGURE II.B-24

FEBRUARY 1979

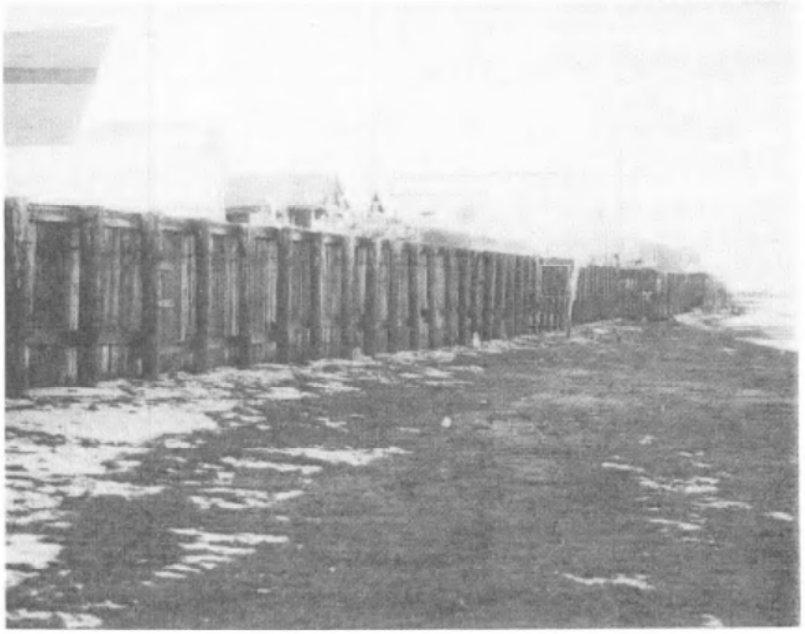

PHOTO A - (REACH 15)

VIEW SOUTH ALONG TIMBER BULKHEAD AT BATES AVENUE, VILLAS (LOWER TOWNSHIP) ON THE DELAWARE BAY SHORE.

FEBRUARY 1979

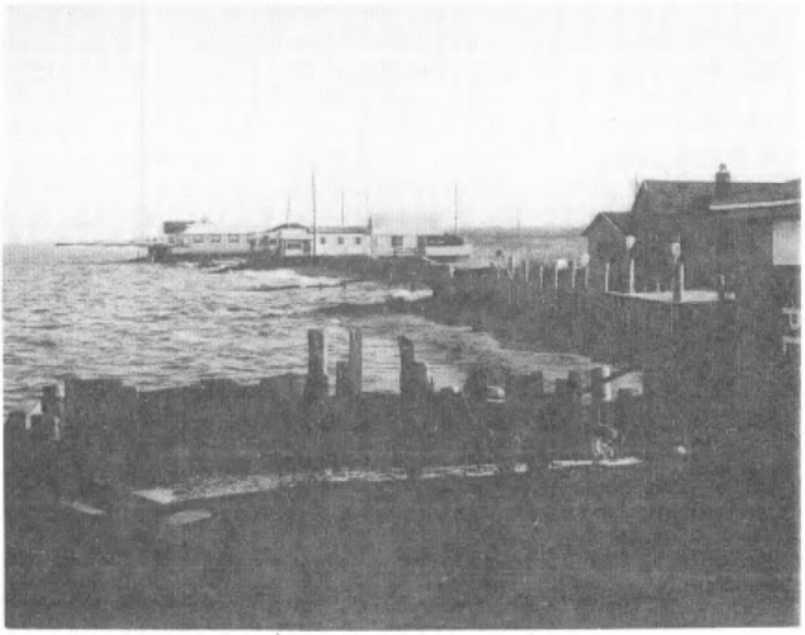

PHOTO B - (REACH 15)

DELAWARE BAY SHORE. DEVELOPMENT AT PIERCES POINT (MIDDLE TOWNSHIP). COTTAGES ARE PROTECTED BY INDIVIDUAL TIMBER BULKHEADS.

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FIGURE II.B-25

C. BEACH OWNERSHIP AND ACCESS

This section presents a general discussion of beach ownership and access in New Jersey.

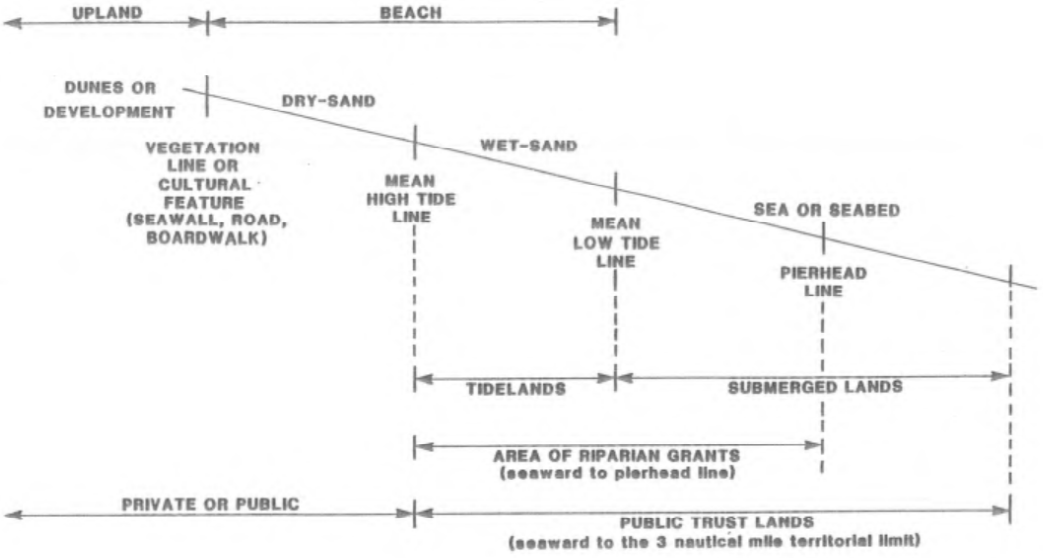
Beach ownership and access issues can best be discussed in terms of beach zones. Generally, the beach can be divided into four areas: the upland; the dry-beach; the wet-sand or foreshore; and the sea or seabed. The physical distinction among these areas is illustrated in Figure II.C-1. The public's traditional interest in and rights to use of the wet-sand area of the beach or tideland (area covered by ebb and flow of tides) are based upon the public trust doctrine.

The public trust doctrine has been recognized under English law since the 13th century when the doctrine developed that the sovereign (state) holds the foreshore and sea "in trust" for public use. The concept was brought to this country during colonial times and continued to apply to submerged lands, navigable rivers, fish and wildlife. After the American Revolution, rights to the tidelands were granted to the people of New Jersey by the Federal government. In the 1800's and 1900's the State sold bay and ocean riparian rights to local and Federal governments, and to private individuals, and associations along about one third of the Atlantic Ocean. In order for an individual or organization to acquire the riparian rights along a portion of shoreline, they first had to own the adjacent upland or dry-sand area. The reverse was not required, however. The riparian land rights did not have to be purchased to acquire ownership of dry-sand or upland shore lands. Tidelands which have been granted to a private entity may be built upon or filled in to the exclusion of the general public only upon issuance of a Waterfront Development permit from the NJDEP, DCR. The grant of tidelands excludes any person other than the grant owner from seeking such a permit.

Although the State has conveyed riparian grants for about 40 percent of its ocean front tidelands, the courts have held that these lands remain impressed with a "public trust" and must be open and unrestricted to the public for the purpose of navigation, commerce, and fishing (New Jersey Beach Access Commission, April 1977). In the case of the Borough of Neptune vs. Borough of Avon-by-the-Sea (61 NJ 296, 1976), the New Jersey Supreme Court extended the public trust doctrine to include recreational use in addition to the traditional rights of navigation, commerce, and fishing.

The dry-sand or upland areas of the State's shores (above the mean high tide line) are not controlled under the public trust doctrine and are subject to private ownership. Until 1978, the public trust doctrine did not apply to New Jersey's dry sandy beaches owned by either local, State, or Federal governments, or by private individuals or associations. In 1978, a New Jersey Supreme Court decision (VanNess vs. Deal (78 NJ 174)) extended the public trust doctrine to apply to the dry sand of muncipially-owned beaches. It should be noted that the court cases to date relate exclusively to publicly-owned lands.

Where the dry-sand beach is in private hands, the question that has been repeatedly raised is whether a public right to use the beach or gain access to the tideland can exist apart from public ownership. Generally what occurs is that private ownership of dry-sand areas, by virtue of access control, forecloses any meaningful recreational use of beach areas by the public in equal terms. Thus, privately owned tidelands have been turned into de facto private beaches. Typically, for private clubs and hotel beaches, actual use of these beaches is often subject to the limitations of



OCEANFRONT AND BEACH DEFINITION DIAGRAM

SOURCE: NEW JERSEY BEACH ACCESS STUDY COMMISSION, 1977.

DAMES & MOORE

FIGURE II.C-1

club membership or to being a guest, thus excluding members of the general public. Similarly, facilities at these establishments, including parking, are not usually open to the public.

A summary of the State's oceanfront tideland ownership status (in shorefront length) by reach, and by reach community, is provided in Table II.C-1. As summarized in Table II.C-2 and Figure II.C-2, of the total linear shorefront distance along the Atlantic coastline of New Jersey, a total of about 72 percent of the tideland (below mean high water line) is owned by the public sector (including Federal, State and municipal ownership.). The remaining 28 percent is under the ownership of private individuals, corporations, and associations. Similarly, about 26 percent of the linear oceanfront distance of dry-sand or upland (above the mean high water line) is owned by the private sector. However, as indicated in Figure II.C-2, the public portion under Federal, State, and municipality control is appreciably different, with the State controlling far more of the public tidelands than the public dry sand areas.

It has been estimated that 95 percent of the publicly owned ocean beach frontage, and 55 percent of privately owned frontage is available for public use (NJDEP, 1977). This can be attributed to the fact that some private beach owners lease beach areas to municipalities. For example, Atlantic City leases its municipally-oriented free beaches from the private individuals and corporations who own nearly all oceanfront, lots, the boardwalks, and riparian grants along the Atlantic City oceanfront.

Along the Delaware River, much of the waterfront is in private ownership, belonging to industrial, commercial, or residential interests. Despite this, public access exists at many street ends, and along a 20 to 30 foot strip behind some bulkheads.

Backbay beaches include the beaches bordering the Manasquan, Navesink, Metedeconk, and Shark Rivers, Barnegat Bay, Great and Little Bay, Absecon Bay, Great Egg Harbor, and the intra-coastal waterway. Bay beaches include those located along Raritan Bay going north toward the harbor of New York and New Jersey, and along the Delaware Bay and River. An inventory of the status of ownership and use of 345 miles of bay beaches was made by the U.S. Army Corps of Engineers in 1973. This inventory indicated that much of the land bordering the bays was inaccessible because of extensive wetlands. The National Shoreline Study extended up to South Amboy in Raritan Bay and Pennsgrove on the Delaware River.

From the linear shorefront ownership statistics discussed above, it is not possible to fully assess the availability of suitable public recreational beach areas. The State's supply of suitable public recreational shore areas has been shrinking, in part, by the following factors:

- Demand pressures from expansion and coastward shifting populations accompanied by continuing increases in leisure time, mobility, and disposal income;
- Acquisition for use by private, industrial and commercial interests;
- With increased demand, increasing tendency of private owners to restrict public access;

TABLE II.C-1

SHOREFRONT (TIDELAND) OWNERSHIP BY REACH[1]

Reach Number	Reach Description	County	Political Subdivision	Total Shore Line Length	Approximate Shorefront Length (Linear Feet)					
					Federal Shores	Non-Federal Shores				
						Ungranted Public (State)		Granted		
						Public Shore State Parks & Conservation Areas	Other Ungranted Shores	Municipal Grant (Public)	Private[2] Riparian Grant	Total Granted Shore
1	Raritan Bay	Middlesex & Monmouth	See Table I.C-1 for list	NA	NA	NA	NA	NA	NA	NA
2	Sandy Hook to Long Branch	Monmouth	Sandy Hook - Gateway National Park & Coast Guard Station	32,100	32,100	0	0	0	0	0
			Sea Bright Borough	19,741	0	0	8,550	0	11,191	11,191
			Monmouth Beach Borough	8,630	0	0	6,980	0	1,650	1,650
			REACH 2 TOTAL	60,471	32,100	0	15,530	0	12,841	12,841
3	Long Branch to Shark River Inlet		Long Branch City	23,093	0	0	17,035	0	6,058	6,058
			Deal Borough	8,458	0	0	5,560	0	2,898	2,898
			Allenhurst Borough	1,662	0	0	1,260	110	292	402
			Loch Arbour	1,020	0	0	1,020	0	0	0
			Asbury Park City	5,240	0	0	0	0	5,240	5,240
			Neptune Township	3,270	0	0	270	0	3,000	3,000
			Bradley Beach Borough	4,992	0	0	70	4,055	867	4,922
			Avon-by-the-Sea	2,820	0	0	2,820	0	0	0
			REACH 3 TOTAL	50,555	0	0	28,035	4,165	18,355	22,520
4	Shark River Inlet to Manasquan Inlet		Belmar Borough	7,460	0	0	3,210	3,075	1,175	4,250
			Spring Lake Borough	8,550	0	0	8,500	0	50	50
			Sea Girt Borough	5,610	0	0	5,610	0	0	0
			State Arsenal & Camp Ground (Sea Girt)	1,600	0	1,600	0	0	0	0
			Manasquan Borough	5,700	0	0	5,700	0	0	0
			REACH 4 TOTAL	28,920	0	1,600	23,020	3,075	1,225	4,300
5	Manasquan Inlet to Mantoloking	Ocean	Point Pleasant Beach Borough	9,970	0	0	9,910	60	0	60
			Bay Head Borough	6,679	0	0	4,110	0	2,569	2,569
			REACH 5 TOTAL	16,649	0	0	14,020	60	2,569	2,629
6	Mantoloking to Barnegat Inlet		Mantoloking Borough	11,550	0	0	1,000	0	10,550	10,550
			Brick Township	9,300	0	0	9,300	0	0	0
			Dover Township	11,909	0	0	9,750	2,159	0	2,159
			Lavallette Borough	6,880	0	0	6,880	0	0	0
			Seaside Heights Borough	3,991	0	0	0	0	3,991	3,991
			Seaside Park Borough	8,877	0	0	1,400	0	7,477	7,477
			Berkeley Township (South Seaside Park)	2,820	0	0	1,200	0	1,620	1,620
			Island Beach State Park	52,300	0	523,000	0	0	0	0
			REACH 6 TOTAL	107,627	0	523,000	29,530	2,159	23,638	25,797

TABLE II.C-1 (Continued)

Reach Number	Reach Description	County	Political Subdivision	Total Shore Line Length	Approximate Shorefront Length (Linear Feet)					
					Federal Shores	Non-Federal Shores				
						Ungranted Public (State)		Granted		
						Public Shore State Parks & Conservation Areas	Other Ungranted Shores	Municipal Grant (Public)	Private[2] Riparian Grant	Total Granted Shore
7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)		Barnegat Lighthouse State Park	1,500	0	1,500	0	0	0	0
			Barnegat Light Borough	10,500	0	0	10,500	0	0	0
			Long Beach Township	53,520	0	0	53,520	0	0	0
			Harvey Cedars Borough	10,600	0	0	10,000	0	600	600
			Surf City	7,670	0	0	7,670	0	0	0
			Ship Bottom Borough	7,400	0	0	7,400	0	0	0
			Beach Haven Borough	9,975	0	0	9,975	0	0	0
			Brigantine National Wildlife Refuge (Holgate Unit)	10,000	10,000	0	0	0	0	0
			REACH 7 TOTAL	111,165	10,000	1,500	99,065	0	600	600
8	Little Egg Inlet to Absecon Inlet	Atlantic	Brigantine National Wildlife Refuge (Pullen Island)	13,000	13,000	0	0	0	0	0
			N. Brigantine State Natural Area	13,000	0	13,000	0	0	0	0
			Brigantine City	22,000	0	0	15,009	4,695	2,296	6,991
			REACH 8 TOTAL	48,000	13,000	13,000	15,009	4,695	2,296	6,991
9	Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)		Atlantic City	17,800	0	0	0	4,298	13,502	17,800
			Ventnor City	8,700	0	0	1,900	0	6,800	6,800
			Margate City	8,700	0	0	2,897	0	5,803	5,803
			Longport Borough	7,500	0	0	1,075	0	6,425	6,425
			REACH 9 TOTAL	42,700	0	0	5,872	4,298	32,530	36,828
10	Great Egg Harbor Inlet to Corson Inlet (Pecks Beach)	Cape May	Ocean City	43,500	0	0	16,618	128	26,754	26,882
			Corson Inlet (Ocean Crest) State Park	500	0	500	0	0	0	0
			REACH 10 TOTAL	44,000	0	500	16,618	128	26,754	26,882
11	Corsons Inlet to Townsends Inlet (Ludlam Island)		Strathmere State Natural Area	800	0	800	0	0	0	0
			Upper Township (Strathmere)	9,200	0	0	9,200	0	0	0
			Sea Isle City	26,000	0	0	25,824	0	176	176
			REACH 11 TOTAL	36,000	0	800	35,024	0	176	176
12	Townsends Inlet to Hereford Inlet (Seven Mile Beach)		Avalon Borough	25,000	0	0	22,030	60	2,910	2,970
			Stone Harbor Borough	19,500	0	0	19,398	60	42	102
			REACH 12 TOTAL	44,500	0	0	41,428	120	2,952	3,072

TABLE II.C-1 (Continued)

Reach Number	Reach Description	County	Political Subdivision	Total Shore Line Length	Approximate Shorefront Length (Linear Feet)					
					Federal Shores	Non-Federal Shores				
						Ungranted Public (State)		Granted		
						Public Shore State Parks & Conservation Areas	Other Ungranted Shores	Municipal Grant (Public)	Private[2] Riparian Grant	Total Granted Shore
13	Hereford Inlet to Cape May Inlet (Five Mile Beach)	Cape May	North Wildwood	7,000	0	0	741	0	6,259	6,259
			Wildwood City	7,100	0	0	0	0	7,100	7,100
			Wildwood Crest Borough	9,800	0	0	0	0	9,800	9,800
			Lower Township	2,000	0	0	0	0	2,000	2,000
			U.S. Coast Guard Wildwood Electrical Engineering Center	6,100	6,100	0	0	0	0	0
			REACH 13 TOTAL	32,000	6,100	0	741	0	25,159	25,159
14	Cape May Inlet to Cape May Point		U.S. Coast Guard Receiving Area	5,600	5,600	0	0	0	0	0
			Cape May City	14,700	0	0	120	136	14,444	14,580
			Cape May Point State Park	5,200	0	5,200	0	0	0	0
			Lower Township	2,000	0	0	0	0	2,000	2,000
			Cape May Point Borough	5,200	0	0	5,200	0	0	0
			REACH 14 TOTAL	32,700	5,600	5,200	5,320	136	16,444	16,580
15	Delaware Bay Cape May Point to Stow Creek	Cape May Cumberland	See Table II.B-3 in Volume 1 for a list of municipalities	NA	NA	NA	NA	NA	NA	NA
16	Delaware River Stow Creek to Crosswicks Creek	Salem Gloucester Camden Burlington	See Table II.B-3 in Volume 1 for a list of municipalities	NA	NA	NA	NA	NA	NA	NA
			OCEANFRONT TOTALS[3] (feet)	655,287	66,800	74,900	329,212	18,836	165,539	184,375
			(miles)	124.1	12.7	14.2	62.3	3.6	31.3	34.9

Notes:

NA - Not Available

1. Shorefront ownership data presented in this table are adapted from an unpublished Waterfront Property Survey by the NJDEP, Office of Shore Protection (1978), and the report entitled Public Beach Access to the Oceanfront Beaches by the New Jersey Beach Access Study Commission (1977). No data have been compiled for the Raritan Bay, Delaware Bay, or Delaware River shores. Totals, therefore, only reflect oceanfront (tideland) ownership for Reaches 2 through 16.

2. As discussed in Section II.C of this volume, some oceanfront shores which are privately granted may be available and accessable to the public. Likewise the dry beach adjacent to an ungranted (public) tideland shore may be privately owned and controlled, thus not accessable to the public.

3. Atlantic coast inlets account for approximately three (3) additional miles for a total oceanfront length of approximately 126 miles.

TABLE II.C-2

NEW JERSEY OCEANFRONT OWNERSHIP

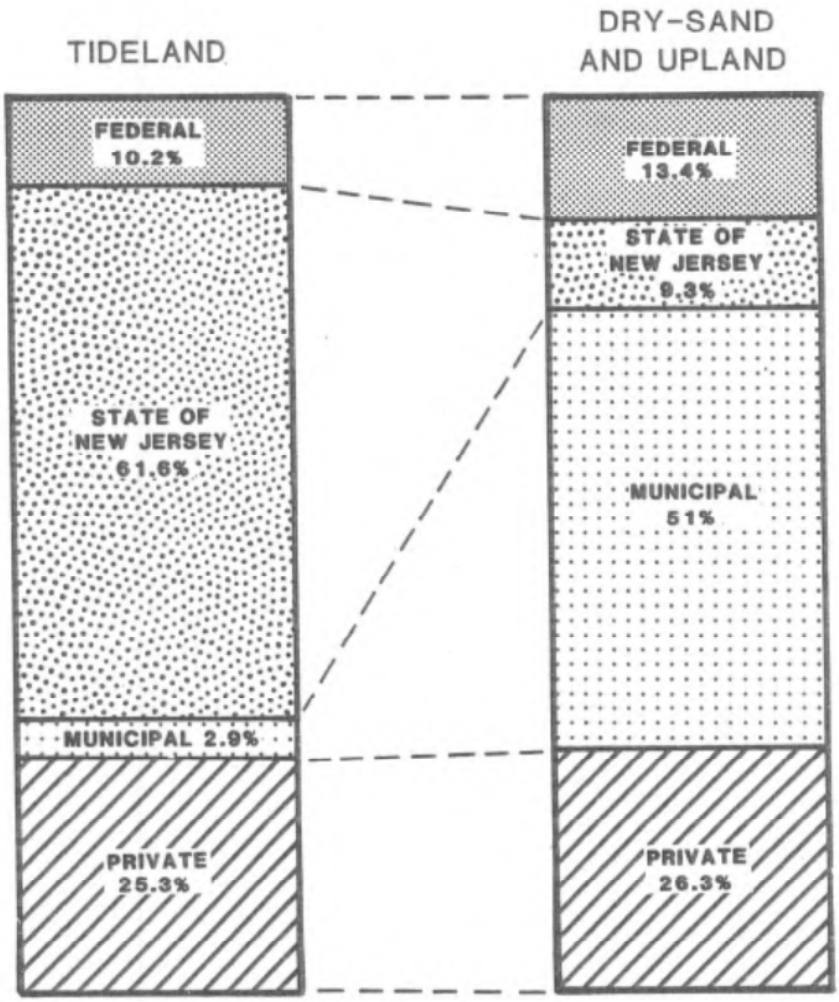
Shorefront Ownership	Percent of Total Oceanfront Tideland Length by Reach													Tideland Oceanfront Total	Upland and* Dry Beach Oceanfront Totals
	2	3	4	5	6	7	8	9	10	11	12	13	14		
Federally Owned**	53.1	0	0	0	0	9.0	27.1	0	0	0	0	19.1	17.1	10.2%	13.4%
State Owned															
Public Shore Parks	0	0	5.6	0	48.6	1.4	27.1	0	1.1	2.2	0	0	15.9	11.4%	9.30%
Ungranted Public Shores	25.7	55.5	79.6	84.2	27.4	89.1	31.2	13.7	37.8	97.3	93.1	2.3	16.3	50.2%	
Municipally Owned (Public)	0	8.0	10.6	0.4	2.0	0	9.8	10.1	0.3	0	0.3	0	0.4	2.9%	51.0%
Privately Owned	21.2	36.5	4.2	15.4	22.0	0.5	4.8	76.2	60.8	0.5	6.6	78.6	50.3	25.3%	26.3%
														100.0%	100.0%

Notes:

Tideland ownership values presented in this table were prepared from data presented in Table LD-4.

* Taken from New Jersey Beach Access Study Commission, April 1977. The upland or dry beach oceanfront land is limited by definition to the first lot landward of the mean high water line.

**Federal Shore may be further subdivided into non-public, including restricted military areas such as the U.S. Coast Guard, Wildwood Electronics Center in Reach 13, and public parks such as Sandy Hook National Park (Reach 2) or Brigantine National Wildlife Refuge Holgate Unit (Reach 7).



OCEANFRONT OWNERSHIP IN NEW JERSEY

SOURCE: ADAPTED FROM NEW JERSEY BEACH ACCESS STUDY COMMISSION, 1977.

DAMES & MOORE

FIGURE II.C-2

- o Pollution which has destroyed or contaminated fish and shellfish areas and fouled certain beaches; and
- o Shore erosion, often accelerated by improper land use and shore erosion control practices.

It is evident then that, even if private shorefront acquisition were to stop, as the demand for State's shoreline grows steadily, the supply of suitable shore would continue to dwindle in response to erosion and pollution.

Although the greatest barrier to public use of beaches is that of beachfront property ownership, it is not the only factor controlling public access to beaches. Another important issue is whether the public has the legal right to cross private dry-sand or upland areas in order to reach the beach area below the high tide line. This issue is a complex one involving constitutional and private property rights. In general the courts have tackled the beach access problem with traditional common law arguments and theories, primarily in case-by-case litigation over isolated tracts of land and with only limited success. The success of common law judicial remedies typically hinge on the historical use of the specific beach areas involved in the litigation and an evidence of that usage. Where historical use patterns do not support one of the common law theories, this approach does little to provide public access to beaches. In fact beach access litigation has had a tendency to be a counterproductive force in that land-owners who previously had voluntarily allowed public access across their property have tended to close off that access to avoid the threat of litigation.

Where shore development is intense, and shore protection devices have been in place for many years, legal beach access concepts are of only passing interest since the judicial system is not likely to require removal of private homes, hotels, etc., or whole towns to make way for public easements. The concepts are also irrelevant when beaches have eroded away.

For a comparative discussion of common law doctrines, litigation, and other related legal concepts and mechanisms regarding public rights to use and acquisition of access to beach areas, the reader is referred to Burka (1974), Maloney and others (1977), and Environmental Comment (March 1980). A summary of landmark beach access litigation in New Jersey is presented in the New Jersey Beach Access Study Commission report entitled Public Access to the Oceanfront Beaches (April 1977).

In addition to the legal access aspects attributable to shorefront property ownership, other restrictions to beach access relate to physical, visual, and financial and considerations. Physical access relates to the difficulties of reaching the water's edge because of lack of transportation and/or lack of parking facilities. Physical access to the shoreline, beach and ocean has also been blocked by private construction precluding access to the water for fishing, walking, or simply viewing. Physical restrictions may also include natural features such as wetlands and dunes, and nuisance structures such as fences and seawalls. Transportation barriers may include inadequate or congested access roadways, inadequate or non-existent public transportation means.

Visual access is impeded where construction blocks off views to the beach and water. The protection of views can enhance the character of a place and contribute to protecting its natural features and property values. Views overlooking water also offer intangible social benefits to the public at large.

While the New Jersey Supreme Court ruled as unconstitutional, the imposition of differential beach fees (Neptune vs. Avon 61 NJ 296) between residents and non-residents, most muncipalities have imposed fees along the entire shorefront for maintenance and services, including lifeguards, cleanup, and provisions for sanitary facilities. Notable exceptions include Atlantic City (which levies an 8 percent luxury tax in its hotels), Upper Township, North Wildwood, Wildwood Crest, Lower Township, and Cape May (NJDEP, 1979). The beach fee and service structure, which varies considerably among the New Jersey shore municipalities, are published annually by the New Jersey Division of Tourism.

Under Federal and State definition, the term "public use," particularly of private property, means recreational use by all on equal terms, regardless of origin or home area. Any device for limitation of beach use for specific segments of population, such as local residents, or similar restrictions on outside visitors, directly or indirectly, is not consistent with the public use as defined above. This definition allows a reasonable beach entrance fee, uniformly applied to all, for use in payment of local maintenance costs. Normal charges made by concessionaires and municipalities for use of facilities such as bridges, parking areas, bath houses and umbrellas, are not usually construed as a charge for the use of a beach as long as they are commensurate with the value of the service they provide and return only a reasonable profit.

The State authority to promote public access through regulatory action is contained in the four fundamental coastal laws: CAFRA, the Wetlands Act, the Waterfront Development Law, and the Tideland Statutes. As will be discussed in Chapter III, various State Coastal Management Program policies pertain to shorefront access. In addition, the State has an opportunity, through its capital spending programs, to insure that funds will be used to maximize the public's access to the shorefront. In particular, Green Acres Program funds may be spent for acquiring waterfront sites for public use. In administering the Shore Protection Program, State disbursement of funds to municipalities is contingent upon their making the shorefront open to the public.

Thus, the issue of beach ownership and access is a complex one. In general, however, it is clear that available, suitable, recreational shoreline areas will continue to decline if current erosion, development and recreational demands trends continue.

D. SOCIOECONOMIC CHARACTERISTICS

The New Jersey shore means different things to different people. In the past it has conveyed the impression of a homogeneous region. Although shore communities have many common characteristics, substantial differences do exist. This section presents a brief discussion of socioeconomic characteristics, highlighting the commonalities and the differences in shore communities and reaches.

1. Seasonality

Seasonal fluctuations in population occur in all of the shore communities, with many communities in Reaches 6-14 (Mantoloking to Cape May Point) experiencing increases by a factor of 10 to 20 (Table II.D-1) during the summer months. The impact of this fluctuation in the seasonality in other aspects of community life, such as the economy, cannot be overstated. The economics of many shore communities are highly seasonal compared with other places in the State. For example, as total employment statewide increased by almost 200,000 between April and August 1978, the four primary counties of the shore region (Monmouth, Ocean, Atlantic, and Cape May) accounted for 41 percent of the increase (82,000 jobs). About half of these are at the various seashore resorts (New Jersey Department of Labor and Industry, May 1978). Seasonal variations in employment for the coastal communities are shown in Table II.D-1. This is a ratio of year round average unemployment rate average unemployment rate for June, July and August. The fluctuations are highest for the communities in reaches 10 to 14, reflecting their economic dependency upon tourism. The average unemployment rate for these shore communities is similar to the statewide rate during the winter months.

Another indicator of seasonality, seasonal housing, sets the shore communities apart from the State and from each other. Moving south from the Raritan Bay to Cape May, the percent of seasonal housing increases from one reach to the next (Table II.D-2 such that in Reach 1 (Raritan Bay shore) most communities have fewer than 5 percent, in Reach 6 (Mantoloking to Barnegat Inlet) most communities have more than 30 percent, and in Reaches 7 to 14 (Barnegat Inlet to Cape May Point) most communities have more than 50 percent seasonal housing (1970 Census of Housing).

2. Employment

In the communities on the Raritan and Delaware Bays (Reaches 1 and 15) the largest category of employment is generally manufacturing (New Jersey Department of Labor and Industry, October, 1979). The largest manufacturing groups are fabricated metal products, and in Salem County, chemical, and allied products.

Communities on the Atlantic shoreline derive most of their employment from retail trade and services. Manufacturing contributes only approximately 13 percent of this region's employment, compared with 31 percent statewide. The Federal government is an important part of the economic base of these communities, especially in Monmouth County. Monmouth and Ocean Counties import a large part of their employed labor force (25.5 percent and 20.7 percent, respectively), while Atlantic and Cape May Counties are relatively self-sufficient in this respect (New Jersey Department of Labor and Industry, October 1979).

TABLE II.D-1

SOCIOECONOMIC INDICATORS

Reach Number	Municipality	Seasonal Population Ratio	Seasonal Unemployment Ratio	Retail Sales per Capita (1977) (where applicable)	Money Income per Capita (1975)	Percent Population Growth (1970-1978)	Percent Growth in Equalized Valuation 1971-1978 (corrected for inflation)
1	Perth Amboy City	ND	0.92	3,724	4,542	-9.4	-4.38
	South Amboy City	ND	0.90	4,570	5,046	-5.5	-1.91
	Sayerville Boro.	ND	0.90	1,977	5,235	-2.5	19.34
	Old Bridge Twp.	ND	0.91	1,034	5,055	4.3	5.49
	Aberdeen Twp.	ND	0.98	2,410	5,113	6.8	2.84
	Keyport Boro.	ND	0.97	7,171	4,905	-3.3	5.48
	Union Beach Boro.	ND	0.97	996	3,857	-3.1	12.91
	Keansburg Boro.	ND	0.97	762	3,780	2.3	-2.83
	Middletown Twp.	ND	0.97	2,440	5,771	10.3	22.28
	Atlantic Highlands Boro.	ND	0.98	3,290	6,221	0.1	14.14
	Highlands Boro.	ND	0.97	1,847	4,678	19.9	68.91
2	Sea Bright Boro.	3.0	0.98	ND	6,252	53.5	36.39
	Monmouth Beach Boro.	1.3	0.90	ND	7,436	69.7	103.37
3	Long Branch City	1.7	0.98	2,091	5,358	-1.1	12.36
	Deal Boro	2.0	0.97	ND	10,154	-2.7	48.71
	Allenhurst Boro.	1.2	0.98	ND	6,881	-9.7	1.18
	Loch Arbour	1.1	1.04	ND	6,965	-0.8	-5.87
	Asbury Park City	2.6	0.98	4,556	4,090	-13.2	-30.73
	Neptune Twp.	ND	0.98	2,400	4,570	-1.1	1.11
	Bradley Beach Boro.	3.4	0.99	2,638	4,161	3.7	-1.24
	Avon-by-the-Sea	2.7	0.98	ND	6,376	3.3	3.14
4	Belmar Boro.	5.1	0.96	8,025	5,205	0.7	19.30
	Spring Lake Boro.	3.3	0.98	2,132	8,927	0.8	-14.76
	Sea Girt Boro.	1.2	0.97	ND	9,771	-0.9	6.19
	Manasquan Boro.	2.9	1.12	6,930	6,121	6.3	12.38
5	Point Pleasant Beach Boro.	7.1	1.10	8,748	5,529	15.3	17.74
	Bay Head Boro.	5.5	1.11	ND	7,051	16.8	10.90
6	Montoloking Boro.	6.4	1.00	ND	8,886	49.5	18.94
	Brick Twp.	1.8	1.12	3,760	4,764	51.6	42.66
	Dover Twp.	1.2	1.10	5,902	5,023	47.5	37.85
	Lavallette Boro.	14.2	1.11	ND	5,836	53.8	41.50
	Sea Side Heights Boro.	25.6	1.10	ND	5,073	31.6	30.59
	Seaside Park Boro.	20.0	1.14	ND	4,709	58.2	41.61
	Berkeley Twp.	1.1	1.11	ND	4,361	125.3	156.37

TABLE II.D-1 (Continued)

Reach Number	Municipality	Seasonal Population Ratio	Seasonal Unemployment Ratio	Retail Sales per Capita (1977) (where applicable)	Money Income per Capita (1975)	Percent Population Growth (1970-1978)	Percent Growth in Equalized Valuation 1971-1978 (corrected for inflation)
7	Barnegat Light Boro.	14.5	ND	ND	5,497	51.4	41.25
	Harvey Cedars Boro.	14.0	1.00	ND	4,972	29.3	61.66
	Surf City Boro.	9.4	1.07	ND	4,807	56.0	48.72
	Ship Bottom Boro.	13.4	1.12	ND	5,676	41.3	37.09
	Long Beach Twp.	12.3	1.12	ND	6,936	47.5	44.44
	Beach Haven Boro.	18.3	1.11	ND	5,333	23.4	37.77
8	Brigantine City	2.7	1.20	1,542	5,004	25.9	72.30
9	Atlantic City	ND	1.19	5,159	3,952	-12.7	-12.54
	Ventnor City	ND	1.21	3,854	5,894	10.7	35.49
	Margate City	ND	1.21	2,150	7,580	1.1	31.99
	Longport Boro.	ND	1.18	ND	8,973	39.4	52.22
10	Ocean City	9.8	2.03	5,946	6,395	20.0	54.64
11	Upper Twp.	3.0	2.07	ND	4,917	69.3	129.87
	Sea Isle City	9.1	2.04	ND	5,101	59.2	95.74
12	Avalon Boro.	11.3	2.09	ND	8,062	66.9	87.46
	Stone Harbor Boro.	14.7	2.00	ND	6,361	23.1	35.04
12	North Wildwood City	15.0	1.94	4,486	5,122	21.4	27.74
	Wildwood City	20.0	1.97	20,635	4,134	-1.8	17.42
	Wildwood Crest Boro.	11.4	2.00	1,826	5,826	13.0	30.69
	Lower Twp.	4.2	1.97	1,386	4,363	62.0	76.30
13	Cape May City	5.9	2.02	6,367	4,340	3.1	76.94
	Lower Twp.	4.2	1.97	1,386	4,363	62.0	76.30
	Cape May Point Boro.	12.3	1.00	ND	5,882	67.6	72.54
15	Lower Twp.	4.2	1.97	1,386	4,363	62.0	76.30
	Middle Twp.	4.5	2.00	ND	4,308	19.8	70.39
	Dennis Twp.	3.3	2.09	ND	4,154	33.1	125.01
	Maurice River Twp.	ND	0.98	ND	3,830	24.8	7.46
	Commercial Twp.	ND	0.98	ND	3,432	3.8	24.02
	Downe Twp.	ND	0.98	ND	3,254	6.7	46.09
	Lawrence Twp.	ND	0.98	ND	3,781	-2.8	64.83
	Fairfield Twp.	ND	0.99	ND	4,045	9.9	25.35
	Greenwich Twp.	ND	0.93	ND	4,557	1.9	-3.43

TABLE II.D-1 (Continued)

Reach Number	Municipality	Seasonal Population Ratio	Seasonal Unemployment Ratio	Retail Sales per Capita (1977) (where applicable)	Money Income per Capita (1975)	Percent Population Growth (1970-1978)	Percent Growth in Equalized Valuation 1971-1978 (corrected for inflation)
16	Lower Alloways Creek Twp.	ND	0.89	ND	4,049	2.9	192.74
	Elsinboro Twp.	ND	0.88	ND	6,040	-9.8	48.21
	Pennsville Twp.	ND	0.90	3,108	5,132	7.6	29.50
	Carneys Point Twp.	ND	0.91	ND	4,645	10.3	24.61
	Penns Grove Twp.	ND	0.91	5,564	4,055	-8.0	4.93
	Oldmans Twp.	ND	0.90	ND	4,599	2.8	60.45
	Logan Twp.	ND	0.96	ND	5,127	31.1	35.53
	Greenwich Twp.	ND	0.95	ND	4,596	2.6	5.26
	Paulsboro Boro.	ND	0.96	3,137	4,167	10.6	54.40
	West Deptford Twp.	ND	0.96	1,133	5,183	37.8	33.45
	National Park Boro.	ND	0.96	767	4,221	4.4	17.37
	Westville Boro.	ND	0.96	4,662	5,162	-6.7	25.75
	Gloucester City	ND	0.96	2,083	4,300	-8.9	7.49
	Camden City	ND	0.97	1,694	3,478	-15.8	-36.28
	Pennsauken Twp.	ND	0.96	5,781	5,038	-4.6	-0.41
	Palmyra Boro.	ND	0.97	3,457	5,114	9.5	25.30
	Riverton Boro.	ND	0.97	3,121	6,019	-12.2	16.77
	Cinnaminson Twp.	ND	0.97	4,432	5,811	2.9	19.45
	Delran Twp.	ND	0.97	2,548	5,273	65.4	56.38
	Delanco Twp.	ND	0.97	ND	4,960	-6.0	32.56
	Beverly, City of	ND	0.96	2,907	4,430	1.4	1.22
	Edgewater Park Twp.	ND	0.95	ND	5,268	25.9	18.69
	Burlington Twp.	ND	0.96	5,567	4,855	7.4	30.07
	Burlington City	ND	0.97	7,449	4,594	3.2	9.19
	Florence Twp.	ND	0.96	ND	4,518	2.1	25.05
	Mansfield Twp.	ND	0.96	ND	5,019	5.7	35.36
	Fieldsboro Twp.	ND	0.97	ND	3,964	-3.7	1.90
	Bordentown Twp.	ND	0.98	ND	5,582	3.3	11.58
	Bordentown City	ND	0.96	2,950	5,482	4.2	36.96

ND – No Data Available

Sources: Monmouth County Planning Board, October 1978
Ocean County Planning Board, 1979
Cape May County Planning Board, November 1973
New Jersey Department of Labor and Industry, June 1979
U.S. Bureau of Census, February 1979 and February 1980
New Jersey Department of Labor and Industry, July 1978
New Jersey Department of the Treasury, Division of Taxation, 1979

TABLE II.D-2

LAND USE INDICATORS

Reach Number	Political Subdivisions (Municipalities/Parks)	Population (1978)	Area (square mile)	Population Density (1978)	Percent Real Property In Residential and Apartment Sectors (1977)	Percent Seasonal Housing Stock (1970)	Equalized Valuation Per Capita (1978)	Community Classification
1	Perth Amboy City	35,146	4.70	7,477	44.4	1.0	11,495	Urban
	South Amboy City	8,822	1.40	6,301	72.5	0	12,926	Urban
	Sayerville Boro.	31,696	16.20	1,956	57.5	1.0	20,034	Urban
	Old Bridge Twp.	50,827	42.00	1,210	82.9	1.0	11,826	Urban
	Aberdeen Twp.	18,879	5.45	3,464	82.9	ND	11,852	Urban
	Keyport Boro.	6,970	1.40	4,978	64.3	1.0	12,756	Urban
	Union Beach Boro.	6,270	1.80	3,483	75.1	4.4	9,773	Urban
	Keansburg Boro.	9,947	0.95	10,470	86.0	20.5	8,304	Urban
	Middletown Twp.	60,264	41.08	1,467	85.2	ND	15,869	Residential
	Atlantic Highlands	5,098	1.20	4,248	85.2	1.0	15,208	Residential
	Highlands Boro.	4,695	0.64	7,335	83.6	11.8	13,547	Recreational
2	Sea Bright Boro.	2,055	0.60	3,425	63.4	15.5	20,285	Recreational
	Monmouth Beach Boro.	3,466	1.10	3,150	91.7	13.4	21,830	Residential
3	Long Branch City	31,430	5.10	6,162	80.4	3.4	11,125	Urban Center
	Deal Boro.	2,336	1.20	1,946	92.8	19.4	43,512	Residential
	Allenhurst Boro.	914	0.30	3,046	73.7	4.7	28,785	Recreational
	Loch Arbour	392	0.10	3,920	86.1	ND	17,679	Residential
	Asbury Park City	14,351	1.49	9,657	69.2	1.0	7,855	Urban
	Neptune Twp.	27,542	4.26	6,465	72.9	1.0	56,051	Urban
	Bradley Beach Boro.	4,319	0.70	6,170	87.8	26.9	13,236	Recreational
	Avon-by-the-Sea	2,235	0.40	5,587	90.2	25.4	22,478	Recreational
4	Belmar Boro.	5,820	1.00	5,820	81.5	29.6	18,939	Recreational
	Spring Lake Boro.	3,926	1.30	3,020	85.8	21.0	32,572	Recreational
	Sea Girt Boro.	2,187	1.05	2,082	92.7	14.3	46,956	Residential
	Manasquan Boro.	5,282	1.40	3,772	82.5	32.3	24,325	Recreational
5	Point Pleasant Beach Boro.	5,629	3.70	1,521	67.0	22.2	26,559	Recreational
	Bay Head Boro.	1,265	0.60	2,108	89.3	37.4	56,685	Residential
6	Montoloking Boro.	477	0.44	1,084	93.0	70.4	127,377	Residential
	Brick Twp.	53,148	26.40	2,013	80.6	12.8	16,500	Residential
	Dover Twp.	64,518	41.62	1,550	73.9	31.5	19,530	Residential
	Lavallette Boro.	2,321	0.65	3,570	90.6	69.9	57,582	Residential
	Sea Side Heights Boro.	1,642	0.35	4,691	74.3	77.7	59,662	Recreational
	Sea Side Park Boro.	2,266	0.60	3,776	86.6	51.0	41,936	Recreational
	Berkeley Twp.	17,838	41.90	425	75.2	69.5	21,593	Residential

TABLE II.D-2 (Continued)

Reach Number	Political Subdivisions (Municipalities/Parks)	Population (1978)	Area (square mile)	Population Density (1978)	Percent Real Property In Residential and Apartment Sectors (1977)	Percent Seasonal Housing Stock (1970)	Equalized Valuation Per Capita (1978)	Community Classification
7	Barnegat Light Boro.	839	0.70	1,198	80.7	ND	64,282	Recreational
	Harvey Cedars Boro.	406	0.55	738	86.9	66.8	168,279	Recreational
	Surf City Boro.	1,761	0.65	2,709	88.1	40.8	62,109	Recreational
	Ship Bottom Boro.	1,525	0.71	2,147	77.4	71.5	56,583	Recreational
	Long Beach Twp.	4,292	4.30	998	86.8	59.2	99,164	Recreational
	Beach Haven Boro.	1,836	1.00	1,836	78.2	56.7	64,099	Recreational
8	Brigantine City	8,488	3.50	2,425	82.0	36.9	26,593	Recreational
9	Atlantic City	41,767	12.40	3,368	37.3	5.5	11,841	Urban Center
	Ventnor City	11,501	2.10	5,476	89.4	22.1	20,341	Recreational
	Margate City	10,688	1.40	7,634	91.6	16.1	27,304	Residential
	Longport Boro.	1,708	1.00	1,708	91.0	ND	51,287	Residential
10	Ocean City	12,695	7.10	1,788	87.0	57.3	56,584	Recreational
11	Upper Twp.	5,778	65.81	87	71.3	33.2	24,865	Recreational
	Sea Isle City	2,725	2.50	1,088	82.6	66.1	59,687	Recreational
12	Avalon Boro.	2,141	4.83	443	78.9	78.6	131,985	Recreational
	Stone Harbor Boro.	1,341	1.68	797	86.1	65.5	64,347	Recreational
13	North Wildwood City	4,753	1.80	2,640	79.9	53.1	42,273	Recreational
	Wildwood City	4,035	1.30	3,103	60.5	64.6	51,025	Recreational
	Wildwood Crest Boro.	3,928	1.00	3,928	54.1	50.9	57,045	Recreational
	Lower Twp.	16,454	27.80	591	77.3	47.0	16,786	Recreational
14	Cape May City	4,529	2.30	1,969	62.6	21.1	25,797	Recreational
	Lower Twp.[1]	—	—	—	—	—	—	—
	Cape May Point Boro	342	0.30	1,138	83.7	71.9	58,844	Recreational
15	Lower Twp.[1]	—	—	—	—	—	—	—
	Middle Twp.	10,449	72.46	144	64.4	29.06	16,849	Recreational
	Dennis Twp.	3,508	66.20	53	58.0	12.61	15,772	Residential
	Maurice River Twp.	4,670	94.73	49	56.9	ND	7,014	Rural
	Commercial Twp.	3,807	33.99	112	19.3	ND	7,823	Rural
	Downe Twp.	1,896	54.33	34	57.2	ND	11,271	Rural
	Lawrence Twp.	2,253	37.34	60	56.0	ND	11,076	Rural
	Fairfield Twp.	5,484	43.39	126	73.5	ND	7,006	Rural
	Greenwich Twp.	981	19.01	51	52.7	ND	13,364	Rural

[1]See statistics for Lower Twp. in Reach 10

TABLE II.D-2 (Continued)

Reach Number	Political Subdivisions (Municipalities/Parks)	Population (1978)	Area (square mile)	Population Density (1978)	Percent Real Property In Residential and Apartment Sectors (1977)	Percent Seasonal Housing Stock (1970)	Equalized Valuation Per Capita (1978)	Community Classification
16	Lower Alloways Creek Twp.	1,441	46.25	31	22.7	ND	28,459	Residential
	Elsinboro Twp.	1,086	13.11	82	77.7	ND	13,499	Rural
	Pennsville Twp.	14,307	24.40	586	47.8	ND	17,700	Residential
	Carneys Point Twp.	7,740	17.90	432	70.5	ND	11,517	Residential
	Penns Grove Twp.	5,271	1.00	5,271	75.0	ND	6,030	Residential
	Oldmans Twp.	2,029	20.10	100	38.4	ND	1,855	Rural
	Logan Twp.	2,412	23.42	103	36.3	ND	5,368	Rural
	Greenwich Twp.	5,826	9.44	617	19.5	ND	62,203	Residential
	Paulsboro Boro.	7,226	2.09	3,457	49.8	ND	11,902	Residential
	West Deptford Twp.	19,187	16.18	1,185	43.3	ND	19,448	Residential
	National Park Boro.	3,565	1.00	3,565	90.7	ND	7,494	Residential
	Westville Boro.	4,823	1.21	3,986	75.9	ND	11,602	Urban
	Gloucester City	13,392	2.83	4,732	62.3	ND	9,323	Urban
	Camden City	86,322	10.39	8,308	59.8	ND	4,959	Urban
	Pennsauken Twp.	34,713	12.27	2,829	54.5	ND	15,884	Urban
	Palmyra Boro.	7,629	1.92	3,973	84.4	ND	11,117	Urban
	Riverton Boro.	2,994	0.70	4,277	92.4	ND	13,819	Urban
	Cinnaminson Twp.	17,450	7.57	2,305	73.0	ND	16,392	Urban
	Delran Twp.	16,644	6.91	2,408	76.5	ND	12,028	Urban
	Delanco Twp.	3,908	2.16	1,809	66.9	ND	14,325	Urban
	Beverly, City of	3,149	0.54	5,831	84.0	ND	7,208	Urban
	Edgewater Park Twp.	9,329	2.86	3,261	77.8	ND	11,603	Urban
	Burlington Twp.	11,405	14.20	803	55.6	ND	17,365	Urban
	Burlington City	11,630	2.44	4,766	59.0	ND	10,213	Urban
	Florence Twp.	8,738	9.65	905	68.4	ND	15,889	Urban
	Mansfield Twp.	2,744	23.09	118	54.1	ND	18,211	Urban
	Fieldsboro Twp.	592	0.30	1,973	65.1	ND	9,933	Urban
	Bordentown Twp.	7,542	7.41	1,017	62.3	ND	15,007	Urban
	Bordentown City	4,677	0.94	4,975	69.0	ND	11,017	Urban

ND – No Data Available

Sources: New Jersey Department of Labor and Industry, 1979
New Jersey Department of Community Affairs, 1977

The employment distribution among industry groups in the shore communities exhibits high seasonal fluctuations in retail trade, small services, amusements, and agriculture/mining, with employment in these categories increasing substantially during the warmer months. Communities on the Atlantic shoreline experience significantly greater changes in this respect than do communities on Raritan or Delaware Bays. Overall, Cape May County exhibits the greatest absolute and percent fluctuations, with covered employment in retail trade expanding by 11,400 (257 percent) between April and August.

3. Real Estate

Approximately 70 to 90 percent of the tax base of most shore communities consists of residential development (Table II.D-2). The major exceptions occur in Reaches 15 (Delaware Bay) and 16 (Delaware River), which contain significant industrial development as discussed above. Not surprisingly, the population density of the latter communities is generally much lower than other shore communities. Per capita valuation is highest for the communities in Reaches 6-14, (Mantoloking to Cape May Point). Percent growth in valuation since 1970 has also been generally higher in these communities.

4. Transportation

The major highways serving the coastal counties from the New York metropolitan area are the Garden State Parkway, U.S. Highway 9, and State Highways 18 and 34. They provide a direct north-south, high-speed, limited access automobile link between the shore counties and the urbanized area to the north. Northern Ocean and Monmouth County shorefront communities are a one to two hour drive from the New York metropolitan area. State Highways 35 and 36 provide access to Monmouth and northern Ocean Shore communities from the highways mentioned above.

Major routes from the Princeton/Trenton area to the Monmouth and Ocean County shore areas is via State Highway 33 and Interstate 195. Similar, high-speed highways link Atlantic City and Cape May Counties with the Philadelphia/Camden and Wilmington metropolitan areas. The Atlantic City Expressway and U.S. Route 30 connect to Philadelphia, and U.S. Route 40 connects Atlantic City with Wilmington. The Atlantic City area and Cape May County are about a one to two hour drive from Philadelphia and Wilmington. Direct automobile access from these major routes to the barrier islands is usually limited to one or two connections. For example, Long Beach Island is connected to the mainland only by State Route 72, which crosses the State from Camden.

Mass transit to the shore communities is available via regularly scheduled bus, rail and air carriers. Transport of New Jersey, Greyhound, Lincoln Transit, and the Asbury Park-New York Transit Corporation are some of the major bus lines that provide regularly scheduled direct service to various shore communities from such destinations as Newark, New York, and Philadelphia. Conrail is the major provider of rail service in the coastal counties, providing direct links from Philadelphia and New York metropolitan areas. Commuter rail service is available between Bay Head-Pt. Pleasant in Ocean County and New York, and between Atlantic City and Philadelphia (State Development Guide Plan, New Jersey Department of Community Affairs, 1977).

Regularly scheduled passenger air service is currently available between Atlantic City's Bader Airport and Philadelphia, Newark, and New York. Other smaller, public and private airports are found near Toms River, Lakewood, Asbury Park,

Wildwood, Sea Isle City, and Cape May. These smaller airports do not have regularly scheduled passenger services.

Access to the Delaware Bay coastal communities is not as well developed. The shoreline is not generally served by roads and shoreline access is only intermittent. The major access route along the Delaware River shore is U.S. Route 130. Along the Delaware Bay Shore area, State Highways 49 and 47 provide shore area access.

5. Coastal Community/Reach Classification

In order to evaluate the direct and indirect socioeconomic impacts associated with the use of any solutions to shore erosion, the communities which comprise the reaches have been classified into various categories. Different communities vary significantly in terms of 1) their abilities to accommodate additional tourists (infrastructure capacity and public services), 2) the level of supporting recreational services provided (boardwalk, amusements, entertainment and retail/service outlets) and 3) their abilities to extract local direct and secondary (locally generated induced and indirect employment and income) economic benefits. For example, communities like Ocean City or Seaside Heights offer a wider array of specialized recreational and tourist oriented goods and services than communities like Bay Head or Deal. They presently possess the boardwalks, specialized retail and service establishments and supporting infrastructure (parking lots, beach patrols, seasonal housing, and motel/hotel units) that enables them to more easily accommodate an increase in beachfront patronage than in smaller communities lacking comparable facilities.

Almost all oceanfront communities, by virtue of their location, offer some level of entertainment, recreational and tourism goods and services. That is, nearly all of them have some tourism orientation. However, the size, local importance and degree of specialization of the local recreational/tourism/entertainment sector varies widely among communities. In some, the income and employment generated by this sector is by far the most important component of the local economy. Further, these communities have provided infrastructure to accommodate the seasonal visitors and adapted themselves to the seasonal fluctuations inherent in the oceanfront tourism and recreational sector. Conversely, in other communities, the tourism/recreational/entertainment sector is much less important, and the community is not greatly dependent on this sector for jobs and income.

a. Methodology

A variety of economic, fiscal, land use, and social indicators for New Jersey's shore communities were examined to determine whether distinct types of communities do exist. The perspective of this analysis was to find communities that were alike in terms of their economic dependence on and orientation toward the tourism/recreational/entertainment sector, i.e., seasonality of population, employment and housing. Further, this analysis looked for communities that offered comparable quantities (size and degree of specialization) of tourism/recreational/entertainment goods and services. Finally, communities were examined from the standpoint of their abilities to accomodate the social and economic effects associated with alternative shoreline erosion management strategies.

The following indicators were examined to see if recognizable community types did exist.

Population

- o Seasonal/Year Round Population Ratio
- o Year Round Total
- o Density

Land Use

- o Real Property Classification
- o Proximity to an urban centers
- o Seasonal Housing Stock
- o Land Area

Economics

- o Employment Distribution
- o Annual/Seasonal Unemployment Ratio
- o Per Capita Money Income
- o Per Capita Retail Sales (where available)
- o Estimated Oceanfront Property Values

Local Community Facilities

- o Presence of a Boardwalk, Convention Center, etc.
- o Accessibility of Beach

Fiscal

- o Effective Tax Rate
- o Equalized Valuation Per Capita

Three coastal community types (including urban, residential, and recreational/water dependent) exist along the ocean shore segment, and an additional coastal community type (rural) was noted along the Delaware River and Bay shores (Reaches 15 and 16). Generic descriptions of each community type were developed based on trends found in the indicators, and all communities were classified into the most compatible coastal community type. Tables II.D-1 and II.D-2 include a number of the indicators used for classifying each community. The generic descriptions of each coastal community type are given below, and the classification of each community is contained in Table II.D-3. Finally, each reach was classified according to the classification of it's component municipalities. That classification is also provided in Table II.D-3 and is discussed below.

The formulation of a reach classification based on the characteristics and type of the communities comprising the reach was difficult in some areas as the reach boundaries were not necessarily contiguous with or compatible to governmental boundaries, development and land use patterns, or socioeconomic criteria. This problem was most noticeable for Reach 3 (Long Branch to Shark River Inlet) which is comprised of all three coastal community types.

(1) Urban Community. The urban coastal community is a spatially concentrated, high density (population) central place offering higher order retail, service, and in particular, specialized recreational, entertainment and tourism goods and services. It serves as a regional (sub-county, county or multi-county area) administrative, service, retail and employment center. The economic market area (for non-recreational goods and services) for the urban coastal community is approximately contiguous with its labor market area. Its market area for recreational and tourist goods and services can

TABLE II.D-3

COMMUNITY/REACH CLASSIFICATION SCHEMES

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Community Classification	Reach Classification
1	Raritan Bay	Middlesex	Perth Amboy City South Amboy City Sayreville Borough Old Bridge Township	Urban Urban Urban Urban	Urban
		Monmouth	Aberdeen Township Keyport Borough Union Beach Borough Keansburg Borough Middletown Township Naval Weapons Station Earle (Leonardo) Atlantic Highlands Borough Highlands Borough	Urban Urban Urban Urban Residential Dedicated Land - Federal Residential Recreational	
2	Sandy Hook to Long Branch		Gateway National Recreation Area and U.S. Coast Guard Station Sea Bright Borough Monmouth Beach Borough	Dedicated Land - Federal Recreational Residential	Recreational
3	Long Branch to Shark River Inlet		Long Branch City Deal Borough Allenhurst Borough Loch Arbour Asbury Park City Neptune Township Bradley Beach Borough Avon by the Sea	Urban Residential Recreational Residential Urban Urban Recreational Recreational	Urban
4	Shark River Inlet to Manasquan Inlet		Belmar Borough Spring Lake Borough Sea Girt Borough State Arsenal and Camp Ground Manasquan Borough	Recreational Recreational Residential Dedicated Land - State Recreational	Recreational
5	Manasquan Inlet to Mantoloking	Ocean	Point Pleasant Beach Borough Bay Head Borough	Recreational Residenital	Recreational
6	Mantoloking to Barnegat Inlet		Mantoloking Borough Brick Township Dover Township Lavallette Borough Sea Side Heights Borough Sea Side Park Borough Berkeley Township Island Beach State Park	Residential Residential Residential Residential Recreational Recreational Residential Dedicated Land - State	Recreational
7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)		Barnegat Lighthouse State Park Barnegat Light Borough Harvey Cedars Borough Surf City Ship Bottom Borough Long Beach Township Beach Haven Borough Brigantine National Wildlife Refuge	Dedicated Land - State Recreational Recreational Recreational Recreational Recreational Recreational Dedicated Land - Federal	Recreational
8	Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island)	Atlantic	Brigantine National Wildlife Refuge North Brigantine State Natural Area Brigantine City	Dedicated Land - Federal Dedicated Land - State Recreational	Recreational
9	Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)		Atlantic City Ventnor City Margate City Longport Borough	Urban Recreational Residential Residential	Urban

TABLE II.D-3 (CONTINUED)

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Community Classification	Reach Classification
10	Great Egg Harbor Inlet to Corson Inlet (Peaks Beach)	Cape May	Ocean City Corson Inlet State Wildlife Mgt. Area	Recreational Dedicated Land - State	Recreational
11	Corsons Inlet to Townsends Inlet (Ludlam Island)		Strathmere State Natural Area Upper Township Sea Isle City	Dedicated Land - State Recreational Recreational	Recreational
12	Townsends Inlet to Hereford Inlet (Seven Mile Beach)		Avalon Borough Stone Harbor Borough	Recreational Recreational	Recreational
13	Hereford Inlet to Cape May Inlet (Five Mile Beach)		North Wildwood City Wildwood City Wildwood Crest Borough Lower Township (East) U.S. Coast Guard, Wildwood Electrical Engineering Center	Recreational Recreational Recreational Recreational Dedicated Land - Federal	Recreational
14	Cape May Inlet to Cape May Point		U.S. Coast Guard Receiving Area Cape May City Cape May Point State Park Lower Township (South) Cape May Point Borough	Dedicated Land - Federal Recreational Dedicated Land - State Recreational Recreational	Recreational
15	Delaware Bay (Cape May Point to Stow Creek)	Cape May	Lower Township (West) Higbee Beach State Wildlife Mgt. Area Middle Township Dennis Creek State Wildlife Mgt. Area Dennis Township	Recreational Dedicated Land - State Recreational Recreational Recreational	Rural
		Cumberland	Maurice River Township Corson Tract State Fish and Wildlife Mgt. Area Heislerville State Wildlife Mgt. Area Commercial Township Downe Township Egg Island-Berrytown (Turkey Point) State Wildlife Mgt. Area Fortescue State Wildlife Mgt. Area Lawrence Township Fairfield Township Dix State Wildlife Mgt. Area Greenwich Township	Rural Dedicated Land - State Dedicated Land - State Rural Rural Dedicated Land - State Dedicated Land - State Rural Rural Dedicated Land - State Rural	
16	Delaware River (Stow Creek to Crosswicks Creek)	Salem	Lower Alloways Creek Township Mad Horse Creek State Wildlife Mgt. Area Artificial Island Federal Disposal Area Elsinboro Township Supawna Meadows National Wildlife Refuge Fort Mott State Park Killcohook National Wildlife Refuge Killcohook Federal Dredge Disposal Area Pennsville Township Carneys Point Township Penns Grove Borough Oldmans Township Pedricktown Federal Disposal Area U.S. Military Reservation	Rural Dedicated Land - State Dedicated Land -Federal Rural Dedicated Land - Federal Dedicated Land - State Dedicated Land - Federal Dedicated Land - Federal Residential Residential Residential Rural Dedicated Land - Federal Dedicated Land - Federal	Rural

TABLE II.D-3 (CONTINUED)

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Community Classification	Reach Classification
16 (Cont'd)		Gloucester	Logan Township	Rural	Residential
			Greenwich Township	Residential	
			Paulsboro Borough	Residential	
			West Deptford Township	Residential	
			National Park Borough	Residential	
			Westville Borough	Urban	
		Camden	Gloucester City	Urban	Urban
			Camden City	Urban	
			Pennsauken Township	Urban	
		Burlington	Palmyra Borough	Urban	Urban
			Riverton Borough	Residential	
			Cinnaminson Township	Urban	
			Delran Township	Urban	
			Delanco Township	Urban	
			Beverly, City of	Urban	
			Edgewater Park Township	Urban	
			Burlington Township	Urban	
			Burlington City	Urban	
			Florence Township	Urban	
			Mansfield Township	Urban	
			Fieldsboro Township	Urban	
			Bordentown Township	Urban	
			Bordentown City	Urban	

extend over several states depending on the size of the central place and the degree of specialization in the goods and services it offers.

A sub-class of the urban coastal community is comprised of these communities located immediately adjacent to an urban center or a heavily industrialized area such that they contain large amounts of local industrial activity (manufacturing employment, high proportion of industrial tax base). These communities are not true urban centers as they are not high level central places serving as regional centers. In spite of their coastal location, they offer relatively few recreational services due to the negative, environmental and aesthetic effects of the adjacent urban areas and industrial complexes. Communities located along the Raritan Bay (Reach 1) and the Delaware River (Reach 16) in the Philadelphia/Camden metropolitan area are examples of this type.

The urban coastal community has a more diverse local economy than the other coastal community types. It provides significant employment opportunities in such non-recreational and non-tourist sectors as manufacturing, finance, insurance, and real estate, transportation, retail, and services (in non-travel related areas). It is not as economically dependent upon seasonal recreational and tourism expenditures as other coastal community types because its economic size and structural diversity generate substantial year-round employment and income.

The lower level of economic dependence upon tourism and water-based recreation for the urban community is reflected in a low proportion of seasonal housing, and small fluctuations in season employment (and unemployment) and seasonal population levels. The year-round housing stock is composed primarily of single family units, but multi-family, rental housing (apartments, townhouses) are available locally within these areas.

Manifestations of the functional specialization of the coastal urban center, in terms of the recreational and tourism goods and services it offers, include the presence of arcades, boardwalks, large hotels or resorts, casinos, convention centers, and integrated historical developments or redevelopments containing speciality eating and drinking, retail or entertainment establishments.

Urban indicators include:

- o High population
- o Percent tax base in non-residential and non-apartment sectors
- o Employment concentrations in manufacturing, retail, commercial, transportation and community and government sectors
- o High per capita retail sales
- o Low seasonal housing proportion
- o Low seasonal population fluctuations and unemployment fluctuations.

(2) Residential Community. The coastal residential community type occurs in two distinct physical forms. The first is a small (usually less than 10 square miles in area), spatially concentrated, densely developed and populated community. Moderate amounts of commercial or retail activity are located on a main thoroughfare along the coast. The second is a large (from 10 to 60 square miles in area) township unit with lower densities of population and development. This form has dispersed clusters of commercial activity (shopping centers, unincorporated villages) and scattered residential developments (subdivisions, Planned Unit Developments and villages). This larger residential community type has a more dense commercial/retail development pattern

along the coast and lower density residential, recreational (parks, campgrounds) or agricultural land uses inland.

Both forms of the coastal residential community type have less diverse, smaller economies than the coastal urban community type. They have lower proportions of their property tax base in the commercial and industrial sectors and usually 90 percent or more of their tax based in the residential and apartment sectors. In addition, they provide fewer local employment opportunities in non-recreational and non-tourism sectors than does the coastal urban community, particularly in government, manufacturing and finance, insurance and real estate.

An exception occurs in the developing residential community where commercial and industrial development has occurred along the Garden State Parkway and other major transportation arteries. In such cases, significant local employment opportunities in industrial and office parks may exist. Further, significant proportions of the resident labor force do commute to permanent, year-round jobs in adjacent urban areas (New York, Philadelphia, etc.)

The residential nature of this community type signifies that it is less dependent economically on recreational and tourism related jobs and expenditures than is the recreational and water-dependent community type. The smaller residential coastal community does have a significant proportion of seasonal housing, and a moderate seasonal population fluctuation. However, it does not have as significant a change in seasonal employment/unemployment rate as does the recreational community type. Finally, it has a lower level of retail and service activity than the other two coastal community types.

The coastal residential community type does offer less specialized recreational and tourist goods and services than the other two community types. These services are concentrated primarily in eating and drinking establishments and the amusement and recreation sector. These communities do not exhibit the functional specialization (boardwalks, large hotels, casinos, amusement parks, etc.) found in the other two coastal community types.

The housing stock is almost totally single family residential (year-round and seasonal) with fewer hotel, motel, and campground units than are found in the recreational, water dependent coastal community type. Also, the housing stock offers fewer locally available, rental, multi-family, year-round dwelling units.

Residential indicators include:

- Population
  - below 15,000 (concentrated)
  - below 100,000 (dispersed)
- High percent tax base (more than 90 percent) in residential and apartments
- Moderate share (less than 20 percent) of seasonal housing
- Moderate seasonal population fluctuation
- Moderate seasonal unemployment/employment change
- Low to moderate per capita retail sales
- Relative absence of employment in manufacturing, fire, transportation and government sectors

(3) Recreational and Water-Dependent Community. The recreational and water dependent coastal community type occurs in two distinct physical forms. The first is a small (less than 10 square miles in area), high developed and densely populated area with an identifiable, waterfront-oriented, central business district. The second is a large dispersed (10 to 60 square miles in area) township form with a waterfront, central business district or economic activity center. The dispersed community type also has scattered areas of recreational activities (campgrounds, parks, etc.), subdivisions, unincorporated villages, and vacant or agricultural land located inland.

The recreational and water-dependent coastal community offers recreational and water-oriented goods and services, including specialized, higher order goods and services (large motels, specialty eating and drinking establishments, amusement park or pier, etc.) that would normally be found only in urban areas. This coastal community type has a highly skewed economic structure, with a high proportion of employment and income generated by the retail and service sectors. Local employment opportunities are concentrated in these two sectors and are proportionately much higher and more important here than in the residential coastal community type. The recreational coastal community type has a significant proportion of real property in the commercial sector and exhibits higher levels of retail sales and service receipts per capita when compared with the coastal residential community.

These communities are very dependent economically upon the receipts and expenditures from recreation consumers and tourists. They have a relative lack of local employment opportunities in such non-recreational and non-water dependent sectors as manufacturing, finance, insurance, transportation, and government. This economic dependence is shown in a high level of seasonal population change (up to 8 to 10 times the year round population in same areas), a high proportion of seasonal housing (above 20 percent), and a high seasonal employment/unemployment fluctuation.

The housing stock in the recreational and water dependent coastal community is predominately single family (year-round and seasonal), but also includes a high proportion of seasonal rental units — hotels, motels, campgrounds, cottages, etc. This community type has a level of functional specialization in terms of recreational and tourism goods and services similar to that of the urban coastal community. However, due to the size differences (population, area, market size labor force, tax base, etc.) between the two community types, the recreational community does not offer the same amount of specialized facilities. Only the larger recreational communities (such as Seaside Heights and Wildwood) have boardwalks, and none have convention facilities or hotels similar to those found in Asbury Park and Atlantic City.

Recreational and water-dependent indicators include:

- population
  - below 15,000 (concentrated)
  - below 60,000 (dispersed)
- high per capita retail sales
- employment concentrations in trade and services
- high seasonal fluctuations in population and employment
- high proportion of seasonal housing
- concentration of real property in commercial sector

(4) Rural Coastal Community. The rural coastal community is a variant of the residential coastal community type. It is found along the Delaware River in Reaches 15 and 16. These communities are characterized by extensive areas (15 or more square miles), low population densities, and scattered commercial activity centers and villages. Their chief difference from the recreational community is in their lower intensity of development, as manifested by a lower concentration of their property tax in apartments, residential, and larger proportions of vacant and agricultural land.

The Delaware River location signifies that these communities have less developed recreational and tourism economic sectors. They do not have the concentration of commercial activities that are found in the residential communities along Raritan Bay and Atlantic Ocean shore areas. However, they may have significant local concentrations of employment in the commercial fishing and shellfishing sectors. Finally, these communities tend to have, on the average, lower levels of equalized valuation per capita.

The rural communities have lower levels of seasonality than the other community types with little or no seasonal housing component, little seasonal employment fluctuation and no significant seasonal population change exists.

Rural coastal community indicators include:

- o large land areas (above 15 square miles)
- o low population density (less than 150 persons per square mile)
- o low or no seasonal population fluctuation, seasonal housing component or seasonal employment fluctuation
- o significant proportions of vacant or agricultural land
- o percent tax base in residential and apartment less than 80 percent

(5) Dedicated Lands. The dedicated lands comprise all those areas that are government owned or managed. This classification includes Federal, State, and local shore parks, wildlife, and conservation areas. Similarly, it also encompasses such Federal and State restricted or semi-restricted lands including military bases and Coast Guard stations. The dedicated Federal and State lands are shown in Figures II.D-1 and II.D-2, respectively, and are identified in Table II.D-3 along with the other four coastal community types.

b. Reach Specific Discussion and Classification

The reaches were classified according to the characteristics and classifications of their constituent municipalities. The intent was to assign a comprehensive and meaningful classification to each reach that was reflective of its prevailing social and economic character, specifically as it related to shore tourism dependency. For the Delaware River and Bay Reaches (15 and 16), the diversity of the communities was so great as to preclude the assignment of any meaningful or accurate reach classification. In this instance, component county segments were classified.

Even though four coastal community types were present, only two types of reaches were present along the Atlantic Coast of the State (Reaches 2-14). These two types were recreational and water dependent reaches; and urban reaches. The relative scarcity of the residential coastal community type resulted in none of the reaches being classified as residential. Table II.D-3 lists the reach and community classifications. The following section includes a brief discussion about the rationale employed in classifying each reach.

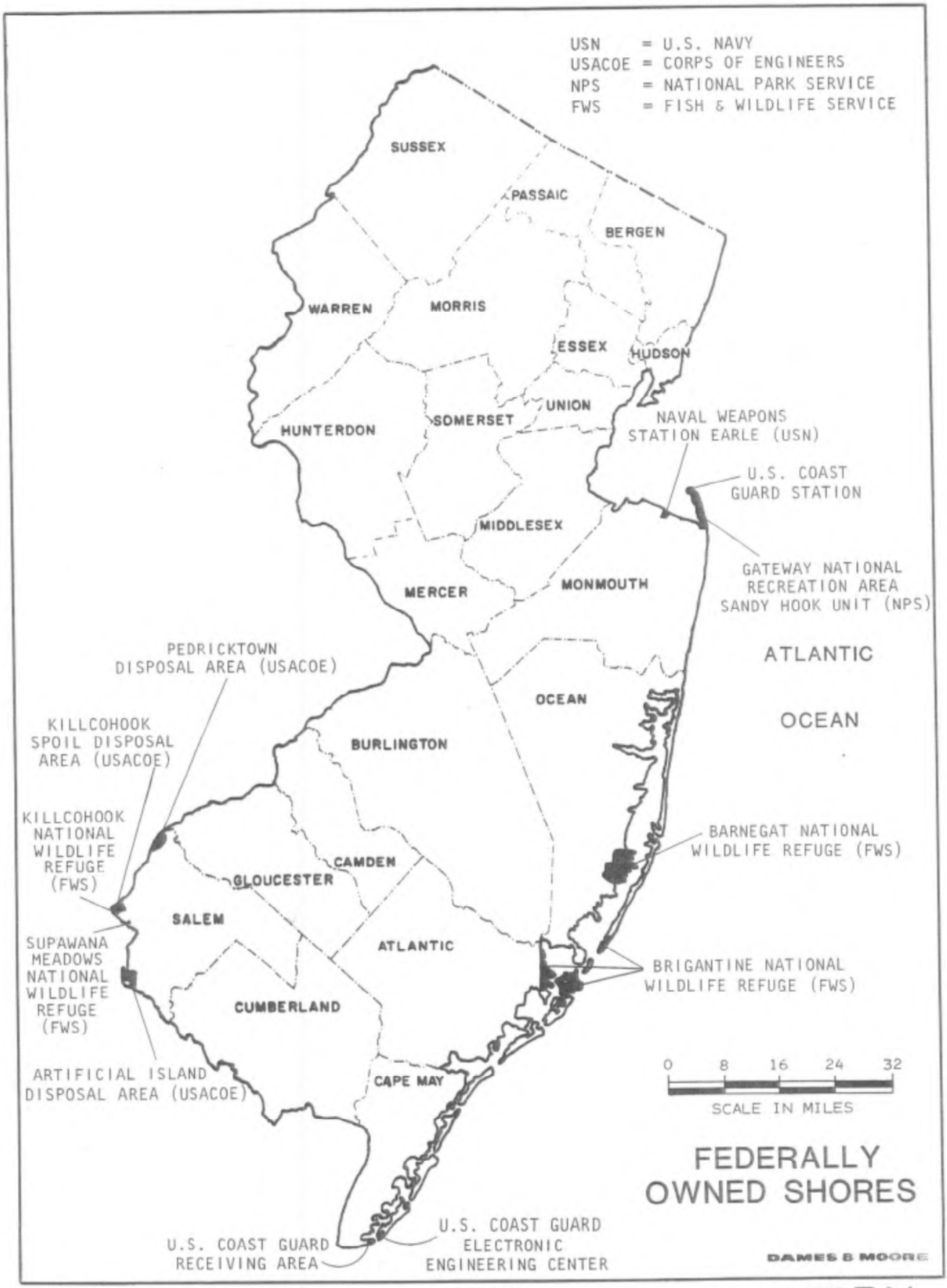

USN = U.S. NAVY
USACOE = CORPS OF ENGINEERS
NPS = NATIONAL PARK SERVICE
FWS = FISH & WILDLIFE SERVICE
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
HUDSON
UNION
SOMERSET
HUNTERDON
NAVAL WEAPONS STATION EARLE (USN)
U.S. COAST GUARD STATION
MIDDLESEX
GATEWAY NATIONAL RECREATION AREA SANDY HOOK UNIT (NPS)
MERCER
MONMOUTH
ATLANTIC OCEAN
PEDRICKTOWN DISPOSAL AREA (USACOE)
OCEAN
KILLCOHOOK SPOIL DISPOSAL AREA (USACOE)
BURLINGTON
KILLCOHOOK NATIONAL WILDLIFE REFUGE (FWS)
BARNEGAT NATIONAL WILDLIFE REFUGE (FWS)
CAMDEN
GLOUCESTER
SALEM
ATLANTIC
SUPAWANA MEADOWS NATIONAL WILDLIFE REFUGE (FWS)
BRIGANTINE NATIONAL WILDLIFE REFUGE (FWS)
CUMBERLAND
ARTIFICIAL ISLAND DISPOSAL AREA (USACOE)
CAPE MAY
0 8 16 24 32
SCALE IN MILES
FEDERALLY OWNED SHORES
U.S. COAST GUARD ELECTRONIC ENGINEERING CENTER
U.S. COAST GUARD RECEIVING AREA
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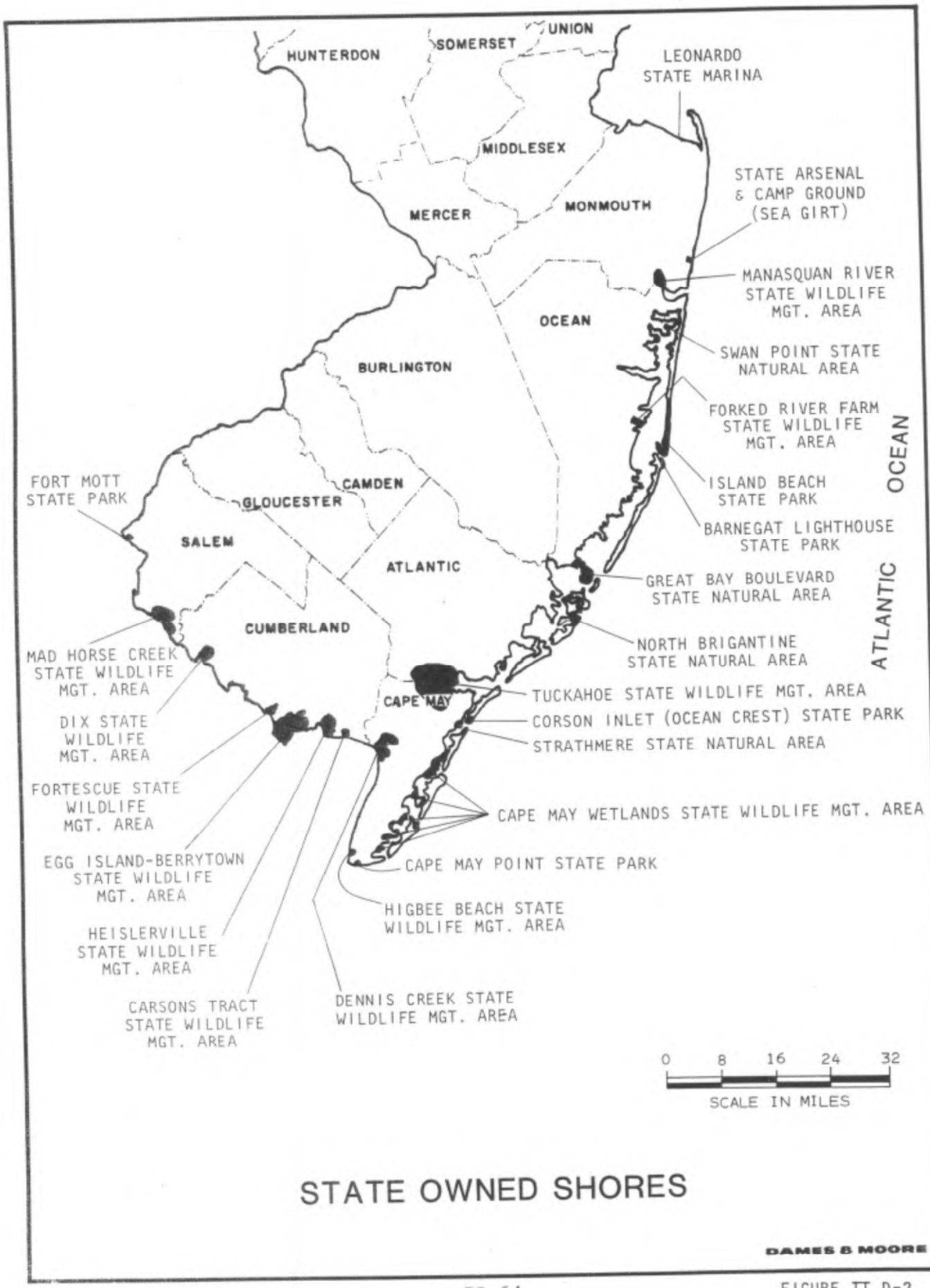
FIGURE II.D-1



STATE OWNED SHORES

DAMES & MOORE

FIGURE II.D-2

(1) Reach 1 — Raritan Bay. The Raritan Bay shore consists primarily of urban coastal communities. As shown in Table II.D-3, the seasonality indicators for these communities are quite low. They have virtually no seasonal housing component and very stable seasonal unemployment ratios. Employment concentrations in the larger municipalities like Perth Amboy, Sayreville and Keansburg are concentrated in the manufacturing sector.

Some of the communities in this reach have shown absolute declines in population and equalized valuation over the last eight years. This lack of growth is further evidenced by the fact that all but two of these municipalities had 1975 per capita money incomes below the State average of $5,600. The presence of the highly industrialized communities like Perth Amboy and South Amboy in the reach has diminished the relative attractiveness of the Raritan Bay shore as a site for saltwater swimming relative to other parts of the State.

The dominance of urban communities in this reach make its overall classification as an urban reach consistent with its economic composition, land use patterns, and relative lack of dependence upon tourism as an integral part of the economy.

(2) Reach 2 — Sandy Hook to Long Branch. The Sandy Hook to Long Branch reach is classified as recreational, due primarily to the presence of the Gateway National Recreation area at Sandy Hook. That park is an important regional park and recreational facility. Sea Bright is classified as recreational while Monmouth Beach is primarily a residential community.

(3) Reach 3 — Long Branch to Shark River Inlet. Reach 3 is a highly-developed, densely populated coastal section encompassing all three community types. The predominant character is a blend of an urbanized region (Asbury Park/Long Branch metropolitan area) with interspersed recreational and residential communities.

This reach offers a variety of highly specialized recreational and entertainment goods and services. This is evidenced by the fact that eight of the reach's communities have boardwalks and accompanying amusement facilities. The communities are generally small in land area with their commercial/recreational centers located linearly along the coast. Half of the eight municipalities having boardwalks and other specialized shorefront recreational and entertainment facilities. The presence of Asbury Park and Long Branch clearly make this an urban reach.

As compared to Reach 1, the various seasonality indicators (housing, population, etc.) are much more significant in this reach, particularly as one proceeds south along the reach. A number of the larger communities had large per capita retail sales levels in 1977, indicating the increasing economic importance of tourism and recreational beach users in the local economies of these municipalities. Employment is less concentrated in manufacturing in this reach than in Reach 1, with proportionately larger concentrations in the trade and service sectors.

(4) Reach 4 — Shark River Inlet to Manasquan Inlet. Reach 4 is recreational in nature. All four component municipalities have boardwalks and high seasonal indicator values, particularly in seasonal housing shares.

(5) Reach 5 — Manasquan Inlet to Mantoloking. The two shore communities in Reach 5 are classified as recreational (Point Pleasant Beach) and residential (Bay Head). Point Pleasant Beach has a boardwalk and other accompanying recreational and entertainment facilities clearly classifying this reach as recreational.

(6) Reach 6 — Mantoloking to Barnegat Inlet. Reach 6 continues the development trend observed for Reach 4 and 5, of small recreationally-oriented shorefront communities. The three communities of Lavallette, Seaside Heights, and Seaside Park provide a concentration of specialized, recreational and entertainment facilities located at the eastern end of Route 37, which provides direct access from the Garden State Parkway. All three communities have boardwalks and amusement facilities. The other outstanding feature of this reach is Island Beach State Park, a 9.5 mile strip of undeveloped beach and dunes.

The seasonality indicators have very significant values in this reach as shown in Table II.D-1. Especially notable are the high proportions of seasonal housing. Employment figures for Ocean County show much higher shares in the retail/wholesale and service sectors than exist statewide. This concentration is found in the Toms River, Seaside Heights area, and reflects the economic importance of the tourism sector. For this reason, this reach is classified as recreational.

(7) Reach 7 — Long Beach Island. Long Beach Island is an 18-mile long barrier island composed entirely of recreational communities. Located at the north and south ends of the island are Barnegat Lighthouse State Park and the Brigantine National Wildlife Refuge-Holgate Unit, respectively. The communities have very high levels of equalized valuation per capita, reflecting the considerable local investment in tourism and the relatively low year-round population levels as compared to the seasonal levels. As expected, the other seasonal indicators have high values. Only one access route to the island exists from the mainland, at the eastern terminus of Route 72 which crosses the State from Camden.

The reach is clearly a recreational reach based on the classes of the constituent municipalities and the obvious primary role of tourism in the local economy.

(8) Reach 8 — Brigantine Island and Pullen Island. Reach 8 is composed of one municipality (Brigantine), and the areas occupied by the Brigantine National Wildlife Refuge (Little Beach or Pullen Island Unit) and the North Brigantine State Natural Area. Over half the length of the reach is contained in Federal and State dedicated lands. Brigantine does not offer the high degree of specialized recreational and entertainment goods and services found in other reaches with boardwalk and amusement piers. This is evidenced by below average per capita money income levels and per capita retail sales. However, recreation and tourism are clearly significant components of the local economy, and the significant seasonality indicators mandate that this reach be classified as recreational.

(9) Reach 9 — Absecon Island. Reach 9 consists of Atlantic City, an urban center, one recreational community (Ventnor City), and two residential communities (Margate City and Longport Borough). Atlantic City clearly dominates this reach. The Atlantic City metropolitan area is manifesting the impacts of casino-related growth as evidenced by the recent growth in assessed valuation in the four municipalities. As of September 1978, 53 percent of the county's total covered employment was in the trade and services sectors (New Jersey Department of Labor and Industry, October 1979).

The past history and projected future of this reach as an urban center offering highly specialized recreational and entertainment goods and services (convention centers, casino industry, the boardwalk, etc.), classify this as an urban reach.

(10) Reach 10 — Peck Beach. Peck Beach consists of one community, Ocean City, classified as a recreational community, and the Corson Inlet (Ocean Crest) State Park at the southern end. Ocean City, clearly a recreational community, has a 2-mile boardwalk and an estimated 4.5 million beach users during the summer of 1979 (Personal communication, Steve Gabriel, Ocean City Planning Dept., 1979). Because of these factors coupled with the proximity to Atlantic City, this reach is classified as recreational.

(11) Reach 11 — Ludlam Island. Ludlam Island is comprised of two recreational communities. The barrier island portion of Upper Township and Sea Isle City have intensively developed coastal strips. The very high seasonal unemployment ratio, and the significant seasonal population ratio signify the tourism orientation of this reach. This reach shares similar characteristics with the other southern barrier island reaches (limited area, high seasonality indicators, limited access from the mainland, etc.) so it is classified as recreational.

(12) Reach 12 — Seven Mile Beach. Both Avalon and Stone Harbor are classified as recreational communities, and have characteristics similar to those of Reach 11 communities. In particular, they have very high seasonal population ratios, high seasonal housing components, and high levels of per capita money income. Reach 12 is classified as recreational.

(13) Reach 13 — Five Mile Beach. Reach 13 is also composed entirely of recreational communities offering a variety of specialized recreational and entertainment facilities including four and a half miles of boardwalk, five amusement piers, and numerous outdoor recreational facilities. As seen in Table II.D-1, the seasonality indicators (most notably the seasonal population ratio) are quite high. From a land use and spatial perspective, this reach is typical of the other southern barrier island reaches and is also classified as recreational.

(14) Reach 14 — Cape May Inlet to Cape May Point. Reach 14 is a historic resort area, possessing a number of architecturally significant Victorian structures. All three reach municipalities are classified as recreational, and the seasonality indicators in Table II.D-1 clearly show the impact of tourism on the reach's municipali ties. Cape May City, in particular, had a level of retail sales per capita in 1977 almost twice the State average. This reach is clearly classified as recreational in that it has physical and land use characteristics similar to those of the other southern barrier island reaches.

(15) Reach 15 — Delaware Bay (Cape May Point to Stow Creek). The Delaware Bay shore is comprised almost entirely of recreational and rural townships located along the Delaware Bay Shore of Cape May and Cumberland Counties. The Cape May townships (particularly Lower Township) have significant recreational and tourism facilities within their boundaries. However, these facilities are primarily located on the ocean frontages of these townships. This reach does not have the intensely developed recreational and entertainment areas along the coast as found in the previous reaches. Further, bayshore communities are quite sparsely populated, particularly in Cumberland County. Also, the seasonality indicators become quite low in this reach — particularly the seasonal population and the seasonal unemployment indicators. The shore area in Cumberland County is significantly less developed than the Atlantic coast, because of wide areas of inaccessible wetland and marsh areas. Finally, a significant proportion of this reach is contained in dedicated lands.

Reach 15 is clearly classified as rural because of the relative lack of development, particularly in the tourism and entertainment sectors.

(16) Reach 16 — Delaware River (Stow Creek to Crosswicks Creek). The Delaware River Reach contains communities from all four coastal types, ranging from the rural community of Lower Alloways Creek Township, to the urban communities of Camden and Gloucester located in the Philadelphia metropolitan area. The Delaware River shore offers minimal beachfront recreational opportunities, and the predominant waterfront land use is in the commercial and industrial sectors as one moves up the Delaware River toward Camden. Seasonality indicators have minimal values, manifesting the lack of any significant tourism-related economic and social impact on this reach. The impact of the Philadelphia metropolitan area is shown in the concentration of industrial land uses found in this reach's waterfront area from Camden to Trenton.

Reach 16 is also so varied in terms of its constituent municipalities that a comprehensive reach-wide classification would not be meaningful. Therefore, the various counties within this reach have been classified according to their member municipalities.

The Salem County section of Reach 16 is composed primarily of rural, sparsely developed townships and dedicated lands. The shorefront communities become progressively more residential proceeding up the Delaware River toward Camden. The low population densities, and low percent of assessed valuation in residential and apartments, for the municipalities in this county indicate that they are rural in character.

The Gloucester County shorefront communities have substantially higher population densities than those in Salem County. Further, they have increasingly commercial and industrial shorefronts in the proximity of Camden. The proximity to the Philadelphia metropolitan area justifies a residential classification for this section of Reach 16.

The presence of Camden, and the concentration of industrial activities located on the shorefront in Camden County, classify this as an urban section. The Burlington County section of the Delaware River Reach exhibits the same patterns of industrialized land uses concentrated along the shorefront that were found in Camden County. This reach sub-section is also classified as an urban shoreline based on its component municipalities classifications.

E. ENVIRONMENTAL SETTINGS: SUMMARY OF SHORE ECOSYSTEM COMPONENTS AND RESOURCES

The following summary sections include descriptions of ecosystem components and resources in the shore areas that may be affected by the shore protection alternatives addressed in this document.

1. Ecosystem Components

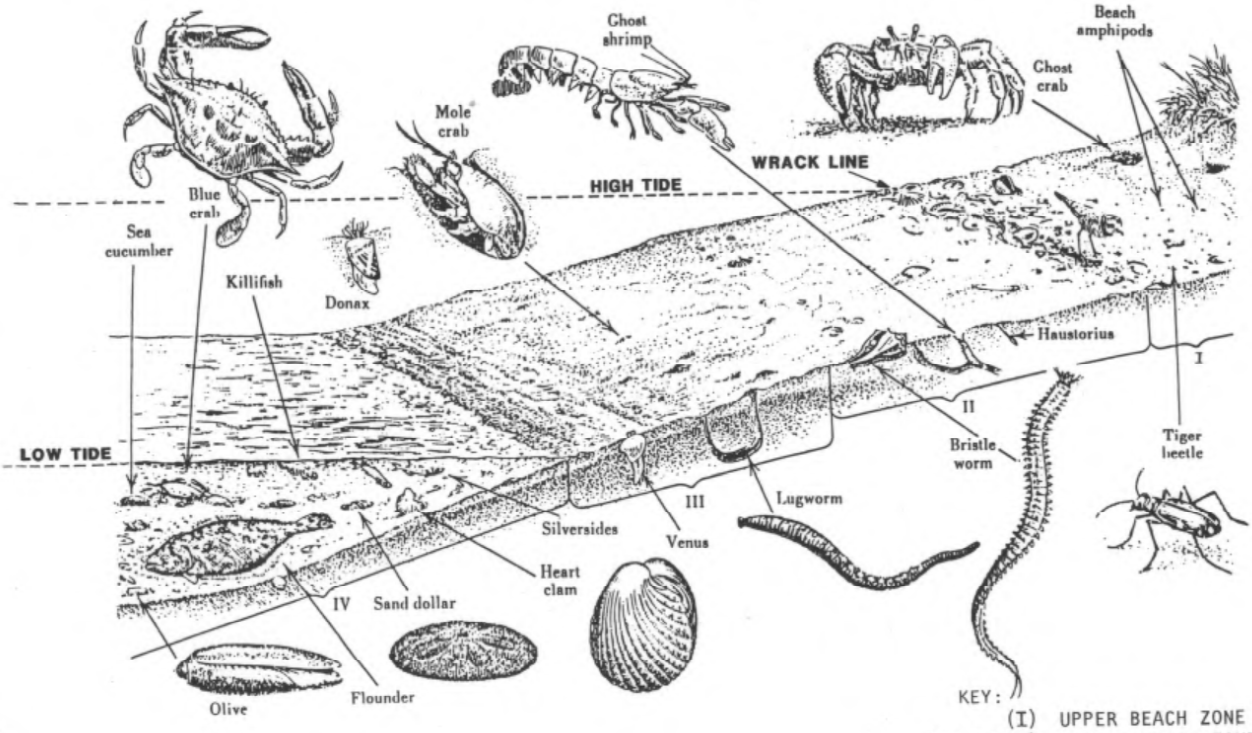
a. Beaches

The New Jersey shoreline beaches found along Reaches 1 to 15 are of two major types — ocean beach and bay beach. This section provides a brief description of the ecosystem of the ocean beach. Reach 16 and the backbays (lagoonal-type systems west of the barrier beach complexes) are treated separately in Section E.1.d below.

For discussions herein, the beach zone is considered as that area shoreward of the sand dune to a water depth offshore of about 2 meters. The beach zone can be divided into upper, middle, and lower zones — each having distinct dominant organisms and faunal associations. A schematic beach cross section including these zones and their faunal associations is provided in Figure II.E-1.

The morphology of the beach zone is affected by many parameters, but heavy wave action has the greatest influence in development of the beach profile. The physical processes governing the dynamics and physical character of ocean beaches have already been described in detail in Volume 1, Chapter I. In general, the severe natural environmental stresses provided by the abiotic factors in the beach zone limits the biota which inhabit the area. The beach is typically a biologically depauperate habitat where resident species exhibit specialized functions or adaptations to cope with the constantly changing conditions. Organism distribution in a high energy beach system is also influenced by salinity, dessication, and sediment grain size. While New Jersey's ocean beaches are composed mainly of coarse-to-fine sand, peat deposits also exist on eroding beaches along several of the southern barrier island reaches.

(1) Upper Beach Zone. The upper beach zone which extends from the dune to just above the high water line is usually dry, except during storms or extra high tides. Storm wave action and high salinity levels generally discourage vegetative establishments. Because dessication is a significant factor in this zone, the fauna tend to rely on the rising and falling of tides and sea spray to minimize drying. Ghost crabs and sand fleas make up a major portion of the upper beach zone fauna. These organisms rely on burrowing to feed, avoid predators, and avoid stressful environmental conditions on the sediment surface. The upper and middle zones serve as important nesting and feeding areas for many shore birds and invertebrates. The most common birds include least and common terns, black skimmers, and piping plovers. The wrack line or strand line, which consists mainly of dried vegetation and floatable debris washed up by the tide, is usually found in the upper zone. Because the sediment under the wrack is protected from rapid drying, it provides a favorable habitat for a variety of marine insects including the beach hopper.



TYPICAL ATLANTIC COAST SANDY BEACH ORGANISMS

REFERENCE: SMITH, 1963.

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FIGURE II.E-1

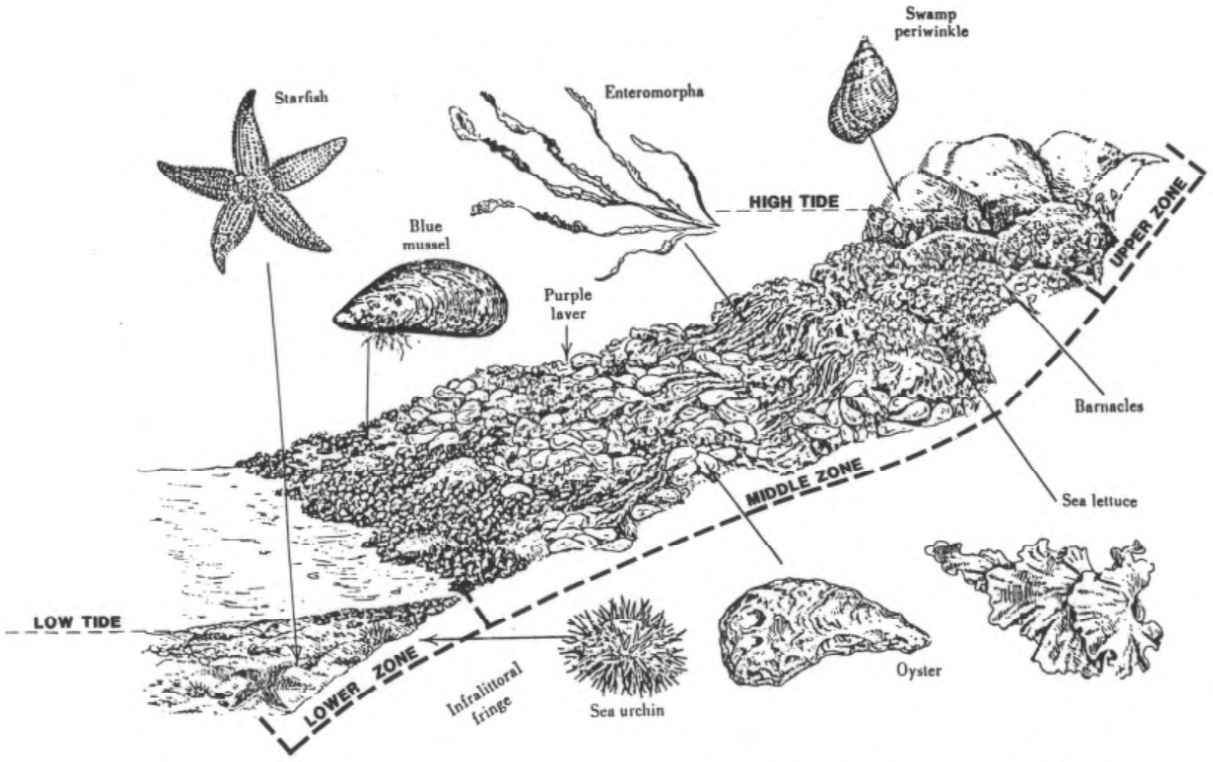
(2) Middle Beach Zone. The middle beach zone is often submerged and is influenced by waves and tidal fluctuations. The animals of this zone are less exposed to the air and thus more susceptible to drying when exposed. Due to the harsh environmental fluctuations provided by wave action, there are few species found in this zone, though there may be significant numbers of certain adapted individuals. Salinity is also a factor influencing the middle zone. Along the New Jersey shoreline, salinity affects beach fauna most significantly near inlets and in bays where there are salinity fluctuations due to fresh water input. The high energy activity of a sandy beach tends to restrict the deposition and retention of fine sediments and thus limits the occurrence of organisms which require an abundance of fine sediments. The primary producers in the middle zone of ocean beaches are microscopic interstitial groups such as diatoms (USACOE, Philadelphia District, November 1976b). Primary productivity likewise is minimal, and most of the energy sources are from detritus and soluble organic compounds washed up by waves and absorbed onto the sand grains from water percolated through the sand (McIntyre, Munro, and Steele, 1970).

Bacteria and diatoms are also important in this zone since they are the primary food source for meiofaunal organisms (microscopic organisms which are found in sand grains). Meiofauna are composed of copepods, ciliates, tardigrades, gastrotrichs, and turbellarians; they play a greater role than macrofauna in the energy flow and nutrient recycling of the sandy beach community. Fecal deposits of shorebirds and the decomposition of macroalgae and other dead organisms left on the upper beach zone by the tide are also important contributions to nutrient supply and energy flow. Middle beach macrofauna consist of amphipods, annelid worms, small clams, and the mole crab — along with other molluscs and crustaceans. As in the upper zone, the fauna of the middle zone are also excellent burrowers and are extremely mobile. The macrofauna contribute to energy flow by collecting food from the area or nearby and releasing waste within the system, making it available for other groups.

(3) Lower Beach Zone. The lower beach zone is nearly always flooded. The fauna here are relatively rich and varied. Numerous polychaetes, crustaceans, and mollusks found in the surface sediments rely on detrital input from the upper and middle zones as well as production from benthic diatoms. Small fish and crabs can be found in the submerged portion of the lower beach zone. Fish and shellfish that might extend shoreward from the nearshore zone to the lower beach zone are also described in Section E.2.a of this chapter.

b. Rocky Intertidal Zone

The rocky intertidal zone does not occur naturally along the New Jersey coast, but has been introduced in the form of manmade structures such as jetties, groins, bulkheads, and seawalls. It can be classified by three sub-zones — upper, middle, and lower. The distribution and composition of organisms in this zone are quite different from that found on the sandy beach intertidal zone. Like the sandy beach, however, species zonation, which is regulated by vertical light penetration, frequency of wetting, amount of spray, hours of exposure to underwater food, carnivorous feeding, and wave swashing of filamentous algae that act as a scouring broom, exists on the intertidal surfaces (Odum et al., 1974). The zonation along a typical mid-Atlantic rocky shore is presented in Figure II.E-2. The most significant variation from the sandy beach habitat is the occurrence of a hard substrate used for attachment by organisms.



COMMON SPECIES OCCURRING ON ROCKY SHORES ALONG THE ATLANTIC COAST

REFERENCE: MODIFIED AFTER SMITH, 1963.

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FIGURE II.E-2

(1) Upper Zone. The upper zone is that area dampened regularly by sea spray. Microscopic blue-green algae and diatoms are found here and are grazed on by periwinkle snails. During extreme spring tides a few barnacles may set, but they do not grow very large. Sea gulls typically use the upper and middle zones for feeding.

(2) Middle Zone. This zone – regularly submerged with the passing of tides and wave action – is called the barnacle zone since barnacles are usually the most common fauna. Also found are algae such as the common rockweed, Fucus sp., and filamentous species. Amphipods, small crustaceans, some polychaetes, and molluscs may also be found in this zone. The species are regulated by their position with respect to wave force and are more abundant on the back and under sides of rocks than on surfaces which receive wave force directly.

(3) Lower Zone. The lower zone is always submerged. Organisms here are usually larger in size than individuals of the same species which are found in the middle and upper zones. Here intra-species competition is important in controlling faunal distribution. The mussel Mytilus is usually dominant and serves as a nutrient regulator. Also common are algae (usually red and brown algae which can compete with mussels and barnacles), barnacles, bryozoans, hydroids, starfish, and crustaceans (crabs and amphipods), and a fish population (flounder, sea robin, common sea bass, and striped bass) which uses the area for feeding and shelter.

Primary productivity in the rocky intertidal zone is higher than that of the sandy beach. In fact, the productivity of rocky shores similar to those along the coast of Maine and Nova Scotia was measured at 1750 grams of carbon (g C)/m^2/yr, as compared to 100 to 900 g C/m^2/yr for Spartina zones (wetlands) along the North Atlantic coast which are typically high productivity habitats. Therefore, the existing jetty/groin system along the New Jersey coast tends to supplement the relatively low productivity of the more dominant sandy shores.

c. Nearshore Zone

The nearshore zone is the zone from a depth of about 2 meters out to the 30-meter isobath. This zone is the same as the inner shelf zone described by VIMS (1977). Along the Atlantic coast, the sediments are typically medium and coarse sands and very frequently mobile. Bacteria concentrations are generally greatest in the nearshore zone, probably due to proximity to shore and contaminant input from inlets and bays.

(1) Phytoplankton. Phytoplankton species composition and abundance in New Jersey offshore waters have been described by Hulburt (1963 and 1970), Malone (1977), Yentsch (1977), and Yentsch and Glover (1977). The populations are comprised mainly of diatoms and dinoflagellates, with Rhizosolenia alata, Thalassionema nitzschioides, Skeletonema costatum, Asterionella japonica, and Chaetoceros socialis being most important. Cell densities of phytoplankton range from 2 to 40 x 10^6 cells/liter in the spring-summer to 0.02 to 1 x 10^6 cells/liter in the fall-winter. The dinoflagellate group is most common in the spring-summer, and the diatoms are the dominant winter flora. The distribution and abundance of the plankton are dependent on temperature and salinity variations, as well as nutrients brought to the nearshore zone through inlets which receive river and bay discharges. The phytoplankton are the major food source for herbivorous zooplankton and are also an important food for filter-feeding bivalves.

(2) Zooplankton. The zooplankton may be classified into three types based on their life cycles — holoplankton, which spend their entire life in the water column as plankton; meroplankton, which spend only a portion of their life cycles as plankton; and tychoplankton, which are occasionally carried off the bottom into the water column by currents. Zooplankton abundance is usually related to the abundance of phytoplankton and the spawning cycle of adult meroplankton species. Important nearshore species are listed in Table II.E-1. The seasonal zooplankton groups occurring in New Jersey waters include the winter-early spring group, dominated by the copepod Acartia clausi, and A. tonsa in late spring. Peak densities usually occur in late spring to early summer following phytoplankton blooms.

(3) Benthos. The benthos of the nearshore zone do not exhibit an apparent faunal difference between north and south. However, their distribution is related to substrate characteristics and topographic features. Temperature is a principal hydrographic factor affecting macrobenthic distribution. The temperature regime in the nearshore zone is influenced by continental climate and bottom waters causing a 12 to 14°C range during the year — with the coldest temperature, 3.5°C, and the warmest, 17°C. Much of the shelf area off the New Jersey coast is characterized by ridge and swale topography which generally trends oblique to the coastline. Benthic communities on the sandy ridges are somewhat different and less abundant than those in the swales, where more shell debris is retained and there is an increase in fine sediments (silt and clay). The increase in benthic faunal resources also attracts greater numbers of demersal fish species which feed on them. Several benthic species found in this zone, including the surf clam, American lobster, and rock crab, are commercially exploited.

(4) Artificial Reefs and Shipwrecks. Within the nearshore zone are numerous shipwrecks and artificial reefs, as discussed in Section E.2.b.(3) of this chapter. Additionally, nearly all solid, non-toxic materials found in the nearshore zone, whether placed there deliberately or accidentally, tend to serve as a suitable substrate for many attaching organisms not common over sandy bottoms (Jensen, 1975). These materials can provide shelter for fish and invertebrates, and the fouling community which develops serves as a food source for larger organisms. Hydroids, sponges, barnacles, mussels, polychaetes, crabs, and lobster are some of the organisms which inhabit wrecks, artificial reef structures, and irregular bottoms. Atlantic cod, pollock, red hake, white hake, scup, tautog, and black sea bass are some of the more common fish species associated with this habitat. Species such as mackerel and bluefish will congregate near structures with a high profile. Table II.E-2 lists species commonly taken in the New Jersey nearshore zone and the percent of species landed over different bottom types.

Household appliances, junked automobiles, discarded automobile tires, building rubble, surplus warships, and excavated rock are all materials that have been used for artificial fishing reefs. Generally, sport fishermen have increased success with fish catches over artificial bottoms.

TABLE II.E-1

ZOOPLANKTON SPECIES COMMON TO
THE NEARSHORE ZONE OF NEW JERSEY

Copepods

- *Labidocera aestiva*
- *Acartia tonsa*
- *Tortanus discaudatus*
- *Centropages hamatus*

Cladoceran

- *Penilia avirostrus*
- *Evadne nordmanni*

Mysid

- *Neomysis americana*

Polychaete

- *Scophthalmus aquosus*
- *Tomopteris helgolandica*

Crustacean – decapod larvae

- *Cancer* sp.
- *Ovalipes* sp.
- *Libinia* sp.
- *Emerita* sp.
- *Paleomonetes* sp.

Fish (larvae and eggs)

- *Anchoa mitchilli*
- *Gadus morhua*
- *Anguilla rostrata*
- *Syngnathus fuscus*
- *Tautoga onitis*
- *Tautogolabrus adspersus*
- *Lophius americanus*

TABLE II.E-2

PERCENT OF SPECIES CAUGHT BY ANGLERS BOTTOM FISHING IN NORTHWEST SECTION OF THE NEW YORK BIGHT, 1970

Species	Private Boat			Headboat		
	Artificial Reefs	Wrecks	Natural Habitats	Artificial Reefs	Wrecks	Natural Habitats
Atlantic cod	8.55		0.36		0.94	4.39
Atlantic herring						0.02
Atlantic mackerel			0.84			0.79
Black sea bass	14.43		0.63	8.03	8.60	2.18
Bluefish			0.84	0.15	0.16	0.07
Hakes (red and white)	52.40	5.32	18.87	51.56	83.83	60.81
Northern kingfish			0.29			0.07
Pollock				0.01	0.29	0.04
Scup	14.43		15.21	25.86	0.71	1.78
Silver hake			9.86	0.14	0.36	11.36
Striped bass			4.39		*	0.76
Summer flounder	8.02		21.57	0.44		6.46
Tautog	1.60	94.67	12.66	12.50	5.00	10.72
Weakfish			0.33			*
Windowpane			0.48			0.02
Winter flounder	0.53		11.00		0.07	0.42
Yellowtail flounder						0.04

*Less than 0.01%.

Source: From Stone et al. (1974)

d. Estuarine Ecology

The intertidal zone of the estuarine beach is generally represented by the following features:

- o Flat, gently sloping beach with wide intertidal exposure, typically composed of fine sands and sediments (generally referred to as mud flats).
- o Mud banks which are held together by wetlands vegetation.

These shore types are found along Raritan Bay, Delaware Bay, and the Delaware River (Reaches 1, 15, and 16). Due to their environmental similarities, the ecology within these reaches and the backbay estuaries is collectively described in this section. The Delaware River reach contains more freshwater species and is described in detail, by river mile, in Tyrawski (1979).

The ecology of mud flats is described in Gray (1976). These broad expanses of mud and sand include intertidal and shallow subtidal habitat. For most of this shallow zone, the only permanent residents are the benthic organisms described below. Estuarine flora and fauna found in the water column occur in the beach zone with the rising and falling of the tide. These pelagic forms (plankton and fish) are also described below. The wetland ecology is discussed in Section E.1.e below.

Estuarine organisms are typically exposed to abrupt changes in temperature, salinity, and chemical and oxygen concentrations over seasonal, daily, and tidal cycles. The predominantly estuarine species belong to groups that are tolerant of wide ranges of variability in these parameters. Most New Jersey bays and estuaries are characterized by a high level of productivity which can support a diverse biota (Weiss and Wilkes, 1974). The estuary is a nutrient trap in which detrital material is formed and benthos retain and recycle nutrients and organic aggregates. Since pollutants can also become trapped, primary productivity is also related to pollution levels which are very high in many bays near urban population centers (Odum, 1971). Productivity in the estuary results from the photosynthetic activities of macrophytes (see also salt marsh and wetlands, Section E.1.e) and phytoplankton (Section E.1.d.(1). of this chapter).

(1) Phytoplankton. Phytoplankton are a major food source in estuaries and provide a substantial food base for numerous filter-feeding organisms (zooplankton and shellfish) and plankton-feeding fish (menhaden and bay anchovy). The phytoplankton community is made up of freshwater, brackish, and saltwater forms. Diatoms, euglenoids, and dinoflagellates are typical dominant forms. During mid to late summer, dinoflagellate blooms are a nuisance to bathers and may result in reduced catches by local anglers. These blooms are produced by the influence of excessive nutrients and usually last only a few days. Extended blooms may result in local oxygen depletion and fish kills.

(2) Zooplankton. Zooplankton are subdivided into three forms — holoplankton, meroplankton, and tychoplankton, which have been described previously for the nearshore zone in Section E.1.c.(2). The major factors limiting the production and dispersal of estuarine zooplankton are temperature and salinity. Peak numbers of zooplankton are usually observed in late spring to early summer, following the characteristic winter-spring phytoplankton bloom. In shallow estuarine waters, where mixing with offshore waters is restricted, dramatic reductions in the standing crop coincide with high summer temperatures. In the winter, the largest concentrations

occur in the lower part of the bays. Common zooplankton in New Jersey bays are Acartia and Eurytemora. Proximity to pollution stress sources usually limits diversity and lowers the degree of dominance by some zooplankters.

Fish eggs and larval forms of benthic invertebrates (such as polychaetes, gastropods, and shrimp) are distributed widely in the region and are an important part of the plankton community. Balanus larvae, larvae of mysid shrimp, and the polychaete Polydora are other important zooplankton forms. Some of the larval fish include Anguilla rostrata, Clupea harengus harengus, Ammodytes americanus, Pseudopleuronectes americanus, Anchoa mitchilli, Syngnathus fuscus, and Menidia menidia (Croker, 1965). Larvae are most abundant from March through July. The most common fish eggs found in estuaries are those of the sea robin and Atlantic menhaden.

(3) Benthic Invertebrates. The nearshore waters of New Jersey's bays and estuaries support an assemblage of both mature and immature forms of benthic macroinvertebrates (e.g., polychaete worms, nematodes, molluscs, and arthropods). The numbers of species are usually highest near the fresh or marine water input; few species are adapted to the highly variable salinities found in the mid-estuary. A relatively static benthic algal community may also be found in the estuaries.

Bottom sediment type also affects species distribution. In general, suspension feeders dominate over sandy bottoms, and deposit feeders dominate in mud bottoms (TRIGOM-PARC, 1974). This is probably due to food availability (Sanders, 1958). Typical infauna and epifauna are made up of suspension feeders such as Ensis, Mya, Mercenaria, and Gemma and deposit feeders such as the polychaetes Arenicola, Streblospio, Pectenaria, Clymenella, amphipods Haustorium, gastropods Nassarius, and bivalve molluscs Tellina and Nucula. The suspension feeders and deposit feeders are, in turn, food for a variety of predators — crabs, fish (eels, flounder), birds (gulls, terns, ducks) and mammals (raccoon).

Polychaete worms are common throughout the tidal portions of many estuarine areas. Decapod larvae are more abundant in the summer. Nearshore benthic invertebrates commonly found include the periwinkle snail (Littorina littorea), fiddler crab (Uca minax), blue mussel (Mytilus edulis), ribbed mussel (Modiolus demissus), sea anemones (Metridium senile), horseshoe crab (Limulus polyphemus), and hermit crab (Pagurus sp). Balanus sp. are also found in areas where there are places to attach. The hard clam (Mercenaria mercenaria), soft-shell clam (Mya arenaria), oyster (Crassostrea virginica), and blue crab (Callinectes sapidus) are all commercially or recreationally important shellfish in the bay estuarine zone. Recreationally, the blue claw crab (Callinectes sapidus) is the most significant shellfish in the State. These crabs are taken during the summer in the bays and estuaries from boats or piers. The blue crab inhabits sandy or muddy bottoms and feeds on oysters, clams, tunicates, fishes, and organic detritus (TRIGOM, 1974). Mating occurs during the summer, with eggs released either the same year or in the next year. The commercially important shellfish are discussed in more detail in Section E.2.a.(2) of this chapter.

(4) Fish. In general, the fish fauna in bays and estuaries are mainly small, euryhaline species that are adapted to continuous residence. Juvenile fishes use the estuaries as nursery grounds; large species use the area for feeding or spawning; and diadromous species use the estuaries as pathways to and from spawning grounds (TRIGOM, 1974). Fluctuating populations are more characteristic of sandy and muddy shores than rocky shores. Many of the fish species which depend on estuaries at least during part of their life cycle are of commercial value. It has been estimated that almost two-thirds of the value of the U.S. commercial fish catch is estuarine-

dependent for some part of their life (McHugh, 1967). Typical estuarine species common to New Jersey are listed in Table II.E-3, with some notes and comments on estuarine usage. Species and habitat usage for Reach 16 (Delaware River) is provided separately in Table II.E-4.

e. Salt Marsh/Wetlands

Wetlands form some of the biologically richest and most valuable ecosystems. The ecological functions of the wetland are related not only to the terrestrial ecosystem but also to the estuarine system. Wetlands provide the following habitats and functions:

- Large quantities of plant life that are a source of organic matter for shellfish and other aquatic life.
- Habitat for furbearing mammals, fish, and waterfowl, including delicate and irreplaceable specimens.
- Nursery areas for wildlife and aquatic species.
- Pollution control by serving as biological and chemical oxidation basins and aiding in natural purification of water.
- Erosion control by serving as sedimentation areas and filter basins.
- Flood and storm control.
- Unique recreational areas and outdoor educational and scientific laboratories.

Salt marsh communities are located in those areas which are periodically flooded by brackish water. Bands or zones consisting of a single species of wetland vegetation occur inland of the water's edge. Smooth cord grass is found closest to the water's edge in areas regularly flooded by the tides. Shoreward of this zone is an area of salt meadow, supporting salt grass and salt bog, beyond which are found high tide bush and sea-myrtle. Common reed may be abundant along the upper marsh edge, especially in areas where the soil has been disturbed. Table II.E-5 provides a list of wildlife species which are most common and can be expected to inhabit the State's wetlands environment. The NJDEP has mapped the distribution of vegetation within the State's coastal wetland. These maps are available through the Department of Coastal Resources.

f. Sand Dunes

Like much of the Atlantic coast from New York to Florida, New Jersey's ocean shore consists of sandy beaches which are backed by sand dunes in some areas. Dune processes have been described by Ranwell (1972), Nordstrom (1977), and CCES (1979). The distribution, height, and width of the State's oceanfront dunes are provided in Figure II.E-3. In New Jersey, much of what was previously a natural sand dune area has been diminished due to extensive development on barrier islands. Some communities have attempted to reestablish dunes using various approaches, including sand fencing and vegetation programs.

TABLE II.E-3

COMMON ESTUARINE FISH OF NEW JERSEY

Fish	Distribution	Spawning Areas	Eating Habits	Comments
Menhaden (Brevoortia tyrannus)	Coastal water areas from May to October	On continental shelf	Plankton and small crustaceans	Used as chum and as bait for recreational fisheries
Striped bass (Morone saxatilis)	Coastal areas	Hudson River and other brackish to fresh water (temp. 58° to 70° F)	Variety of fish, crustaceans, shellfish, and polychaetes	A major game fish
Bluefish (Pomatomus saltitrix)	Coastal areas and continental shelf "Snappers" (young) in bays from August to September	Continental shelf (18 meters deep to shelf edge)	Copepods, crustaceans, molluscan larvae, and several fish fauna	"Snappers" are popular game fish in bays
Winter flounder (Pseudopleuronectes americanus)	Bottom dweller in bays and continental shelf	Bays and estuaries in water 2 to 5 meters deep	Variable shellfish, polychaetes, small fish, and crustaceans	Popular recreational fishing in coastal areas
Summer flounder (Parelichthys dentatus)	Coastal and bay waters in late spring and summer	On continental shelf	Principal foods are small fish crustanceans, and shellfish	Commercial and recreational fishing
River herrings, Alewife (Alosa pseudoharengus), and Blueback (Alosa aestivales)	Coastal areas	Alewife-ponds and sluggish streams Blueback herring - brackish waters	Alewife-plankton feeder	Commercial fishing
Scup (Stenotomus chrysops)	Coastal areas, bottom waters	Shallow coastal areas and bays	Crustaceans, polychaetes, and other bottom forms	Commercial and recreational fishing
Spot (Leistomus xanthurus)	Coastal waters	At sea, autumn and winter	Crustaceans, polychaetes, small fish, and shellfish	Mainly recreational in New Jersey
Croaker (Micropogon undulatus)	Coastal waters	Offshore fall winter	Bottom feeder, crustaceans, shellfish, and polychaetes	Mainly recreational in New Jersey
Atlantic silverside (Menidia menidia)	Salt and brackish water in protected bays, estuaries	Shallow bays and marshes, over sandy bottoms, 15-22° C	Plankton and small invertebrates	Used for bait
Mummichog (Fundulus heteroclitus)	Extremely shallow, brackish water	Sandy or pebbly shallows	Omniverous, on diatoms, shrimp, small crustacea, amphipods, and small molluscs	Used for bait
Weakfish (Cynoscion regalis)	Coastal areas	Large estuaries or near their mouths	Molluscs, crustaceans, and small fish	Popular coastal recreational fish
Tautog (Tautoga onitis)	Demersal, coastal species	Lower estuaries and shallow coastal areas	Chiefly invertebrates, crabs, hermit crabs, sand dollars, shrimp, amphipods, mussels, and barnacles	Recreational fish
American eel (Anguilla rostrata)	Offshore to fresh water	Off Bermuda	Scavenger, anything living or dead	Recreational, increasing commercial importance
White perch (Morone americana)	Brackish water ponds and estuaries	Spring in brackish or fresh water	Small fish, crustaceans	Recreational
Toadfish (Opsanus tau)	Shoal water, sandy or muddy bottoms	Spring and summer in hard objects	Voracious feeder, crustaceans, polychaetes, and fishes	Taken accidentally by recreational fishermen

Source: TRIGOM (1974); Eisler (1961)

TABLE II.E-4

USE OF SHALLOW WATER AREAS BY COMMON FISH SPECIES
DELAWARE RIVER - REACH 16

Species	Permanent Habitat	Spawning Areas	Nursery Areas	Foraging Areas	Migration Areas
Atlantic sturgeon		X	X		
Short-nosed sturgeon		X	X		
Blueback herring		X	X	X	X
Alewife		X	X	X	X
American eel	X		X	X	X
Menhaden			X	X	
Carp	X	X	X	X	
Bay anchovy		X	X	X	
Silvery minnow	X	X	X	X	
Satinfin shiner	X	X	X	X	
Spottail shiner	X	X	X	X	
White catfish	X	X	X	X	
Channel catfish		X		X	
Brown bullhead	X	X	X	X	
Banded killifish	X	X	X	X	X
Mummichog	X	X	X	X	X
White perch	X	X	X	X	X
Spot			X	X	X
Striped bass		X	X	X	X
White sucker	X	X	X	X	
Blue crab	X	X	X	X	X
American shad		X	X	X	X

Source: Tyrawski (1979).

TABLE II.E-5

COMMON WILDLIFE SPECIES IN MARSH OR

WATER-RELATED HABITATS OF NEW JERSEY

BIRDS	AQUATIC SPECIES
Semi-palmated plover	Ribbed mussel
Killdeer	Soft clam
Spotted sandpiper	Anemone
Lesser yellow leg	Barnacle
Gulls	Common mud snail
Mallard	Fiddler crab
Canvasback	Square back crab
Greater scaup	
Bufflehead	REPTILES & AMPHIBIANS
Great heron	Northern diamondback terrapin
Little heron	
Blue heron	MAMMALS
Green heron	Muskrat
Black-crowned night heron	Raccoon
Clapper rail	Meadow vole
Long-billed marsh wren	Meadow jumping mouse
Redwinged blackbird	House mouse
Marsh hawk	Short-tail shrew
Fish crow	White-footed mouse

Source: Dames & Moore (1979).

LOCATIONS OF NATURAL SAND DUNES ALONG THE NEW JERSEY COAST

Larger Areas

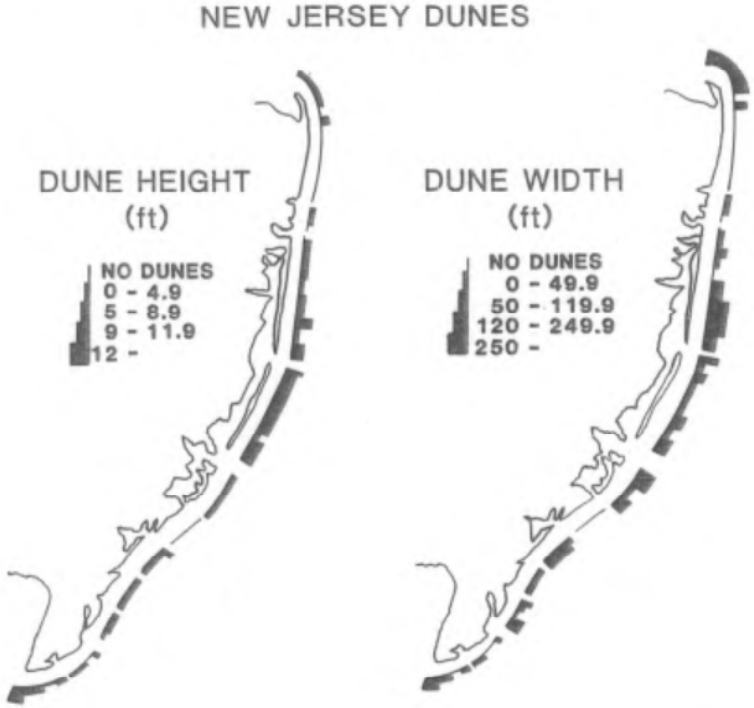
Reach No.	Location
2	Sandy Hook - Gateway National Recreation Area
6	Island Beach State Park
8	Little Beach (Pullen Island)
15	Higbee Beach (Lower Township, Delaware Bay Shore)

Small Areas

Reach No.	Location
4	Sea Girt Borough
10	Corson Inlet State Wildlife Mgt. Area (Ocean Crest State Park)
9	Strathmere State Natural Area
14	Cape May Point State Park
12	Avalon Beach

Other manmade modified dune areas adjacent to developed locations on parts of Reaches 5, 6, 7, 8, 10, 11, 12, 13

Source: After WAPORA (1979).



HEIGHT AND WIDTH RANGES OF NATURAL OR MANMADE DUNES

REFERENCE: ADAPTED FROM CCES, 1979.

DAMES & MOORE

FIGURE II.E-3

The ecology of the typical natural dune system at Island Beach State Park consists of a zoned mosaic dominated by topographically determined environmental features (Martin, 1959). The topography and vegetation are interrelated and interactive. Most community types may occur on more than one topographic facet, and each topographic facet can usually support more than one community type. Highly specialized flora and fauna inhabit the dunes due to the characteristically harsh environmental conditions (e.g., salt spray, wind, wide temperature range, low moisture content of the substrate, and continual shifting of sands).

Dune formation is typically enhanced by available vegetation trapping wind-driven sand. The vegetation also helps to stabilize dunes once they are formed. The vegetation typical of dune zones of New Jersey is limited to a few species of grasses, sedges, and forbs that can withstand salt spray, sand blast, sand burial, flooding, and drought. On secondary dune ridges, the vegetation tends to be more mature and less tolerant to foredune physical exposures. American beach grass is the dominant foredune plant of the North Atlantic region (Woodhouse, 1978). Plant species which commonly vegetate a dune community are dune grass, seaside spurge, seaside rocket, dusty miller, and beach heather. Other vegetation that may be associated with the natural dune zone are bayberry, marsh elder, beach plum, seaside goldenrod, poison ivy, and Virginia creeper, most of which grow mainly landward of the primary dune. The dunes also attract a large number of insects which live among the vegetation and interstitial sands (Ranwell, 1972). The dune plant and insect communities provide shelter and food for many species of birds and mammals. Many species of birds use the sand dunes for either resting, feeding, or nesting; these species are listed in Table II.E-6. The cottontail rabbit, Norway rat, opposum, box turtle, white-footed mouse, and raccoon are other fauna which may be found around an undisturbed dune area.

2. Resources

a. Biological

1) Fisheries. Many fish species found along the New Jersey coast are of commercial or recreational importance. The nearshore zone is a rather homogeneous environment with respect to the physical and chemical characteristics of the water column and bottom sediments. Normally this would lead to a less diverse fish community; however, the proximity of large bays (e.g., Raritan, Barnegat, and Delaware), wetlands, and coastal inlets increases the total number of species that may be found. The nearshore zone serves as a migratory pathway and a spawning, feeding, and juvenile ground for many species found in the mid-Atlantic region.

Three main factors which affect fish distribution and migration are seasonal water temperature changes, spawning, and food availability. Migrations may result in the schooling of large numbers of a given species in a specific area at a particular time of year, while adjacent areas may contain very few fish of this species. Over a relatively short time, the situation may be reversed or a particular species may be absent in all areas. Such changes in abundance and distribution can be related to food availability as well as to the life cycle and population dynamics of the species.

Important recreational fishing species in the nearshore zone include scup, black sea bass, striped bass, summer flounder, weakfish, bluefish, Atlantic and chub mackerel, Atlantic cod, northern kingfish, tautog, and red, silver, and white hake. Other species taken occasionally include sea robin, northern puffer, spot, drum, croaker, pollock, and bonito. These species are taken by hook and line from charter

TABLE II.E-6

BIRDS COMMONLY FOUND IN NEW JERSEY SAND DUNE HABITATS

Rock dove

Common crow

Sanderling

Laughing gull

Great black-backed gull

Common grackle

Common tern

Song sparrow

Mocking bird

Brown thrasher

Red-winged blackbird

Rufous-sided towhee

Eastern kingbird

American kestrel

Source: National Park Service (1974); USACOE, Philadelphia District (November 1976b).

and private fishing boats. The nearshore commercial fishery consists mainly of scup, summer flounder, butterfish, black sea bass, and Atlantic menhaden. The general distribution and life histories of fish with commercial and recreational importance in the nearshore zone have been well documented by Saila and Pratt (1973); TRIGOM (1974); Perlmutter (1974); and McHugh and Ginter (1978). The reader is referred to these sources for additional information on overall distribution, abundance, and life history of the important species discussed briefly here.

(2) Shellfisheries. The major shellfish species which occur in the nearshore zone of New Jersey are the surf clam, blue crab, and lobster. Commercial landings for different species are given in Table II.E-7a. The surf clam is economically the most important shellfish and is reported to depths of less than 50 meters. Major beds are located from Absecon Inlet south, where in 1975, 74 percent of the New Jersey harvest was taken within 3 miles of the coast (USACOE, Philadelphia District, November 1976b). Haskins and Merrill (1973) reported a large degree of surf clam density variation in New Jersey waters. Considerable differences in yields were experienced over distances as short as 100 meters. Typically, areas near inlets consistently have had high yields. New Jersey surf clam landings from 1972 to 1975 are presented in Table II.E-7b. The surf clam is seldom buried deeper than 7 inches and usually occurs in sandy bottoms. The clams spawn twice a year, first in July and August, and again in October. Eggs and sperm are cast into the water, fertilization occurs, and the larvae remain in plankton for days before settling on the bottom.

Overfishing for the surf clam is a condition of concern in New Jersey, and the NJDEP has developed "off limit" zones in the State's southern offshore sector. Additionally, all State clam waters (within the 3-mile limit) are closed between May 1 and November 30. Despite these conservation measures, clammers can still fish in Federal waters (beyond the 3-mile limit).

In the summer of 1976, a large cell of oxygen-depleted water (less than 2 ppm DO) — which was extremely detrimental to coastal fish and shellfish resources — occurred off the New Jersey coast. Surf clam loss from this occurrence was estimated at 69 percent of the total New Jersey surf clam biomass (207,000 metric tons) and 16.3 percent of the estimated Middle Atlantic Bight biomass (875,000 metric tons), (Chang et al., 1976). Assessment of the long-term impacts of such a loss and the potential recovery rate of the area are difficult to estimate. Thus, it is important that the unimpacted and remaining brood stock beds not be adversely affected so that recovery may occur as quickly as possible.

The American lobster is also found in the nearshore zone of the State, from the intertidal zone to a depth of 700 meters (TRIGOM-PARC, 1974). Although they prefer irregular bottoms which have crevices for shelter, lobsters frequently occur on sand or mud bottoms where they can make burrows. Lobsters feed primarily on fish (dead or alive) and invertebrates such as isopods, decapods, molluscs, and echinoderms. Their natural predators are cod, skates, sharks, and other lobsters. The oxygen depletion of 1976 affected the northern New Jersey nearshore zone more than the southern sector, the effects of which are presented in Halgren (1976). New Jersey lobster landings for 1976 and 1977 were 645,508 and 797,060 pounds, worth 1.2 and 1.5 million dollars, respectively.

The rock crabs, Cancer irroratus and C. borealis, are also found in the New Jersey nearshore zone. C. irroratus is common near sandy bottoms, whereas C. borealis prefers irregular substrate and is more often found around wrecks. Both occur from low water out to 600 to 800 meters (TRIGOM-PARC, 1974). The rock crab is a

TABLE II.E-7a

COMMERCIAL LANDINGS OF MAJOR SPECIES OF SHELLFISH
IN NEW JERSEY IN 1974

Species	Pounds	Rank	Dollars	Rank
Blue crab	2,870,675	2	$ 724,123	5
Red crab	25,263	11	1,860	13
Rock crab	345,693	7	22,212	11
Lobster	1,191,297	5	1,915,856	2
Hard clam	1,741,000	3	1,739,312	3
Soft clam	87,240	10	72,700	8
Surf clam	22,656,648	1	2,948,367	1
Conch	107,714	9	31,790	9
Mussel	7,050	13	3,755	12
Oyster	1,009,914	6	1,028,702	4
Bay scallops	16,248	12	24,372	10
Ocean scallops	327,686	8	506,860	6
Squid	1,286,819	4	237,034	7
TOTALS	31,673,247		$9,256,944	

Source: Thomas et al. (1975).

TABLE II.E-7b

SURF CLAM VESSELS AND LANDINGS BY AREAS
(1972-1974 and 1975)

	Number of Vessels				Landings (millions of pounds)			
Fleet	1972	1973	1974	1975	1972	1973	1974	1975
Cape May-Wildwood	34	30	22	NA	14.8	12.5	12.6	16.5
Atlantic City	4	8	11	NA	1.4	4.7	6.4	14.8
Point Pleasant	12	13	11	NA	4.8	4.1	3.5	4.1

NA = not available.
Sources: Ropes et al. (1975); Ropes and Ward (1974)

predatory species which feeds on bivalves and invertebrates. Cod and other bottom-feeding fish feed on the crab. Fertilization of eggs occurs in winter, and the eggs hatch in summer. The rock crab, which suffered mortality during the oxygen depletion of 1976, supports a minor shellfishery totalling 9.9 and 21.2 thousand dollars in 1976 and 1977, respectively (NMFS, 1978).

(3) Birds. Galli (1978) and Howe and others (1978) describe habitat preference, distribution, and occurrence and man-related impacts on birds which are likely to occur within the shore areas of New Jersey. Data on population trends, movements, distribution, and location of waterfowl in New Jersey can be found in Widjeskog and others (1978 and 1979). Table II.E-8 lists the most common birds and their preferred habitat. The table shows that different habitats may be used by the same bird for different activities (i.e., nesting and feeding). Migrant birds whose range extends along the New Jersey shoreline are listed in Table II.E-9, along with their period of migration and habitat types. The occurrence of colonial waterbirds and nesting sites is reported in Galli (1978). Table II.E-10 lists colonial waterbirds with nesting sites in oceanfront Reaches 2 to 14.

The peregrine falcon has been reintroduced into New Jersey through a captive breeding program designed to return the falcon to former or new nesting sites (McLain and Moritz, 1975). Cornell University (1979) reported a pair of peregrine falcons nesting in Manahawkin in 1979, the first siting in the eastern United States in more than 20 years. Frier (1978b) has reported wintering locations in New Jersey for the bald eagle. These locations include Nantuyent Cove in Reach 12 (Delaware Bay Shore) and an area around Brigantine National Wildlife Refuge in the southern back-bay section of Reach 4 and northern section of Reach 5.

(4) Threatened and Endangered Species. The endangered, threatened, and peripheral species of potential occurrence in New Jersey are listed in Table II.E-11. Three species of endangered marine turtles are found in the mid-Atlantic, including the hawksbill, Atlantic ridley, and leatherback. The loggerhead and green sea turtle are considered as threatened species. Little is known about the occurrence of the hawksbill turtle. The loggerhead, green sea turtle, and Atlantic ridley are all coastal species normally found in tropical and subtropical waters. The loggerhead is probably the most common marine turtle in the area and may nest as far north as the northern New Jersey coast. The leatherback is found most often far at sea.

Of the whales, the finback and humpback are most likely to occur near the New Jersey coast. Although not listed as threatened or endangered, the gray seal, harbor seal, and Atlantic harbor porpoise are unique animals which have been reported in New Jersey coastal waters and estuaries (USACOE, Philadelphia District, November 1976b). The short-nosed sturgeon is an endangered fish species which occurs in New Jersey coastal waters. Being anadromous, it enters coastal rivers to spawn, but little is known about its distributional habits. Since it is known to spawn in the Hudson River (Short-nosed Sturgeon Recovery Team, 1977), it is most likely to be found in the Lower New York Harbor Area (Raritan Bay) at some time during migrations.

The Arctic and American falcons are endangered migrant species which fly over the New Jersey area during the fall and spring. While most American peregrine falcons move down the interior of the United States, the major flyway of the Arctic peregrine falcon is along the east coast of the United States (Nature Conservancy, 1976). During migration, the falcons commonly use coastal barrier islands for feeding and resting because of their remoteness and extensive marshes which provide vast feeding areas of prey (e.g., ducks and other shorebirds). Neither the American nor

TABLE II.E-8

BREEDING BIRDS: HABITAT USE AND POPULATION TRENDS

Species	Habitat		
	Marshes	Uplands Woody Vegetation	Beach Littoral
LONG-LEGGED WADERS			
Green heron	F,a	N	—
Little blue heron	F,n	N	f
Cattle egret	f	N	—
Great egret	F,n	N	f
Snowy egret	F,n	N	f
Louisiana heron	F	N	f
Black-crowned night heron	F,n	N	f
Yellow-crowned night heron	F	n	f
Glossy ibis	F,n	N	—
WATERFOWL			
Mute swan	N,F,a	—	f
Canada goose	N,F,a	—	f
Mallard	N,F,a	n	f
Black duck	N,F	n	f
Gadwall	N,F,a	n	—
Pintail	N,F,a	—	—
Green-winged teal	N,F,a	—	—
Blue-winged teal	N,F,a	—	—
American widgeon	N,F,a	—	—
Northern shoveler	N,F,a	—	—
Redhead	N,F,a	—	f
Ruddy duck	N,F,a	—	f
Red-breasted merganser	N,F	—	F
RAPTORS			
Bald eagle	F	N	F
Marsh hawk	N,F	—	f
Osprey	F	N	n,F
Short-eared owl	N,F	—	f
RALLIDS			
Clapper rail	N,F	—	—
Virginia rail	N,F,a	—	—
Black rail	N,F	—	—
Common gallinule	N,F,a	—	—
American coot	N,F,a	—	f

TABLE B-8 (Continued)

Species	Habitat		
	Marshes	Uplands Woody Vegetation	Beach Littoral
SHOREBIRDS			
American oystercatcher	n,F	—	N,F
Piping plover	—	—	N,F
Upland sandpiper	—	N,F,b	—
Spotted sandpiper	f	—	N,F
Willet	N,F	—	n,F
GULLS			
Great black-backed gull	f	—	N,F
Herring gull	n,f	—	N,F
Laughing gull	N,F	—	f
TERNS			
Gull-billed tern	F	—	N,f
Forster's tern	N,F	—	F
Common tern	n,f	—	N,F
Roseate tern	—	—	N,F
Least tern	—	—	N,F
Black skimmer	n,F	—	N,F
PASSERINES			
Horned lark	—	—	N,F
Fish crow	F	N,F	f
Long-billed marsh wren	N,F	—	—
Yellowthroat	N,F	N,F	—
Red-winged blackbird	n,f	N,F	—
Sharp-tailed sparrow	N,F	—	—
Seaside sparrow	N,F	—	n
Song sparrow	f	N,F	—

Notes:
N, n = nesting
F, f = feeding

Upper case letters indicate the principal habitats for feeding or nesting.

— = indicates non-use of a habitat.
a = primarily brackish and freshwater impoundments.
b = open, grassy fields, etc.

Source: Howe et al. (1978).

TABLE II.E-9

MIGRANT BIRDS: OCCURRENCE AND HABITAT PREFERENCE

Species, Common Name	Normal Period of Migration	Habitat	Remarks
Pied-billed grebe	Mar-Apr, Aug-Nov	M,B	
Cory's shearwater	Jun-Nov	P	Visitor from eastern Atlantic
Greater shearwater	May-Dec	P	Southern hemisphere breeder
Sooty shearwater	May-Sep	P	Southern hemisphere breeder
Wilson's storm-petrel	May-Nov	P	Southern hemisphere breeder
Gannet	Oct-Dec, Mar-May	P,L	
Double-crested cormorant	Mar-May, Aug-Nov	L,B	Uncommon summer vagrant
Great blue heron	Mar-May, Aug-Nov	M,B	
Canada goose	Mar-Apr, Oct-Nov	B,M,U	
Snow goose	Mar-Apr, Oct-Nov	M,B	Winters commonly in southern New Jersey
Pintail	Feb-Apr, Sep-Nov	M,B	
Green-winged teal	Mar-Apr, Sep-Nov	M	
Blue-winged teal	Mar-May, Aug-Nov	M	
Ring-necked duck	Feb-Apr, Oct-Nov	M	
Canvasback	Mar-Apr, Oct-Dec	B,M	
Lesser scaup	Mar-Apr, Oct-Nov	B	
Common goldeneye	Mar-Apr, Oct-Dec	B	
Bufflehead	Mar-Apr, Oct-Dec	B	
White-winged scoter	Mar-May, Oct-Dec	L,B	
Surf scoter	Mar-May, Oct-Dec	L,B	
Black scoter	Feb-Apr, Sep-Nov	L,B	
Ruddy duck	Mar-May, Sep-Nov	B,M	
Hooded merganser	Feb-May, Sep-Nov		
Sharp-shinned hawk	Mar-May, Sep-Nov	U,L	
Cooper's hawk	Mar-May, Sep-Nov	U,L	
Marsh hawk	Mar-Apr, Sep-Nov	M	
Osprey	Mar-May, Aug-Oct	B	
Peregrine falcon	Mar-May, Sep-Oct	L,M	
Merlin	Mar-May, Sep-Oct	L,U	
American kestrel	Mar-May, Aug-Nov	L,U	
Virginia rail	Apr-May, Aug-Oct	M	
Sora	Apr-May, Aug-Oct	M	
Semipalmated plover	Apr-Jun, Jul-Oct	L,M	
American golden plover	Apr-May, Aug-Nov	Grassy fields, L	Rare in spring
Black-bellied plvoer	Apr-Jun, Jul-Nov	L,M	
Ruddy turnstone	May-Jun, Aug-Oct	L,M	
Whimbrel	Apr-May, Jul-Sep	M,L	
Spotted sandpiper	Apr-May, Jul-Oct	L,M	
Willet	Apr-May, Jul-Oct	L,M	
Greater yellowlegs	Apr-May, Jul-Nov	B,M	
Lesser yellowlegs	Apr-Jun, Jul-Nov	M	Uncommon in spring
Red knot	May-Jun, Jul-Oct	L,M	
Pectoral sandpiper	Apr-May, Jul-Oct	M,U	
White-rumped sandpiper	May-Jun, Aug-Oct	L,M	
Least sandpiper	Apr-May, Jul-Oct	M	
Dunlin	Mar-May, Sep-Dec	L,M	
Short-billed dowitcher	Apr-May, Jul-Oct	M,L	
Semipalmated sandpiper	Apr-Jun, Jul-Nov	B,L,M	
Western sandpiper	May-Jun, Aug-Oct	L,B,M	Rare in spring
Red phalarope	Apr-May, Aug-Nov	P	
Northern phalarope	Apr-Jun, Jul-Oct	P	
Pomarine jaeger	Apr-May, Sep-Dec	P	
Parasitic jaeger	Apr-May, Aug-Nov	P	
Ring-billed gull	Feb-May, Jul-Nov	L,B,U	
Bonaparte's gull	Mar-May, Oct-Dec	L,B	
Forster's tern	Jul-Oct	B, L,M	
Caspian tern	Apr-May, Aug-Oct	B,L	
Black tern	May, Jul-Sep	B, M,L	Rare in spring
Tree swallow	Mar-May, Jul-Nov	M,U,B,L	

Notes:
P = pelagic.
L = beach and littoral ocean waters.
B = bays and estuaries.
M = marshes (and impoundments).
U = uplands with woody vegetation.

Source: Howe et al. (1978).

TABLE II.E-10

NESTING LOCATIONS OF IMPORTANT WATER-RELATED BIRDS
FOR OCEAN FRONT REACHES

Common Name	REACH NUMBER									
	2-5	6	7	8	9	10	11	12	13	14
Glossy ibis			B	B	B	B	B	XB	B	
Black-crowned night heron	X		B	B	B	B	B	XB	B	X
Yellow-crowned night heron			B	B	B	B		XB	B	
Green heron				B			B	B	B	
Snowy egret			B	B	B	B	B	XB	B	
Cattle egret				B		B		XB	B	
Little blue heron			B	B	B	B	B	XB	B	
Louisiana heron			B	B		B	B	XB	B	
Great blue heron	X	B								
Herring gull	X		XB	B	B	B	B	B	B	
Laughing gull			XB	B	B	B	B	B	B	
Great black-backed gull			B	B	B	B		B		
Gull-billed tern		B							B	
Forsters tern				B			B	B	B	
Common tern	X	XB	XB	B	B	B		B	B	X
Least tern	X	B	B	XB	B	X	XB	XB	X	X
Black skimmer	X			B	B		XB	B	B	
Oyster catcher							B	X	B	
Great egret			B	B	B	B	B	XB	B	
Piping plover								X		
Osprey	X	B	B	B		B	B	B	B	

X = ocean, beach, dune, or barrier island locations.

B = locations on backbay or tributary wetlands.

Source: Galli (1978); Frier (1978a).

TABLE II.E-11

ENDANGERED AND THREATENED SPECIES OF POTENTIAL OCCURRENCE WITHIN THE AREA AFFECTED BY THE MASTER PLAN

Endangered Species

FISH	
Short-nosed sturgeon	*Acipenser brevirostrum*
MARINE REPTILES	
Atlantic hawksbill	*Eretmochelys imbricata*
Atlantic loggerhead	*Caretta caretta*
Atlantic ridley	*Lepidochelys kempi*
Atlantic leatherback	*Dermochelys coriacea*
MARINE MAMMALS	
Sperm whale	*Physeter macrocephalus*
Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalus*
Sei whale	*Balaenoptera borealis*
Humpback whale	*Megaptera novaeangliae*
Atlantic right whale	*Eubalaena glacialis*
BIRDS	
Bald eagle	*Haliaeetus leucocephalus*
Peregrine falcon	*Falco peregrinus*

Threatened Species

FISH	
Atlantic sturgeon	*Acipenser oxyrhynchus*
American shad	*Alosa sapidissima*
Atlantic tomcod	*Microgadus tomcod*

TABLE II.E-11 (Continued)

Threatened Species (Continued)

BIRDS

Pied-billed grebo*	Podilymbus podiceps
Great blue heron*	Ardea herodias
Marsh hawk*	Circus cyaneus**
Merlin	Falco columbarius
Upland sandpiper* (Plover)	Bartramia longicauda
Roseate tern*	Sterna dougallii
Barred owl*	Strix varia
Short-eared owl*	Asio Flammeus**
Short-billed marsh wren	Cistothorus platensis
Bobolink*	Dolichonyx oryzivorus**
Savannah sparrow*	Passerculus sandwichensis
Ipswich sparrow*	Passerculus sanwichensis princeps
Grasshopper sparrow*	Ammodramus savannarum

MARINE REPTILES

Atlantic green turtle	Chelonia mydas

Peripheral Species

MARINE MAMMALS

Harp seal	Phoca groenlandica
Gray seal	Halichoerus grypus
Hooded seal	Cystophora cristata

*Breeds in New Jersey.
**Status designation applicable to breeding population only.

Source: NJDEP (1975).
Federal Register, Vol. 44, No. 12 (January 17, 1979), pp. 3635-3654.

Arctic peregrine falcons presently breed in the eastern United States, though the American falcon did at one time.

Ospreys have been declining nationwide in recent years. Although not on the Federal list of endangered or threatened species, this bird is on the Audubon Blue List (Arbib, 1977) and the New Jersey Endangered Species List (NJDEP, 1975). The primary reasons for the decline of this species are the loss of reproductive potential from pesticide poisoning and the ingestion of other toxic substances. The cumulative effect of DDT and the industrial pollutant PCB poses a serious threat because of their concentrations in some species of the osprey's basic food source (i.e., fish). The reduced use of DDT and other persistent pollutants has helped to reestablish some of the osprey populations. Illegal hunting of this species is also a problem in some coastal regions.

The southern bald eagle is another endangered species whose range extends over New Jersey. It is found in all of North America, with a preferred habitat confined to the coastal zones, internal lakes, rivers, and reservations, and along mountain ridges during migration; however, the bald eagle population has been declining steadily. The most limiting factor is loss of natural habitats, primarily along waterfronts, due to clearing of the land for both human habitation and industrial development, and removal of old dead trees. Additional causes of declining population include poisoning with such toxicants as pesticides and mercury, human disturbance and noise, reduction of food sources by industrial effluents, electrocution on high voltage lines, and intentional or accidental killing of the birds.

b. Cultural and Historic

Historic resources, as defined by NJDEP/NOAA (1978), include objects, structures, neighborhods, districts, and manmade or man-modified features or landscapes, including archeological sites, which are either in or eligible for inclusion in the State or National Registers of Historic Places. In the context of this document, related resources may also include manmade features — such as utilities, pipelines, or outfalls — which are actively being used, thus warranting consideration in the master planning process.

Depending on the nature of alternatives implemented under the Master Plan, a number of cultural resources may be directly or indirectly affected. The resources most likely to be affected by shore protection alternatives specifically addressed in this document are summarized below.

(1) Historic Places. The list of historic places provided in Table II.E-12 is taken from the National Register of Historic Places (F.R. Vol. 44, No. 26, February 6, 1979), the State Register of Historic Places (NJDEP, June 1978), and the Inventory of Cultural Resources (NJDEP Office of Historical Preservation, March 1978). The list includes both public and private properties that are considered by the NJDEP to have significant historic or cultural merit and are located in areas likely to be affected, either directly or indirectly, as a result of the implementation of any of the various shore erosion control or land use management alternatives addressed in Volume 1 Chapter II. Also included are locations presently under consideration for, or that have been nominated to be included in, the Federal and State Registers of Historic Places.

Although Table II.E-12 contains some locations which are somewhat removed from the present shorelines, it is important to consider the trend of long-term erosional effects or the possibility of future secondary effects associated with

TABLE II.E-12

HISTORIC PLACES BY SHORELINE REACH

REACH 1 — Raritan Bay

Alexander Hamilton Steamship, Atlantic Highlands Borough

Henry Hudson Springs, Bayside Drive, Atlantic Highlands Borough

Lawrence Kearny House, Catalpa Street, Perth Amboy City

Life Boat Station of New Jersey, Twin Lights, Highlands Borough

Seabrook-Wilson House, Port Monmouth Road, Middletown Township

REACH 2 — Sandy Hook to Long Branch

Asbury Park Convention Center, Asbury Park

Coast Guard and Park Service Property (Fort Hancock), Sandy Hook

Ordinance/Quartermaster Wharf No. 536, Sandy Hook

U.S. Life Saving Station, Sandy Hook - Gateway National Recreation Area, Visitors Center

REACH 3 — Long Branch to Shark River Inlet

Long Branch Church of the Presidents, 1260 Ocean Avenue, Long Branch

Moses Taylor House, Ocean Avenue, Long Branch

Ocean Grove Historic District, Atlantic Ocean, Main, Wesley Lake and Fletcher Lake, Neptune Township

The Reservation, 1-9 New Ocean Avenue, Long Branch

REACH 6 — Mantoloking to Barnegat Inlet

Old Coast Guard Station, Ocean Avenue, Seaside Park Borough

U.S. Life Saving Station No. 14, Island Beach State Park, Seaside Park

REACH 7 — Long Beach Island

Barnegat City Public School (Light Museum), 501 Central Avenue, Barnegat Light Borough

Barnegat Lighthouse, Barnegat Lighthouse State Park

REACH 8 — Brigantine and Pullen Island

U.S. Coast Guard Station, Little Beach Island, Galloway Township, approximately 3 miles NNE of Brigantine City

TABLE II.E-12 (Continued)

REACH 9 — Absecon Island

Absecon Lighthouse, Pacific and Rhode Island Avenue, Atlantic City

Holmhurst Hotel, Pennsylvania Avenue and Boardwalk, Atlantic City

Lucy the Elephant, Decature and Atlantic Avenue, Margate City

Morton Hotel, South Virginia Avenue, Atlantic City

Shelburne Hotel, Michigan Avenue and Boardwalk, Atlantic City

Site of Marlborough-Blenheim Hotel, Ohio Avenue and Boardwalk, Atlantic City

Site of the Traymore Hotel, Illinois Avenue and Boardwalk, Atlantic City

REACH 14 — Cape May Inlet to Cape May Point

Cape May Historic District, entire city of Cape May

Cape May Lighthouse, Cape May Point State Park

Hereford Lighthouse, north end of Central Avenue, North Wildwood City

REACH 15 — Delaware Bay

Beacon-Hancock House, south side of Bayside Road, Greenwich Township

Cold Spring Church, west side of Old Shore Road, along Delaware River, Lower Township

REACH 16 — Delaware River

Bordentown Historic District, area including Farnsworth, 2nd and 3rd Avenue, Crosswick, Court Bank, Bordentown City

Burlington Historic District, Wood and Broad Streets, Burlington

Daniel Rubart House, West Front Street, Florence Township

Dr. Henry Grant Tylor House and Office, Cooper Street and Delaware River, Camden

Fort Billings Park, Billingsport Road at Third Street on Riverfront, Clonwell Road and North Delaware Street, Paulsboro

Fort Mott and Finns Point National Cemetary, Delaware River at Finns Point, Pennsville Township

Goose Island, west of Bridgeport on Goose Island, separated from New Jersey shore by marsh, Logan Township

Griffith Morgan House, behind U.S. Steel Company, along Delaware River, Pennsauken Township

Hatch House, River Road, Pennsauken Township

TABLE II.E-12 (Continued)

REACH 16 (Continued)

Joseph Cooper House, head of 7th Street in Pyne Point, Camden

Ladd's Castle, Lafayette Avenue and Riverfront, West Deptford Township

Lapourcade House, Riverbank, Edgewater Park Township

Newton Friends Meeting House, Cooper Street and Delaware River, Camden

Oneida Boat Club, Hight Street, Burlington City

Parker House, Front Street, Florence Township

Pearson-How, Cooper, Lawrence House, Micro District, High Street at Delaware River, Burlington

Quaker School, York and Penn Streets, Burlington

Red Bank Battlefield, east bank of the Delaware River and at the west end of Hessun Avenue, National Park Borough

Redroe Morrist House, on Delaware River, west of Salem, Elsinboro Township

Roebling Historic District, 2nd through 5th Avenue, Aldens, Norman Amboy Avenue, Florence Township

Salisbury Site, along bank of Delaware River, west of Bridgeport, Logan Township

Shore Factory Building, Penn Street and Pearl, Burlington City

Water Works, Pearl Street on the waterfront, Burlington City

W.B. Lewis House, Hearts Ease, Front Street, Florence Township

West Thompson House, Front and Summer Street, Florence Township

References:

New Jersey State Register of Historic Places (NJDEP, 1978).
National Register of Historic Places (F.R. Vol. 44, No. 26, February 6, 1979).
Inventory of Cultural Resources, NJDEP, Office of Historic Preservation (1978).

implementation of engineering or land management alternatives that may influence the integrity or tourism-related use of a particular location.

The erosion conditions near the historic places listed in Table II.E-12 for the Raritan Bay, Delaware Bay, and Delaware River shore areas (Reaches 1, 15, and 16), are not likely to be a threat in the near future. Typical shore erosion control projects along those reaches would be small and not likely to adversely impact visitation of public historic places. Therefore, the historic places in Reaches 15 and 16 are presented herein for consideration in general shore management planning only.

(2) Prehistoric Archaeological Sites. This subsection describes the occupation of early man in the general areas affected by the Shore Protection Master Plan alternatives. Shipwrecks of potential archaeological significance are addressed in Section E.2.b.(3) of this chapter.

There are numerous sites of prehistoric significance in the New Jersey coastal zone; our descriptions are limited to those sites which have been reported to exist along the shore of a reach or other location where shore protection measures are planned. These sites should be investigated fully prior to implementation of any shore erosion control programs.

It is not known exactly when early man first began to settle the coastal areas of New Jersey. Available evidence indicates that man's occupation of the Atlantic coastal region dates to 12,000 years before present (B.P.), (Ritchie, 1969; Saxon, 1973). The early Americans, known as Paleo-Indians, were primarily mobile hunters and gatherers whose spear points have been discovered in direct association with the bones of large, late glacial period mammals (Ritchie, 1969). Evidence indicates that the Paleo-Indians probably migrated along major river systems and ranged through both coastal and inland areas of New Jersey. It has been postulated that the Paleo-Indians changed living styles or migrated out of the area around 8,000 years B.P., perhaps in response to changing climatic conditions or the extinction of many large grazing animals (Thomas, 1974).

The second major stage of cultural development in the mid-Atlantic region involved Archaic hunters and gatherers who were adapted to both forest and coastal living and were somewhat nomadic (Salwen, 1965; Cross, 1941). Kinsey and others (1972) postulate an extremely sparse population in early Archaic time (10,000 to 6,000 years B.P.). It is likely that the late Paleo-Indian populations along the Atlantic seaboard were also very sparse. During the transitional period between the time of the Archaic and more recent Woodland Indians (3,000 to 2,500 years B.P.), the sea level approached its present levels and occupation sites were located nearer to modern shorelines (BLM, 1978).

The potential for occurrence of remnants or artifacts of past cultures in the coastal areas of New Jersey is related to the history of early man's migration through the Atlantic Coastal Plain and the history of sea level changes and shoreline migration across the continental shelf during the end of the Wisconsin Glacial Period. Indications of prehistoric human occupational sites might include artifacts (stone tools, projectile points, etc.), burial sites, shell middens or heaps, fossil mammal remains, and old river courses. When Paleo-Indians first came into this region, the shoreline was nearly 100 miles east of its present position, and the geographical configuration of New Jersey was far different from what it is today.

Considerable geologic and geophysical evidence suggests that the surface morphology and deposits on the New Jersey continental shelf resulted from the erosion and reworking of the coastal sediments during the advance of the shoreface as glaciers to the north melted and sea level rose across the shelf (Duane, 1976; Swift et al., 1972, 1973; Stahl et al., 1972). Because of the migration of this erosional shore zone across the shelf, it is unlikely that many features associated with postulated human occupation of the now submerged terrain are intact, such as shell middens and burial sites. Small durable artifacts, such as stone tools or projectile points, may remain buried at shallow depths, but would be extremely difficult to identify in advance of any proposed disturbance of the seafloor — such as sand mining required for beach nourishment.

Aboriginal sites attributable to Woodland, Archaic, and Paleo-Indians have been reported along the New Jersey shore by various authors (e.g., Skinner, 1913; Cross, 1941; J. Milner Assoc., 1978 (unpublished)). Many finds by novice collectors have never been reported. Today many of the reported sites are gone — victims of the activities of early farmers, seashore resort developers, and sea level rise with its associated erosion.

The recently completed Assessment and Predictive Survey for Prehistoric Archaeological Resources in the New Jersey Pinelands includes an assessment of reported sites located in the southern half of the State (including shore areas). This study was prepared for the New Jersey Office of Historic Preservation and the Pinelands Commission by the Monmouth College Archaeological Research Lab. Findings to date indicate that only a few sites reported for the Atlantic oceanfront reach communities may be affected by actions specifically addressed in this Plan. There are numerous sites along the shorelines of communities bordering on backbay and tributary waterways of Ocean, Atlantic, and Cape May Counties. Several sites have also been reported along the Delaware Bay shore. The shoreline reach municipalities with reported sites of prehistoric significance are listed in Table II.E-13. Table II.E-14 provides a list of reported site areas not specifically affected by alternative engineering plans.

To date, the only documented prehistoric artifact to have been collected on the continental shelf east of New Jersey is a "stone bowl" or granite mortar, which is reported to have been dredged at a depth of about 50 feet (15 meters), approximately 7 miles southeast of Manasquan, New Jersey (Kardas and Larrabee, 1976 (unpublished)). Its general appearance and shallow depth indicate that it probably falls within Archaic cultural patterns rather than those of earlier Paleo-Indians. Although not well documented, several aboriginal artifacts have been reported by clam dredgers off Long Beach Island, Wildwood, and Cape May (J. Cresson, personal communication). By themselves these reported artifacts are only suggestive, but they are a valuable confirmation when combined with other evidence of possible human occupation of the continental shelf.

The likelihood of finding Paleo-Indian and Archaic sites on the continental shelf is discussed by Emery and Edwards (1966). These authors considered the Atlantic States, between the Gulf of Maine and Georgia, as the most favorable area for submerged habitation sites of early man. Kardas and Larrabee (unpublished, 1976) report that the more usable environments on the continental shelf, and the more likely locations for the discovery of man's artifacts, occur in areas now at depths of less than 100 feet.

TABLE II.E-13

REPORTED PREHISTORIC SITES IN REACH MUNICIPALITIES

Reach Number	Reach Name	General Site Location
1	Raritan Bay	Aberdeen, Keyport, Union Beach, Belford
2	Sandy Hook to Long Branch	Sandy Hook (bayside)
7	Long Beach Island	Barnegat Light State Park (inlet shore) Harvey Cedars (backbay shore) Beach Haven (ocean shore) Brigantine National Wildlife Refuge – Holgate Unit, (bayshore of spit)
8	Brigantine Island	Brigantine (Absecon Inlet shore)
14	Cape May Inlet to Cape May Point	Cape May Point
15	Delaware Bay	Maurice River Township Lower Township Downe Township
16	Delaware	Numerous sites in Gloucester, Camden and Burlington Counties

Sources:

Skinner (1913); Cross (1941); Monmouth College Archaeologic Lab (in preparation); J. Miller Assoc. (1978, unpublished).

TABLE II.E-14

REPORTED PREHISTORIC SITES ON BACKBAY AND TRIBUTARY WATERWAY SHORES

County	General Site Location
Monmouth	Manasquan River, sites on north and south shores
Ocean	Metedeconk River, sites on north and south shores
	Toms River, sites on north and south shores
	Barnegat Bay, numerous sites on west shore
	Little Egg Harbor, west shore sites
Atlantic	Great Bay, west shore sites
	Reeds Bay, west shore sites
	Absecon Bay, west shore site
	Great Egg Harbor Bay, west shore site
	Great Egg Harbor River, north shore
Cape May	Ludlam Bay, west shore sites
	Great Sound, west shore sites

Source: Monmouth College Archaeological Research Lab (in preparation).

Numerous fossils of mammoth, mastodon, giant moose, and other late Pleistocene or early Holocene animals have been dredged from the surface of the continental shelf east of New Jersey and may be taken as indicators of resources available to early hunters. Most of the finds have been near the Hudson Canyon and are probably related to that former major watercourse. Other similar finds have been reported from the nearshore off Mantoloking (5 miles off Long Beach Island) and about 10 miles east of Seven Mile Beach (Kraft, 1977). Fossils washed ashore at Brigantine Island include portions of extinct deer, caribou, giant moose, and possible bison (Kardas and Larrabee, 1976, unpublished). Nearly 50 mastodon remains have also been found in various parts of the New Jersey mainland.

(3) Shipwrecks and Artificial Fishing Reefs. For more than 200 years, the bay and ocean waters bordering New Jersey have been used extensively by shipborne commerce traveling to and from the major ports in the New York and Philadelphia areas. Natural forces, accidents, and wars have resulted in more than 500 shipwrecks, some dating to as early as the 1600's. In addition to the historic significance of many of the shipwrecks, nearly all provide unique habitats for marine organisms, including finfish and lobster. Wreck fishing is an important part of the State's water-related tourism industry.

Also traditionally important to the sport and commercial fishing are artificial fishing reefs (Jensen, 1975). At least three such reefs have been planned and constructed in the ocean off New Jersey. The Monmouth Beach Reef was constructed about 1.8 miles east of Monmouth Beach using old automobile tires and a few automobile bodies. Approximately 4.7 miles east-northeast of Manasquan Inlet, the Sea Girt Reef was constructed from old tires and miscellaneous junk. Another artificial reef was constructed of wooden boats and automobile tires, 6 miles off North Wildwood on Five Fathom Bank, but was swept away during the March 1962 storm (Jensen, 1975). A further discussion of the ecological significance of artificial reefs and shipwrecks is provided in Section E.1.c(4) of this chapter.

Table II.E-15 presents the approximate number of known shipwrecks at various distances form shore adjacent to each of the shoreline reaches. A summary of the location and history of the most reported wrecks is provided by Krotee and Krotee (1966).

(4) Unique Geologic Areas. Several areas along the shores of New Jersey that may be considered geologically unique are described in Table II.E-16. Geologically unique offshore areas are discussed in Section E.2.b.(5) of this chapter.

(5) Marine Sanctuaries. In 1977, the NJDEP suggested that six areas along the Atlantic coast be considered for nomination as marine sanctuaries under the Marine Protection, Research and Sanctuaries Act of 1972 (P.L. 532, 16 U.S.C., 1431-1434). The six areas presented in Table II.E-17 are currently being reviewed by NOAA's Office of Coastal Zone Management for possible inclusion on the National Marine Sanctuary list. Selection of areas would afford them protection from activities such as dumping of waste and dredge spoils and sand mining; it would also make Federal monies available for maintenance and management. It is anticipated that the final selection of proposed marine sanctuary sites will not occur for several years.

TABLE II.E-15

APPROXIMATE NUMBER OF NEW JERSEY SHIPWRECKS
WITHIN DESIGNATED DISTANCE OF SHORE

Reach Number	1 Mile	3 Miles	10 Miles
1*	10	11	NA
2	4	7	26
3	9	16	22
4	4	5	10
5	1	5	6
6	9	13	26
7	12	18	29
8	3	10	28
9	3	5	12
10	3	3	5
11	3	4	9
12	4	5	11
13	4	6	13
14	0	2	6
15*	3	4	7
16*	6	NA	NA

NA = not applicable.

*Shipwreck counts for Reaches 1, 15, and 16 were taken from NOAA, NOS Nautical Charts of the areas involved.

Source: Krotee and Krotee (1966).

TABLE II.E-16

UNIQUE GEOLOGIC AREAS ON THE NEW JERSEY SHORE

Nature and Location	Reaches Affected	Significance/Comments
Bayshore Bluffs[1] (Monmouth and Middlesex Counties)	1	Unique Raritan bayshore bluffs along Atlantic Highlands on the east, and Cliffwood Beach (Aberdeen) to the west, are areas where coastal plain sedimentary formations outcrop. Although stabilized, filled, or developed to a large degree, these bluffs contain exposured rocks of Late Cretaceous Age. The units cropping out along Cliffwood Beach are among the oldest coastal plain formations exposed in the United States. In some areas, well preserved plant and animal fossils are found within the various stratigraphic units. Because of the completeness and access of the Late Cretaceous stratigraphic column along the bay shore, it was used as the paleontological key to the Continental Offshore Stratigraphic Test (COST) wells on the outer continental shelf of New Jersey
Aberdeen Fossil Dig[1, 2] (Monmouth County)	1	Of particular interest along the bay-shore bluffs is the fossil dig at Aberdeen Township. This dig has been reported to be the site where unique Mesosoic insect fossils (ants) were recovered in 1965. Apparently the actual recovery site was in strata of the same age, outcropping somewhere to the west of the existing dig; however, that area has since been covered with sand fill. Unlike adjacent areas, when erosion and flood control structures were constructed by the State along Aberdeen Township in 1972, the fossil dig site was not covered. Recent sluffing problems have threatened residences above the dig so the State is considering remedial measures which could possibly involve filling of the fossil dig site.
Headland Bluffs of[3] Long Branch and Deal (Monmouth County)	2, 3	The headland bluff along the shores of Long Branch and Deal were historically eroded by waves and littoral currents, thus supplying sands for transport to beaches both north and south. The area is now heavily developed and stabilized with various shore protection structures. The result has been littoral starvation and loss of valuable recreational beaches. Continued "protection" of the bluffs will only aggravate the situation.
Cape May Diamonds[4] (Cape May County)	14, 15	Clear quartz pebbles ("diamonds") have been collected from Cape May beaches, dunes, and overwash areas by visitors and local residents for more than 100 years. Most commonly the pebbles have been recovered between Cape May Point and the Higbee Beach area, but they have also been recovered from ocean beaches and occasionally gravel pits several miles inland. There is no unique source or any particular point of concentration of the Cape May diamonds. The pebbles are probably derived from Pleistocene gravels which cover large areas of southern New Jersey. In recent years, the Cape May diamonds have been harder to find, probably due to the stabilization of eroding shores and increased development of the coastal areas of the Cape.

Sources:

(1) Personal communication, J. Gell, NJDEP, Office of Environmental Review.

(2) Asbury Park Press (May 13, 1979); Sunday Herald (May 13, 1979).

(3) Dames & Moore (this study).

(4) Widmer (1959); personal communication, S. Halsey, NJDEP, Division of Coastal Resources.

TABLE II.E-17

NEW JERSEY OFFSHORE AREAS UNDER CONSIDERATION FOR NOMINATION AS MARINE SANCTUARIES

Area	Reaches Affected	Significance/Comments
Hudson Canyon	None	Unique geologic area encumbering approximately 60 miles along the ancestral Hudson River bed on the now submerged continental shelf. Serves as a habitat for various commercial fish and shellfish species.
Shrewbury Rocks and associated rock outcroppings	2	Unique geologic area of submarine rock outcroppings beginning near Monmouth Beach and extending east-northeast. Although the rocky areas are essentially devoid of significant sand resources, they serve as a habitat for various fish and shellfish. The area has been a popular sport-fishing grounds for more than 300 years.
Great Bay/Mullica River Estuary	7,8	A pristine semi-enclosed estuary with valuable salt marshes and fish spawning areas. Includes approximately 18 square miles but does not conflict with proposed Master Plan alternative.
Offshore Ridges including Manasquan Ridge and Barnegat Ridge	5, 6, 7	Certain areas of the continental shelf are characterized by a sandy ridge and swale topography which is valuable as a congregation area for valuable migratory fish. These same sand ridge areas tend also to be valuable sand resource areas. Sand extraction would be restricted should these areas receive sanctuary status.
Barrier Beach Inlets	4, 5, 6, 7, 8, 9, 10, 11, 12, 13	The numerous inlets discussed in Volume 1, Section I.C.3.b.(4), serve as critical pathways for tidal circulation of coastal estuaries, transport of marine food web organisms and nutrients, andromous fish migration, migratory waterfowl wintering, shellfish productivity, and human recreational and commercial surface water activities. Sand extraction from certain inlets and inlet shoals could be limited should inlets receive sanctuary status. This is unlikely, though, since inlets would eventually shoal up and thus would be inaccessible with recreational and commercial watercraft.
Shipwrecks and Artifical Reefs (Multi Locations)	All	As discussed in Section E.2.b(3) of this chapter, numerous shipwrecks and artificial reefs have cultural or unique habitat significance. Under sanctuary status, areas within 1/4 mile of the center of each location would be protected. Since some shipwrecks occur within known sand resource areas, use of these resources would be affected.

c. Other

(1) Coastal Utilities and Submarine Cables, Pipelines, and Outfalls. Coastal utilities – including roads, water sewers, pipelines, outfalls, and electric, telephone, and related offshore cables – are all worthy of consideration in evaluating alternative adjustments to shoreline erosion. Unlike private property losses, utility damage is often more than a localized problem. This is particularly true in the extreme case where erosion damages affect major water, sewer, or power lines, or roads, whereby an entire community – including areas away from the shoreline – can be impacted. The benefits of protecting utilities, therefore, cannot be ignored.

Due to the level of development and the severity of erosion along the coast of New Jersey, continuing erosion is a threat to utilities along some portion of almost every reach. Certain reaches however, are more vulnerable to major utility losses. Although a specific description of the utilities in all the communities in each reach is not practical herein, the reaches can be grouped into either of the following two categories with regard to vulnerability to major utility damages during storm erosion events: (1) vulnerable low-lying barrier reaches (2, 6, 7, 8, 9, 10, 11, 12, 13), and (2) less vulnerable headland, bay-shore, and river reaches (1, 3, 4, 5, 15, and 16).

Submarine cables and pipelines exist beneath many inlets along the New Jersey coast, the Delaware River, and western Raritan Bay. There are also major communication cables on the seabed east of Long Beach Island (Reach 7) and the Delaware Bay mouth south of Cape May Point (Reach 14). The only submarine pipeline on the continental shelf is a natural gas transmission pipeline, which originates at Morgan, on the Raritan Bay shore (Reach 1), and extends 35 miles across the Bay and shelf to Long Beach, Long Island, New York. The cables and pipeline both occur in areas of reported suitable sand resources.

(2) Waste and Waste Water Disposal and Treatment Sites. At present, no reported solid or liquid waste disposal impoundments are being threatened by erosion along the shores of the 16 Master Plan reaches. Should erosion threaten such sites where hazardous material is involved, its release to estuarine or ocean waters could have deleterious effects on the quality of local water and sediments. There are at least two major dredged material disposal areas located along reach shorelines – the federally controlled Artificial Island and the Pedricktown Disposal Area on the Delaware River shore (Reach 16). There are other smaller State and Federal disposal sites along shores of backbays, inlets, and tributary waterways.

Until regional sewage collection and treatment systems were installed for communities along the coast, nearly all large communities discharged untreated or paritally treated sewage into tidal waters through outfalls of varying lengths or by barging to designated disposal sites. Several outfall pumping stations along the Monmouth County ocean shore have been damaged by erosion. With the installation of regional collection and treatment facilities, most of the community outfalls have been abandoned, but the regional system outfalls still are used. A list of the major active outfalls is provided in Table II.E-18. Although no sewage treatment facilities are in proximity to eroding shores, the outfalls and associated effluent collection networks (trunk lines, holding facilities, etc.) continue to be important to the operation of the regional systems.

The dumping of dredged materials and chemical wastes at approved disposal sites offshore New Jersey has occurred since before the turn of the century. The major active disposal sites close to the New Jersey shore are those located in the apex of the New York Bight offshore of Monmouth County. These disposal areas are essentially off limits with respect to sand extraction for beach nourishment.

TABLE II.E-18

LOCATIONS OF MAJOR ACTIVE OR PLANNED EFFLUENT OUTFALLS

System	General Location of Outfall	Affected Reach
Gateway National Park System	Short Outfall Near End of Sandy Hook	2
Bayshore Outfall Authority	Between Sandy Hook and Seabright (about 1/2 mile long)	2
North East Monmouth Regional Sewer Authority	Monmouth Beach (about 1/2 mile long)	2
Long Branch Sewage Authority	Long Branch (about 1800 feet long)	3
Ocean Township Sewage Authority	Deal (proposed extension to 1/2 mile total length)	3
Neptune Township Sewage Authority	South Bradley Beach (about 1 mile long)	3
Ocean County North	Mantoloking (about 1 mile long)	6
Ortley Beach Plant	Ortley Beach (about 1/2 mile long)	6
Ocean County Central	South Seaside Park (about 1 mile long)	6
Ocean County Southern	Ship Bottom (about 1 mile long)	7
Atlantic County Sewage Authority	Atlantic City (about 1 mile long)	9
Cape May Regional Municipal Utilities Authority	South end Ocean City (under construction, planned length 1 1/2 mile)	10
	Avalon (planned 1 1/2 mile long)	12
	Wildwood Area (planned 1 1/2 mile long)	13

Source: Personal communication, N. Goldfine, NJDEP, Division of Water Resources.

CHAPTER III

POLICY REVIEW

A. INTRODUCTION

During the growth of the resort areas on the Atlantic Coast in the late 19th century, local communities and private citizens responded individually to erosion problems resulting from coastal development. Subsequently, New Jersey conducted studies and issued reports on the problem and established public agencies to oversee shore protection (New Jersey Board of Commerce and Navigation, 1922). Organized Federal assistance began in 1930 with the creation of the Beach Erosion Board, a branch of the Corps of Engineers. The Board made cooperative studies of erosion problems on a cost-sharing basis but no money was appropriated for shore protection unless Federal property was involved.

The Corps of Engineers has gradually expanded the range of erosion adjustment options over the years. Three major phases of erosion adjustment emphasis are recognized. Structural control measures such as seawalls and bulkheads dominated the Federal response during the 1930's and 1940's. In New Jersey, in the early 1940s, new State legislation (P.L. 1940, C. 52; N.J.S.A. 12:6A-1) authorized and empowered the then Department of Conservation and Economic Development (now the Department of Environmental Protection), to repair, reconstruct or construct bulkheads, seawalls, breakwaters, groins, jetties, beach fills, dunes, and other shore protection structures. It was not until the late 1950's, after extensive research, that beach nourishment and dune stabilization were added as the preferred erosion control measures at the Federal level. Sand bypassing was also added as a specialized adjustment in the early 1960's. A major shift in basic Federal policy toward land use management controls followed the completion of the National Shoreline Study (USACOE, 1971). Federal emphasis on land management alternatives for erosion problems has also come from new directives and reviews of existing policy in the coastal zone as a result of the President's first (May 1977) and second (August 1979) Environmental Messages and the Heritage Conservation and Recreation Services' Draft Environmental Impact Statement on Alternative Policies for Protecting the Barrier Islands (HCRS, January 1980).

New Jersey's initial trends toward a management approach to erosion problems were embodied in the special area Location and Use Policies of the New Jersey Coastal Management Program - Bay and Ocean Shore Segment (NJDEP/NOAA, 1978), as discussed below, with the policies related to erosion hazard areas, beaches, dunes, coastal engineering use policies, and flood hazard areas being the most applicable. Nonstructural (e.g., beach fill and dune stabilization) methods are preferred over structural (e.g., seawalls and bulkheads). However, the end result is one of protection of existing coastal development; that is, a strategy of a static shoreline. This emphasis on control measures was further developed with the passage of the Beaches and Harbors Bond Act of 1977 (P.L. 1977, c. 208). The New Jersey Commission of Capital Budgeting and Planning, recognizing that the previous level of funding (about $1 million per year) was inadequate as the State level of funding to municipalities for the increasing problem of beach erosion, recommended a $30 million bond issue which was approved by voters of the State and provides $20 million for State aid for shore protection purposes.

New Jersey Coastal Resources and Development Policies related to shore erosion and shore protection, as amended since 1978, are provided in the New Jersey Coastal Management Program (NJDEP/NOAA, August 1980) and Coastal Resource and Development Policies (NJDEP, DCR, June 1981). A summary of the existing State programs and policies that affect shore erosion management are provided in Section B of this chapter. Existing relevant Federal programs and policies influencing shore protection, coastal development, and resource use are summarized in Section C of this chapter. New directions in Federal policy, as set forth in the President's Environmental Messages of May 1977 and August 1979, and the HCRS draft environmental impact statement on barrier islands (HCRS, January 1980), are also discussed in Section C.

B. NEW JERSEY PROGRAMS AND POLICIES

1. The New Jersey Coastal Management Program

New Jersey's policies on shoreline erosion and management were developed in the context of the New Jersey Coastal Management Program. The Program itself was developed by DEP over a 5-year period with financial assistance from the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA), and was approved by NOAA in September 1980. Contained in the program are a detailed set of Coastal Resource and Development Policies. These policies, which form the substantive element of the Program, were adopted as rules by the Department (NJAC 7:7E-1.1 et seq.) and govern all regulatory and planning decisions in the Coastal Zone, including those on shore protection.

The major direction represented by the specific policies are summarized by the following basic coastal policies:

- Protect the coastal ecosystem;
- Concentrate rather than disperse the pattern of beneficial coastal residential, commercial, industrial, and resort development, and encourage the preservation of open space;
- Employ a method for decision-making which allows each coastal location to be evaluated in terms of both the advantages and the disadvantages it offers for development;
- Protect the health, safety and welfare of people who reside, work and visit in the coastal zone;
- Promote public access to the waterfront through linear walkways and at least one waterfront park in each waterfront municipality;
- Maintain active port and industrial facilities, and provide for necessary expansion in adjacent sites;
- Maintain and upgrade existing energy facilities, and site additional energy facilities determined to be needed by the N.J. Department of Energy (DOE) in a manner consistent with the policies of this Coastal Management Program; and
- Encourage residential, commercial, and recreational mixed-use redevelopment of the developed waterfront.

Within the context of these eight basic policies, New Jersey has developed a coastal management strategy whereby decisions on use of coastal resources is made based on specific Location, Use and Resource policies. Individual proposed actions are evaluated using the framework established by the policies to determine their acceptability. This determination is stated in terms of actions that are encouraged, required, acceptable, conditionally acceptable, discouraged, or prohibited.

Policies adopted by the State of New Jersey which specifically address the issue of shoreline protection include the following:

(1) Location Policies. Location policies classify all land and water features of the coastal area into one of four categories and assign a policy on the use of each type of location in each category. One such category, "Special Areas," provides protection to areas that merit more focused attention as they constitute a highly valued natural resource, serve important purposes of human use, form a significant natural hazard, are sensitive to impact, or are particular in their planning requirements. Special Area designation of areas which are influenced by erosional processes include those identified in Table III.B-1.

(2) Use Policies. Particular uses within the coastal area have applicable policies and rationale which reinforce location policies. Those dealing with shoreline protection are identified in Table III.B-2.

(3) Resource Policies. In addition to location and use policies, resource policies have been developed by the State in insure that the effects of the proposed development on various resources of the built and natural environment of the coastal zone are properly considered. The policies are to serve as a standard to which proposed development should adhere. The resource policies relevant to the Shore Protection Master Plan are presented in Table III.B-3.

2. New Jersey Statewide Comprehensive Outdoor Recreation Plan (SCORP)

The 1977 New Jersey Statewide Comprehensive Outdoor Recreation Plan (SCORP), (NJDEP, 1977) is designed to serve as the basis for sound decision making concerning open space and recreation in the State in the same function as its 1967 and 1973 predecessors. The document serves as as reference for planning policy in the administration of New Jersey's Green Acres open space acquisition and outdoor recreation programs, and also meet requirements for the State's continued participation in the Federal Land and Water Conservation Fund Program. As a policy document, SCORP recommendations attempt to set priorities by which objectives can be met.

Although it was undertaken as an update of the 1973 SCORP, the 1977 SCORP is based primarily on data obtained from studies and inventories conducted under the continuing planning program during the interim. The two most noteworthy studies completed, the Study of the Demand for Outdoor Recreation in New Jersey and the Recreationally Disadvantaged Needs Study, were undertaken to correct deficiencies in the earlier SCORP plan. As discussed in Chapter VI, Section A of this report, the SCORP recreational demand projections are utilized in the design of Master Plan recreational beach development alternatives for each oceanfront reach.

TABLE III.B-1

NEW JERSEY COASTAL MANAGEMENT PROGRAM
COASTAL RESOURCE AND DEVELOPMENT POLICIES
LOCATION POLICIES APPLICABLE TO THE MASTER PLAN: SPECIAL AREAS

POLICIES	RATIONALE
Beach and Dune System (Including Beaches, Dunes, Erosion Hazard Areas, and Overwash Areas) Activities that adversely affect the natural functioning of the Beach and Dune System are discouraged unless, specifically permitted by policies below.	Rationale for the policies pertaining to each of the components of the Beach and Dune System are provided below.
Beaches	
(a) Development is prohibited on beaches, except for development that has no prudent or feasible alternative in an area other than a beach, and that will not cause significant adverse long-term impacts on the natural functioning of the beach and dune system, either individually or in combination with other existing or proposed structures, land disturbances or activities. Examples of acceptable activities are: (i) Demolition and removal of paving and structures, (ii) Dune creation and related sand fencing and planting of vegetation for dune stabilization. (iii) The reconstruction of existing amusement and fishing piers and boardwalks, (iv) Temporary recreation structures for public safety such as first aid and lifeguard stations, (v) Shore Protection Structures which meet the Use conditions indicated in Table IILB-2, and (vi) Linear development which meets the Policy on Location of Linear Development.	Undeveloped beaches are vital to the New Jersey resort economy. Unrestricted access for recreational purposes is desirable so that the beaches can be enjoyed by all residents and visitors of the state. Public access with be required for any beaches obtaining state funds for shore protection purposes. Beaches are subject to coastal storms and erosion from offshore currents. Public health and safety considerations require that structures be excluded from beaches to prevent or minimize loss of life or property from storms and floods, except for some shore protection structures and linear facilities, such as pipelines, when nonbeach locations are not prudent or feasible. Wet sand beaches have been designated a Geographic Area of Particular Concern (GAPC) by DEP under the Federal Coastal Zone Management Act.
(b) Public access to beaches is encouraged. Coastal development that unreasonably restricts public access to beaches is prohibited.	

TABLE III.B-1 (Continued)

POLICIES	RATIONALE
Dunes	
Development is prohibited on Dunes, except for development that has no prudent or feasible alternative in an area other than a dune, and that will not cause significant adverse long-term impacts on the natural functioning of the beach and dune system, either individually or in combination with other existing or proposed structures, land disturbances or activities. Examples of acceptable activities are: (i) Demolition and removal of paving and structures; (ii) Limited, designated access ways for pedestrian and authorized motor vehicles between public streets and the beach that provide for the minimum feasible interference with the beach and dune system and are so oriented as to provide the minimum feasible threat of breaching or overtopping as a result of storm surge or wave runup; (iii) Limited stairs, walkways, pathways, and boardwalks to permit access across dunes to beaches, provided they cause minimum feasible interference with the beach and dune system; (iv) The planting of native vegetation to stabilize dunes; (v) Sand fencing, either a brush type barricade or a picket type, to accumulate sand and aid in dune formation; (vi) Shore Protection Structures which meet the Use conditions of Table III.B-2; and (vii) Linear development which meets the Policy on Location of Linear Development.	Ocean and bayfront dunes are an irreplaceable physical feature of the natural environment possessing outstanding geological, recreational, scenic and protective value. Protection and preservation in a natural state is vital to this and succeeding generations of citizens of the State and the Nation. The dunes are a dynamic migrating natural phenomenon that helps protect lives and property in adjacent landward areas, and buffers barrier islands and barrier beach spits from the effects of major natural coastal hazards such as hurricanes, storms, flooding and erosion. Natural dune systems also help promote wide sandy beaches and provide important habitat for wildlife species. Extensitive destruction of dunes has taken place in this century along most of the coast. This disruption of the natural processes of the beach dune system has led to severe erosion of some beach areas, jeopardized the safety of existing structures on and behind the remaining dunes and upland of the beaches; increased the need to manage development in shorefront areas no longer protected by dunes; interfered with the sand balance that is so essential for recreational beaches and the coastal resort economy; necessitated increased public expenditures by citizens of the entire State for shore protection structures and programs; and increased the likelihood of major losses of life and property from flooding and storm surges. The policy encourages the natural functioning of the dune system and encourages restoration of destroyed dunes, to protect and enhance the coastal beach dune areas, and to devote these precious areas to only those limited land uses which preserve, protect and enhance the natural environment of the dynamic dune system.
Erosion Hazard Area	
(a) Development is prohibited in Erosion Hazard Areas, except for: (i) Linear development which meets the policy on location of Linear Development; and (ii) Shore protection activities which meet the appropriate Coastal Engineering Use policies in Table III.B-2. (b) A development proposed in an Erosion Hazard Area may, by including a Coastal Engineering project, such as an earthern berm, mitigate the projected erosion and change the classification of the site so that it is no longer an Erosion Hazard Area.	As a result of continuing rising sea levels an active storm-induced sand movement and offshore currents (littoral drift), the Atlantic coastline of New Jersey is a retreating shore. Coastal erosion also affects the bayshores of New Jersey. The rate of retreat, or erosion, is not uniform, and varies locally depending upon the nature and magnitude of coastal processes operating within individual parts of the shoreline. Certain parts of the shoreline have a higher risk for further erosion. Development other than restoration measures should be sharply restricted in these areas in order to protect public safety and prevent loss of life and property.

TABLE III.B-1 (Continued)

POLICIES	RATIONALE
Overwash Areas	
Development is prohibited on Overwash Fans, except for development that has no prudent or feasible alternative in an area other than an Overwash Fan, and that will not cause significant adverse long-term impacts on the natural functioning of the beach and dune system, either individually or in combination with other existing or proposed structures, land disturbances or activities. Examples of acceptable activities are:	Overwash Areas indicate weaknesses in natural and built shore protection. Hazard has been demonstrated, often with extensive property damage. This is a natural shoreline movement process associated with storms and rising sea level and is the principal technique by which barrier islands migrate inland. Overwash Areas are unsuitable locations for further development, and public funds should not be used to rebuild damaged shore protection structures. The return of these areas to a natural state, particularly if new dune formation is promoted is, therefore, desirable.
(i) Demolition and removal of paving and structures;	
(ii) Limited, designated access ways for pedestrian and authorized motor vehicles between public streets and the beach that provide for the minimum feasible interference with the beach and dune system and are so oriented as to provide the minimum feasible threat of breaching or overtopping as a result of storm surge or wave runup;	
(iii) Limited stairs, walkways, pathways, and boardwalks to permit access across dunes to beaches, provided they cause minimum feasible interference with the beach and dune system;	
(iv) The planting of native vegetation to facilitate dune development;	
(v) Sand fencing, either a brush type barricade or a picket type, to accumulate sand and aid in dune formation;	
(vi) Shore Protection Structures which meet the Use conditions of Table III.B-2;	
(vii) Linear development which meets the Policy on Location of Linear Development; and	
(viii) Removal of newly deposited Overwash Fans from public roads or developed lots.	
Coastal Bluffs	
(i) All development on bluffs, from the waterward limit of the toe buffer to the first cultural feature, that will endanger the health, safety and welfare of people and property, is prohibited.	Coastal bluffs are most prominent in New Jersey along the Delaware River at Roebling and Florence and along the Raritan Bay at Aberdeen Township and Atlantic Highlands. They have a significant function in storm damage prevention and flood control, by eroding in response to wave action and resisting erosion caused by wind and rain runoff. Bluff erosion is also an important source of beach sediment where the coastal bluff faces and open water body. Disturbance of coastal bluffs which undermine their natural resistance to wind and rain erosion increase the risk of their collapse and cause cuts in the bluff. This increases danger to structures at the top of the bluff and reduces the bluff's ability to buffer upland areas from coastal storms. Vegetation helps stabilize bluffs and can reduce the rate of erosion caused by wind and rain runoff. A construction setback on the tableland is required to protect life and property.
(ii) All development is prohibited on the bluff face and within the crest and toe buffer areas. The stabilization of the face and buffer areas through vegetation is encouraged for the protection of the health, safety and welfare of people and property.	
(ii) Structural mitigation measures designed for the purpose of slowing bluff erosion are conditionally accepted, provided that they do not interfere with natural shoreline sediment supply.	
(iv) All development on the tableland is conditionally acceptable, based on the rate of bluff erosion. In general, structures are prohibited in areas which will be eroded during the life of the structure. If a bluff has an erosion history of five feet a year and the projected life of the structure is fifty (50) years, then the structure is prohibited within 250 feet (50 x 5) of the crest buffer. Applicants shall submit historical evidence recording bluff movement and submit.	

TABLE III.B-1 (Continued)

POLICIES	RATIONALE
Inlets	
Inlets consists of an Ocean portion and a Semi-enclosed or Back Bay portion. Development in inlets must be consistent with the General Water Area Policy for one of these water area types, and with the following policies.	Inlets play a vital role in the estuarine ecosystem. They control patterns of backbay currents, salinity and nutrient distribution and provide migratory pathways between the ocean and the back bays for marine and estuarine species.
(i) Filling is prohibited.	Submerged infrastructure is a hazard in inlets since the strong currents may expose and break the pipes or cables. There is also a possibility of anchors snagging and breaking the infrastructure.
(ii) Submerged Infrastructure is discouraged.	
Public Open Space	
(i) New or expanded public or private open space development is encouraged at locations compatible or supportive of adjacent and surrounding land uses.	As the rapid urbanization of New Jersey continues and leisure time increases, open space will play an increasingly important role in maintaining a desirable living environment for the residents of New Jersey. Even though the supply of open space has decreased under the growing pressure for development, the State's expanding population will require more public open space to satisfy its needs.
(ii) Development that adversely affects existing public open space is discouraged.	Not only is open space the basic resource for recreation facility development, it also performs other worthwhile functions. Open space can create public spaces in densely settled areas, shape urban growth, provide buffers for incompatible uses, retain contiguous farmland, insure the preservation of wildlife corridors, increase the economic value of adjacent land, and preserve distinct architectural, historic, and geologic sites.
(iii) Development within existing public open space, such as campgrounds and roads, is conditionally acceptable, provided that the development complies with the Coastal Resource and Development Policies and is consistent with the character and purpose of the public open space.	The distribution of open space should not only be centered around the preservation of unique areas, but must also respond to the needs of people. Where possible, open spaces should be contiguous both visually and physically to promote a sense of continuity and to afford users continued movement through the public open spaces.

Source: New Jersey Coastal Management Program (NJDEP/NOAA, August 1980) and Coastal Resource and Development Policies (NJDEP, DCR, June 1981).

TABLE III.B-2

NEW JERSEY COASTAL MANAGEMENT PROGRAM
COASTAL RESOURCE AND DEVELOPMENT POLICIES
USE POLICIES APPLICABLE TO THE MASTER PLAN: COASTAL ENGINEERING USES

POLICIES	RATIONALE
Shore Protection Priorities	
Non-structural solutions to shoreline erosion problems are preferred over structural solutions. The infeasibility and impracticality of a non-structural solution must be demonstrated before structural solutions may be deemed acceptable.	Past reliance on costly structural shore protection measures, such as groins and jetties to retard the longshore transport of sand by the littoral drift, and seawalls, bulkheads and revetments to prevent waves from reaching erodible materials has proven to be an inadequate and incomplete solution. Bulkheads are deteriorating. Groins are starving the natural longshore transport of sand. Man has modified and destroyed dunes that provide natural protection against storm surges. Inlets frequently develop shoals which prevent safe navigation. The natural processes along the shoreline must be carefully evaluated over reaches or regions of the coast to determine the likely long term effects of shore protection measures. Non-structural measures realistically recognize the inevitability of the ocean's advancement and the migration of barrier islands. Yet this concern must be balanced against the short term benefits of structures to protect the present intense recreational use of the narrow strip of oceanfront land in New Jersey.
Beach Nourishment	
Beach nourishment projects, as a non-structural shore protection measure, are encouraged, provided that:	Beach nourishment depends upon an adequate quantity and suitable quality of beach nourishment material, otherwise the material may quickly return to the ocean.
(i) The particle size of the fill material is compatible with the existing beach material to ensure that the new material will not be removed to a greater extent than the existing material would be by normal tidal fluctuations;	
(ii) The elevation, width, slope, and form of proposed beach nourishment project are compatible with the characteristics of the existing beach; and	
(iii) The sediment deposition will not cause unacceptable shoaling in downdrift inlets and navigation channels.	
Dune Management	
Dune restoration and maintenance projects as a non-structural shore protection measure, including sand fencing, revegetation, additions of non-toxic appropriately sized material, control of pedestrian and vehicular traffic, are encouraged.	A natural dune field provides a strong measure of natural protection for adjacent land uses.

TABLE III.B-2 (Continued)

POLICIES	RATIONALE
Structural Shore Protection	
(a) The construction of new shore protection structures, including jetties, groins, seawalls, bulkheads, and other retaining structures to retard longshore transport and/or to prevent tidal waters (waves) from reaching erodible material is acceptable only under the following conditions:	Structural solutions to shore protection are appropriate and essential at certain locations, given the existing pattern of urbanization of New Jersey's shoreline. However, the creation, repair, or removal of publicly-funded shore protection structures must serve clear and broad public purposes and must be undertaken only with a clear understanding of the regional consequences of natural shoreline sand systems. Retaining structures are acceptable in some cases because of the need to protect existing development or to allow limited appropriate new development, or mitigate or eliminate a trap formed by an existing, usually adjacent bulkhead construction at an angle of less than 90 degrees from the shoreline.
(i) The structure is essential to protect water dependent uses or heavily used public recreation beach areas in danger from tidal waters or erosion, the structure is essential to protect coastal-dependent uses, or the structure is essential to protect existing structures and infrastructure in (built-up, urban) developed shorefront areas in danger from erosion,	
(ii) The structure is designed to eliminate or mitigate adverse impacts on local shoreline sand supply,	
(iii) The structure will not create net adverse shoreline sand movement conditions downdrift, including erosion or shoaling.	
(iv) The structure will cause minimum feasible adverse impact to living marine resources, and,	
(v) The structure is consistent with the State Shore Protection Master Plan.	
(vi) If the proposed project requires filling of a Water Area it must also be consistent with the General Water Area Policy for Filling.	
(vii) The structure is designed, and will be maintained, for at least a 50-year period of intended use.	
(b) A new, short retaining structure that connects two existing lawful retaining structures is normally acceptable provided that extensive filling is not involved.	
(c) Maintenance or reconstruction of an existing retaining structure is conditionally acceptable, provided it does not result in extension of the structure by more than 18 inches in any direction. Maintenance or reconstruction of an existing retaining structure which results in extension by more than 18 inches shall be considered new construction.	
(d) Rip-rap is a preferred construction material for retaining structures as it provides a habitat for aquatic life and helps absorb wave energy.	

TABLE III.B-2 (Continued)

POLICIES	RATIONALE
Dredged Spoil Disposal	
Dredge spoil disposal is conditionally acceptable under the following conditions: (i) sediments are covered with appropriate clean material that is similar in texture to surrounding soils, and (ii) the sediments will not pollute the groundwater table by seepage, degrade surface water quality, present an objectionable odor in the vicinity of the disposal area, or degrade the landscape.	Dredge spoil disposal is an essential coastal land and water use that is linked inextricably to the coastal economy and has serious impacts on the coastal environment. Evolving State and Federal policies on protection of the marine and estuarine coastal environment have sharply limited the creation of new dredge spoil disposal areas in the past decade. Yet selective dredging must continue if inlets and navigation channels are to be maintained. The coastal policy recognizes the importance of this use of coastal resources and the need for land disposal sites.
Dredge spoil disposal is prohibited on natural undisturbed wetlands, and on formerly spoiled wetlands that have revegetated with wetland species.	
The use of uncontaminated dredge material of appropriate quality and particle size for beach nourishment is encouraged. Creation of useful materials such as bricks and light weight aggregate from the dredge material is encouraged.	Use of inefficient equipment and methods in the movement of dredge spoils, and resulting spillage of fuels, emission of toxic or noxious gases, loss of dredged materials, and noise and vibrations produced by faulty or worn out equipment and machinery may cause water pollution, air pollution and discomfort both for the crews and for the human population along the disposal route and in nearby areas.
The use of uncontaminated dredge material for purposes such as restoring landscape, enhancing farming areas, creating recreation oriented landfill sites including beach protection and general land reclamation, building islands, creating marshes, capping contaminated spoil areas, and making new wildlife habitats is encouraged.	
Effects associated with the transfer of the dredged materials from the dredging site ot the disposal site shall be minimized to the maximum extent feasible.	
Sand and gravel mining for mineral extraction or beach nourishment is conditionally acceptable in the deep ocean and inlets providing that:	
(i) areas of finfish and shellfish concentration are neither directly or indirectly degraded,	
(ii) the physical and chemical impacts associated with turbidity and release of toxic agents from substrate layers are minimized to the maximum extent practicable, and adhere to applicable water quality standards, and	
(iii) the visual impact of dredging machinery from shore areas is acceptable.	

Source: New Jersey Coastal Management Program (NJDEP/NOAA, August 1980) and Coastal Resource and Development Policies (NJDEP, DCR, June 1981).

TABLE III.B-3

NEW JERSEY COASTAL MANAGEMENT PROGRAM
COASTAL RESOURCE AND DEVELOPMENT POLICIES
RESOURCES POLICIES APPLICABLE TO THE MASTER PLAN

POLICIES	RATIONALE
Marine fish and Fisheries	
Actions are conditionally acceptable to the extent that minimal feasible interference is caused to the natural functioning and migratory patterns of estuarine and marine estuarine dependent species of finfish and shellfish.	Finfish (freshwater, estuarine, and marine) and shellfish resources provide significant recreation experiences for residents of New Jersey and interstate visitors. These resources also help the State's economy, by leading to expenditures of approximately $375.8 million per year, with fishing yielding approximately $217.2 million and shellfishing yielding $158.6 million. DEP also estimates that 1,868,000 people participated in marine/estuarine recreational fishing in 1976 in New Jersey. Commercial landings for all finfish and shellfish in New Jersey during 1978 were 163,603,000 lbs., valued at $44.35 million dockside and an estimated $110.9 million retail value, according to Department of Commerce statistics. The 1956 landings of 540 million pounds of all finfish and shellfish indicate the true potential of this industry. Interference with fish resources includes blockage of anadromous finfish spawning runs, reduction in the critical capacity of estuaries to function as finfish nursery areas, reduction of summer dissolved oxygen level below 4 ppm stimulating anoxic phytoplankton blooms, introduction of heavy metals or other toxic agents into coastal water, rise in ambient water temperature regime especially during summer and fall periods, unacceptable increases in turbidity levels, siltation, or resuspension of toxic agents, and introduction of untreated effluents from domestic and industrial sources.
Shellfisheries	
Any development which would result in the destruction of a potentially productive shellfish area is discouraged. Any development which would result in the contamination or condemnation of a potentially productive shellfish area is prohibited. Water dependent development which requires new dredging in these areas is discouraged. Maintenance dredging in these areas is conditionally acceptable. Any project which would discharge untreated or improperly treated domestic or industrial waste waters or toxic or hazardous substances directly into waters so as to adversely affects a potentially productive shellfishing area is prohibited.	Estuarine shellfish are harvested by both commercial and recreational fishermen, with the sport group concentrating on hard clams. Oysters, bay scallops and soft clams are predominantly commercial species. Commercial dockside landing values in New Jersey for 1978 were $3.43 million for estuarine mollusks, with an estimated retail industry value of $8.7 million. The commercial harvest is estimated to support employment of 1,500 persons in fishing, distribution, processing, and retail. Sport clammers numbered 17,000 in 1976. In addition to direct human consumption, shellfish play an important role in the overall ecology of the estuary. Young clams are important forage foods for a variety of finfish such as winter flounder, and crabs and migratory waterfowl, especially the diving species. Hard clams are widely distributed in New Jersey's coastal estuaries, inhabiting most waters where the salinity is about 15 parts per thousand or greater. Suitable bottom substrate and dissolved oxygen are also important determining factors. Hard clams usually recolonize areas that are dredged, provided that anoxic conditions are not present. Water presently condemned for shellfishing may not be directly or immediately important to human economics. These areas, however, serve for restocking fishable areas through production of motile larvae. Shellfish in condemned waters also are not lot of estuarine ecological food-webs, but serve as a food source to other species of wildlife.

TABLE III.B-3 (Continued)

POLICIES	RATIONALE
Vegetation	
Coastal development shall preserve, to the maximum extent practicable, existing vegetation within a development site. Coastal development shall plant new vegetation, particularly appropriate native coastal species, to the maximum extent practicable.	The steady loss of vegetation is a nearly inevitable result of urbanization. Terrestrial vegetation stabilizes soil, retards erosion and runoff, promotes infiltration of surface water, reduces the force of wind, provides foods, shelter and breeding sites for wildlife, and adds to aesthetic values for recreation and domestic life. Trees release life-giving oxygen, filter particulate pollutants, provide foods and fuel, with no energy input necessary by man. Because each site is unique, the degree of vegetative preservation required will depend upon the environmental conditions within and adjacent to the development site. In general, the greater the intensity of development permitted, the less vegetation preservation required. "Appropriate native coastal species" means that species selection must reflect the natural physiological limitations of species to survive in distinct habitats, which include all environmental processes (natural and artificial) that operate within a site. Non-suitable species plantings will do poorly or die, if preserved through an intensive maintenance program of 'pH' adjustment fertilization and irrigation, will cause unacceptable ground and surface water impacts. New vegetative plantings should reflect regional geophysical suitability. Illustrative appropriate species for Barrier Beach Sites include plants tolerant of salt spray and occasional saline flooding, such as American holly, red cedar, black cherry, beach plum, beach grass, bayberry, beach heather, etc.
Wildlife	
Coastal development which does not incorporate management techniques which minimize disturbance to important wildlife habitats, is discouraged. Development that would significantly restrict the movement of wildlife through the site to adjacent habitats and open space areas is discouraged.	Important Wildlife Habitats are areas that provide primary productivity or primary habitat for a wide range of game and non-game species. Depletion of this resource would cause a general population decline of species that are not rare or endangered. Wildlife is an important natural resource of the coast. Desirable on-site wildlife management techniques which could mitigate adverse impacts, and favor minimal feasible interference include preservation and dedication to open space of senstive habitats of sufficient width, especially along drainageways and waterways, to preserve wildlife movement corridors, placement of nesting boxes, and planting of vegetative wildlife food species.

TABLE III.B-3 (Continued)

POLICIES	RATIONALE
Flood Hazard Areas	
(a) Dedication of undeveloped flood hazard areas for purposes of public open space is encouraged, especially where such areas are designated to the New Jersey Wild and Scenic Rivers System.	Past development of lands susceptible to flooding in New Jersey has led to flood damages, with sometimes tragic social, economic and ecological consequences. Intensive development of Flood Hazard Areas leads to increased runoff, reduction in flood storage capacity, increased size and frequency of downstream flooding, erosion of stream banks and downstream deposition of sediments with consequent reduction in estuarine productivity. Flood plains serve as important wildlife habitat for endangered and threatened species, game and fur-bearing species, and rare species of vegetation. Flood Hazard Areas can also be key elements in the creation of stream corridor-oriented open space, hiking or cycling trails, and passive recreation areas.
(b) Certain land uses are prohibited, under the Flood Hazard Area Control Act and rules, in the floodway portion of fluvial flood hazard areas, inlcuding uses such as placing, depositing, or dumping solid wastes on the delineated floodways; processing, storing or disposal of pesticides, domestic or industrial wastes, radioactive materials, petroleum products or hazardous materials; erection of structures for occupancy by humans or livestock or kennels for boarding of domestic pets; storage of materials or equipment or construction of septic tanks for residential or commercial use (see N.J.A.C. 7:13-1.2 et seq.). Not affected by this policy are hazard-free activities such as recreation, agriculture, soil conservation projects and similar uses which are not likely to cause obstructions, undue pollution, or intensify flooding. According to N.J.A.C. 7:13-1.4(c), any lawful, pre-existing prohibited uses may be maintained in a delineated floodway provided, that if expanded or enlarged, they do not increase the flood damage potential. Property owners in delineated floodways may rebuild damaged structures, providing that any expansion or enlargement will not increase the flood damage potential.	
(c) Most land uses are also regulated, under the State Flood Hazard Area Control Act and rules, in the fluvial flood fringe. Structures for occupancy by humans are conditionally acceptable provided that: the first habitats elevation is one foot above the 100 year flood prone line established by HUD Flood Insurance Maps, and the structure will not increase flood damage potential, by obstructing flood waters.	
(d) Construction acceptable in flood hazard areas must conform with applicable flood hazard reduction standards, as adopted by the Federal Insurance Administration in HUD (Federal Register, Vol. 41, No. 207, Part II, October 26, 1976), as amended.	
(e) In river areas designated as components of the New Jersey Wild and Scenic Rivers System, land uses are regulated or prohibited in accordance with N.J.A.C. 7:38-1.1 et seq. including special regulations adopted for a particular river, or sections thereof, upon designation to the system.	
Secondary Impacts	
Coastal development that induces further development shall demonstrate, to the maximum extent practicable, that the secondary impacts of the development will satisfy the Coastal Resource and Development Policies. The level of detail and areas of emphasis of the secondary impact analysis are expected to vary depending upon the type of development. Minor projects may not even require such an analysis. Transportation and wastewater treatment systems are the principal types of development that require a secondary impact analysis, but major industrial, energy, commercial, residential, and other projects may also require a rigorous secondary impact analysis.	Further development stimulated by new development and the cumulative effects of coastal development, including development not directly managed by DEP, may gradually adversely affect the coastal environment. The capacity of existing infrastructure does, however, limit the amount and geographic extent of possible additional development. Secondary impact analysis, particularly of proposed infrastructure, enables DEP to ascertain that the direct, short term effects, and the indirect or secondary effects of a proposed development will be consistent with the basic objectives of the Coastal Management Program. Secondary impact analysis enables DEP to evaluate likely cumulative impacts in the course of decision-making on specific projects.

TABLE III.B-3 (Continued)

POLICIES	RATIONALE
Public Access to the Shorefront	
Coastal development adjacent to all coastal waters, including both natural and built-up waterfront areas, shall provide perpendicular and linear access to the waterfront to the maximum extent practicable, including both visual and physical access. Shorefront development that limits public access and the diversity of shorefront experiences is discouraged.	New Jersey's coastal waters and adjacent shorelands are valuable public resources which are limited in area. They are protected by New Jersey's Shore Protection and Waterway Maintenance Program and patrolled by the New Jersey Marine Police which are both financed by all state residents. Past developments have often blocked the waters from public view and/or made physical access to the waterfront difficult or impossible. In addition, some municipalities which own land immediately inland of the state-owned riparian land have enacted laws or regulations making waterfront access inconvenient, expensive or impossible for non-residents. These policies have served to limit the opportunity of inland residents for waterfront recreational activities.
All development adjacent to water shall, to the maximum extent practicable, provide, within its site boundary, a linear waterfront strip accessible to the public. If there is a linear waterfront path on either side of the site, and the use, due to operation or security reasons, cannot allow continuation of passage along the water's edge, a pathway around the site must be designed that connects to the other parts, or potential parts of the waterfront path system in adjacent parcels.	Projects such as the experimental Beach Shuttle operated by DEP since 1977 to Island Beach State Park from Toms River serve to carry out the policy of providing maximum practical public access to the shorefront.
Municipalities or private development that do not currently provide, or have active plans to provide, access to the water will not be eligible for Green Acres or Shore Protection Bond funding.	The basis for the Shorefront Access policy came in part from the research in the report entitled Public Access to the Oceanfront Beaches: A Report to the Governor and the Legislature of New Jersey, April 1977, prepared in part by DEP-OCZM.
	The developed waterfront, due to its past industrial utilization, has been closed to the people that live adjacent to the waterfront. DEP intends to promote a horizontal network of open space at the water which could be visualized as a narrow strip used for walking, jogging, bicycling, sitting, or viewing, which is continuous, even if the path must detour around existing or proposed industry due to security needs or the lack of pre-existing access. The path or strip will connect existing and interseet with future waterfront parks, open space areas, and commercial acitivities. The goal of this policy is the piecing together of a system that will provide continuous linkages and access along the entire waterfront.
Public Services	
Coastal actions shall insure, to the maximum extent practicable, that adequate levels of public services will be provided to meet the additional demands for public services likely to be generated by the proposed development.	New development places additional demands on public services. Unless the existing supply can satisfy these demands or extensions to the supply can be available when development is complete, the deficiencies may adversely affect the health, safety, or welfare of the proposed new users.
	In coastal areas there are special problems associated with the high seasonal population fluctuation and the relatively high percentage of senior citizens who typically make greater demands on health services. These coastal issues make the demonstration of adequate service supply during peak demand periods an especially critical issue.

Source: New Jersey Coastal Management Program (NJDEP/NOAA, August 1980).
Coastal Resource and Development Policies (NJDEP, DCR, June 1981).

The State through its Green Acres Administration has, since 1961, been assisting its counties and municipalities in the acquisition of tracts of land for open space. A list of oceanfront lands acquired under the Green Acres Program is presented in Table III.B-4. Green Acres local grant funds are generally matched on a 50-50 basis with county and municipal funds. Funds are also available for State acquisition of open space and recreational lands.

The principal sources of funds for open space acquisition and recreation facility development at present, are the 1974 Green Acres and Recreation Opportunities Bond Act and the Federal Land and Water Conservation Fund Program. As of July 1, 1977, over $73.4 million of the $200 million authorized by the 1974 Green Acres bond referendum has been committed to specific projects (NJDEP, 1977). In 1978, an additional $200 million Green Acres Bond Issue passed by referendum, with $100 million earmarked for urban areas.

Other potential sources of Federal funds for shore recreation projects include the Public Works Program and Community Development Funds. Together, these programs have already stimulated millions of dollars worth of recreational development throughout the State. However, open space purchases and recreational development have been predominantly inland. As shown in Table III.B-4, only 139 acres of oceanfront property had been purchased under the Green Acres Program as of July 1981.

The private sector is also a major supplier of recreation opportunities in New Jersey. It is anticipated that private investment in recreation facilities and open space will represent a significant portion of the future recreation-related expenditures to occur in the State.

TABLE III.B-4

GREEN ACRES LOCAL ASSISTANCE PROGRAM
OCEAN FRONT ACQUISITION PROJECTS* BY COUNTY

	Acres
Cape May County	
Cape May Point Borough	11.8
Sea Isle City	31.8
Wildwood Crest	10.2
Monmouth County	
Monmouth County, Seven Presidents Parks, Long Branch	33.2
Ocean County	
Beach Haven Borough	4.5
Berkeley Township	2.0
Dover Township	9.4
Long Beach Township	4.6
Seaside Park Borough	31.4
TOTAL	138.9

*Approved as of July 1981.

Source: Provided by NJDEP, Office of Green Acres, July 1981.

C. FEDERAL PROGRAMS AND POLICIES

1. Federal Programs and Policies Relevant to Shore Protection, Coastal Development, and Resource Use.

Numerous Federal programs and policies influence the degree and extent of shore protection, coastal development, and resource use — sometimes without regard to possible conflict. The most important programs include those administered by the U.S. Army Corps of Engineers and others dealing with National Flood Insurance, and Federal Disaster Relief. A detailed discussion of each of these programs and the related policies are presented in this section. Other Federal programs relevant to coastal development and preservation are also summarized in this section. New direction in Federal polices on shore protection are discussed in Section C.2.

a. U.S. Army Corps of Engineers Programs

Three activities carried out by the U.S. Army Corps of Engineers — shoreline protection, regulatory functions (permits), and navigational dredging — greatly influence shore protection, coastal development, and resource use. Authority for these programs is found in the Rivers and Harbors Act of 1899, the Flood Control Act of 1941, and certain terms of the Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977.

(1) Shore Protection Programs

(a) General. Prior to 1930, Federal interest in shore problems was limited to the protection of Federal property and navigation improvements. Beginning in that year, a series of laws was passed by Congress which gave Federal agencies a broader role in studying and mitigating shore problems around the nation. A summary of pertinent Federal statutes concerning shore protection is provided in Table III.C-1. Under these various legislative authorities, the Corps of Engineers currently researches the causes of beach erosion, investigates and studies specific shore erosion problems, and constructs — or in certain cases, reimburses local and state governments for construction of — shore protection and beach restoration projects.

The legislation listed in Table III.C-1 states the conditions for, and extent of, Federal participation in shore erosion control, which is best summarized in the Shore Protection Program (USACOE, 1971).

> Basically, it relates Federal participation to public benefit and requires the active participation of the sponsoring local interests. Under this concept, Federal participation is greatest where the protected shore areas are publicly owned and appropriate facilities to encourage full public use are provided. As much as 70 percent of the construction cost can be borne by the Federal Government in such cases. At the opposite end of the scale, where the protected shore area is privately owned and there is no public use, no Federal funds can be provided. Between these extremes, Federal participation in providing protection is proportional to public use and benefit. The remaining costs are borne by the sponsoring local interests. Additionally, local interests are normally required to provide all

TABLE III.C-1

PERTINENT FEDERAL STATUTES CONCERNING SHORE PROTECTION

Statute or Policy	Program Affected	Pertinent Regulatory Effect
Pre 1930	Shore Erosion Control	o An advisory board on sand movement and beach erosion appointed by the Chief of Engineers was the principal instrumentality of the Federal Government in shore erosion control. Federal interest was limited to protection of Federal property.
River and Harbor Act of 1930 P.L. 71-520 Amended by P.L. 79-166 P.L. 79-727	Shore Erosion Control	o Federal Government assumed a broader role in shore protection. o Congress authorized creation of the Beach Erosion Board. The Board was empowered to make studies of beach erosion problems at the request of, and in cooperation with, cities, counties, or states. The Federal Government bore up to half the cost of each study, but did not bear any construction costs unless federally owned property was involved.
River and Harbor Act of 1935 P.L. 74-409	Shore Erosion Studies	o Section 5 Required that reports to Congress regarding studies and surveys for improvement of river mouths or inlets include information concerning the configuration of the shoreline and probable erosional or accretional effects to adjacent areas that may be expected to result from the improvement.
Flood Control Act of 1936 P.L. 74-738 Amended by P.L. 75-761 P.L. 77-228	Emergency Assistance	o Specified local requirement for emergency flood control and dictated greater. use of nonstructural alternatives.
Flood Control Act of 1938 P.L. 75-761	Shore Erosion Control	o Section 3 Authorized assistance to evacuate or relocate properties from high hazard flood areas in lieu of structural mitigation where appropriate.
Flood Control Act of 1941 P.L. 77-228 Amended by P.L. 84-95 P.L. 87-874 P.L. 93-251	General Assistance	o Authorized operation and maintenance for flood control and allied purposes under jurisdiction of the Army Crops of Engineers.
River and Harbor Act of 1945 P.L. 79-166 Amends P.L. 71-520	Shore Erosion Studies	o Section 2, 3 and 4 Further empowered Beach Erosion Board to study shore erosion problems and determine suitable methods for protection, restoration, and development of beaches and to publish results including opinions and recommendations regarding project adoption, degree of public interest, and Federal cost share.
Flood Control Act of 1946 P.L. 79-526 Amended by P.L. 93-251	Emergency Assistance	o Section 14 Provided authority to the Corps of Engineers to undertake emergency measures to prevent erosion damages to highways, bridge approaches, public works, and nonprofit public facilities

TABLE III.C-1 (Continued)

Statute or Policy	Program Affected	Pertinent Regulatory Effect
River and Harbor Act of 1946 P.L. 79-727 Amends P.L. 71-520 Amended by P.L. 84-826 P.L. 87-874 P.L. 89-298 P.L. 91-611	Shore Erosion Control	o Section 1 Corps of Engineers given additional authority in construction, but not maintenance, of works for restoration and protection against shore erosion by waves and currents of publicly owned shores. Also outlines specific cost-sharing rules for Federal participation in construction of projects where state and local publicly owned and Federal shores are protected (Refer to Table D-3 for current cost-sharing guidelines).
Federal Disaster Act of 1950 P.L. 81-875 As Amended by P.L. 82-107 P.L. 83-134 P.L. 87-502	Emergency Assistance	o Authorized Federal agencies, when directed by the President in any major disaster, to provide assistance to states by performing on public or private lands protective and other works essential for preservation of life and property, clearing debris wreckage, making emergency repairs to and temporary replacement of public facilities damaged or destroyed.
Flood Control Act of 1955 P.L. 84-71	Hurricane Studies	o Authorized the Corps to conduct general investigations of the eastern and southern seaboards of the United States with respect to hurricanes to identify problem areas and to determine the feasibility of hurricane protection. No cost-sharing limit specified.
Flood Control Act of 1955 P.L. 84-99 Amended by P.L. 87-874 P.L. 91-606 P.L. 93-251	Emergency Assistance	o Corps authorized to assist in flood emergency preparation in flood fighting and rescue operations, or in the emergency repair or restoration of any Federal flood control work threatened or destroyed by flood.
River and Harbor Act of 1956 P.L. 84-826 Amends P.L. 79-727	Shore Erosion Control	o Authorized Federal assistance in projects to protect and restore private property where such action is incidental to protect nearby publicly owned shores or if such protection could result in public benefits. o Provided for Federal assistance for periodic nourishment on the same basis as new construction, for a period specified by the Corps (usually 10 years), when it could be the most economic remedial measure. o Accordingly, Federal participation is limited to restoration of 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.
Flood Control Act of 1958 P.L. 85-500	Hurricane Protection	o Section 203 Established precedent for cost sharing on hurricane protection by limiting the Federal share to a maximum of 70 percent. (In 1978 the President proposed that the cost sharing for this type of project be modified to require a local interest contribution equal to 20 percent of the project investment cost instead of the traditional 30 percent.)

TABLE III.C-1 (Continued)

Statute or Policy	Program Affected	Pertinent Regulatory Effect
River and Harbor Act of 1962 P.L. 87-874 Amends P.L. 79-727	Shore Erosion Control	Section 103 o Under special cases increased the proportion of construction costs borne by the Federal Government for publicly owned shore parks and conservation areas to a maximum of 70 percent. o Made the total cost of pre-authorization surveys a Federal responsibility. o Introduced multi-purpose concept in shore protection studies by providing for surveys in the interest of shore erosion control, hurricane protection, and related purposes. Generally the cost associated with each purpose is apportioned in accordance with applicable laws and policies. o This legislation as amended provides for construction of small shore and beach restoration and protection projects not specifically authorized by Congress, when, in the opinion of the Chief of Engineers, such work is advisable and when the Federal share on such projects does not exceed $1 million. The same cost-sharing rules apply to these small projects as to the larger projects which require specific authorization by Congress.
Amends P.L. 84-99	Emergency Assistance	o Section 206 Provided authority for emergency shore protection of federally authorized and constructed hurricane and shore protection works being threatened and for repair or restoration of Federal authorized and constructed hurricane or shore protection structures damaged or destroyed by extraordinary wind, wave, or water action. Emergency actions are authorized when, at the descretion of the Chief of Engineers, such action is warranted, and then only to the extent necessary to ensure the adequate functioning of a project to protect imminent and substantial loss of life and property.
River and Harbor Act of 1963 P.L. 88-172	Shore Erosion Control	o 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.
River and Harbor Act of 1968 P.L. 90-483 Amends P.L. 87-874	Shore Erosion Studies	o Section 106 Charged the Chief of Engineers with the task of minimizing erosion damage by requiring the Corps to study and report on the condition of the Nation's shorelines and to develop suitable means to restore, protect, and manage them effectively. In August 1971, 3 years after the enactment of this legislation, the Corps issued its Report on the National Shoreline Study.
	Shore Erosion Control	o Section 111 Provided authorization to "...investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works." Projects whose cost is limited to $1 million or less do not require Congressional approval when such work is performed. o The Federal Government bears the entire cost of installing, operating, and maintaining such projects. This authority applies to both public and privately owned shores damaged by Federal navigation projects. o Exercise of the Section 111 authority to provide mitigation measures at Federal expense is not mandatory. o Section 215 Permits local interests to expedite construction of authorized projects for which Federal funds are not immediately available. Under certain circumstances, local interests proceed with construction at their own expense; the Federal share of the cost of that construction can be reimbursed from later appropriations. Such reimbursement cannot exceed $1 million.

TABLE III.C-1 (Continued)

Statute or Policy	Program Affected	Pertinent Regulatory Effect
Disaster Relief Act of 1970 P.L. 91-606 Amends P.L. 84-99	Emergency Assistance	o Authorized Corps to provide emergency shore restoration even where there has been no federally authorized project. The authority only applies when the President has declared the event a major disaster.
Flood Control Act of 1970 P.L. 91-611 Amends P.L. 79-727 Supplements P.L. 87-874	Hurricane and Multi-Purpose Protection	o Section 208 o Authorized 70 percent cost sharing for projects including hurricane protection and for multi-purpose projects to be used at the discretion of the Secretary of the Army.
Water Resources Development Act of 1974 (Shore Erosion Control Demonstration Act) P.L. 93-251 Amends P.L. 77-228 P.L. 77-526	Shore Erosion Control	o Section 9 o Clarified the requirement that as a condition of project authorization, local interests must hold and save the United States free from damages due to construction. The law states that such a requirement does not include damages due to the fault or negligence of the United States or the contractors. While the Government may be liable for damages resulting from the negligence of an employee, no recovery is allowable resulting from the exercise of a discretionary function by a Government official. o Section 54 Authorized a national shoreline erosion control demonstration program to demonstrate low-cost methods of controlling erosion at selected sheltered shoreline areas and establishment of a Shoreline Erosion Advisory Panel. Provisions provide for a 5-year program. o Section 55 Authorized the Secretary of the Army, acting through the Chief of Engineers, to provide technical and engineering assistance to non-Federal public interests in developing structural and nonstructural methods of preventing damages attributable to shore and streambank erosion.
Disaster Relief Act of 1974 P.L. 93-288 Amends P.L. 91-606	Emergency Assistance	o Section 201 Authorized Federal technical assistance and grants to states on developing comprehensive disaster plans and programs, to include hazard reduction, avoidance, and mitigation. o Authorized emergency services for shore protection assistance to supplement the efforts and available resources of state and local governments and private relief organizations. o Section 401 Authorized the repair, reconstruction, or replacement of any facility owned by the United States which is damaged or destroyed by any major disaster. o Section 406 Recommended diminishing the presence of damageable property in hazard areas rather than promoting its increase.
River and Harbor Act of 1976 P.L. 94-587 Amends P.L. 79-727	Shore Erosion Control	o Section 156 Allows extension of the period authorized for Federal participation in periodic beach nourishment (sand replenishment) to 15 years after date of construction, if appropriate.

necessary lands, easements, and rights-of-way, hold and save the United States free from claims for damages, prevent water pollution which would affect the health of the bathers, maintain the completed works, and assure continued public use of the protected area. Other legislation provides that the Federal Government bear the entire cost of protecting federally owned shore areas and of mitigating or preventing shore damages attributable to Federal navigational works.

The general intent of existing Federal legislation is to prevent or control shore erosion caused by wind- and tide-generated waves and currents along the nation's shores and beaches. The Corps' present strategy for dealing with shore erosion includes reconstructing eroded beaches and dunes by nourishment with sand dredged from backbays, inlets, and offshore sources, and stabilizing the beach fill with groins. These measures are designed to protect specific areas against normal erosion processes rather than the severe 100- or 200-year storm. Development of the coastal zone for resort and recreation has resulted in many Corps navigation projects involving inlet stabilization. These projects have, in some cases, contributed to shore erosion problems.

Generally, the Federal Government's responsibility for shoreline erosion protection is limited to publicly owned land areas to which the general public is granted access. Limited Federal cost sharing is also available to protect private property if a project is required to complete a protective measure for other publicly owned lands or results in substantial public benefits. Public benefits may include recreational use and prevention of land loss or damage to public facilities — such as boardwalks, buildings, highways, and parks — and enhancement of property values and prevention of loss of historic or scenic aspects of the environment. Where public benefits accrue mostly in the form of recreational use, the Federal share varies directly with the degree of public use. Benefits are measured as the differences in these values under conditions expected with and without the contemplated control measures.

The Federal Government is not normally held responsible for damages incidental to shore protection works or activities. Usually, as a precondition of project authorization, local interests are required to hold and save the United States free from damages due to construction, operation, and maintenance of the project works. The Chief of Engineers does, however, have discretionary authority under certain conditions to provide remedial work to correct certain adverse conditions resulting directly from a shore protection project.

The Corps is authorized to investigate and construct, operate, and maintain projects, at full Federal expense, for the prevention or mitigation of shore damages attributable to Federal navigation works. The authority to provide mitigation (P.L.90-483) at Federal expense is not mandatory, however. Where such projects are undertaken, the degree of mitigation is normally dependent on a reduction of erosion or accretion only to the level which would be attained without the influence of the navigation works at the time the works were accepted as a Federal responsibility. The damaged shorelines need not be restored to historic dimensions; rather, the work is usually performed to lessen the existing damage or prevent subsequent damage. Federal shore erosion control legislation does <u>not</u> authorize:

- Correction or erosion at upstream locations caused by streamflow.

- o Restoration of damaged beaches by extension beyond their historic shoreline unless required for protection of upland areas.

- o Funding of shore protection devices for limitation of use to specific segments of the population, such as local residents, or similar restrictions on outside visitors, directly or indirectly.

In addition to the shore erosion control program described above, the Corps also provides programs for hurricane and emergency coastal storm and flood protection. The Federal interest in shore projects to protect against hurricanes or abnormal tidal damage from coastal storms is not well defined by legislation. Congressional authorization for Corps construction of such projects on a case-by-case basis has essentially established the Federal policy. Hurricane-related projects generally provide the same kind of protection in the same areas as erosion control projects – differing primarily in the degree of protection. In addition, new protection of areas that have generally not been protected under shore erosion control programs is often provided. Both programs benefit public recreation and protect against storms, but hurricane protection offers a greater degree of safety.

Emergency shore protection involves restoration and repair of existing federally authorized shore protection structures, whereas shore erosion control and hurricane programs are for new work. Emergency restoration of hurricane or shore erosion protection structures, under P.L. 84-99, is not a program under which non-Federal interests can substitute shore erosion control or hurricane protection programs.

Under P.L. 84-99, as amended, the Corps does not have any authority for the emergency protection of non-Federal works being threatened or the repair or restoration of such works damaged by a storm. This does not, however, preclude the Corps from furnishing emergency flood-fighting assistance during a storm, including strengthening project features where preservation of a federally constructed project is threatened. Emergency shore protection is usually for the rehabilitation or restoration of damaged Federal projects already constructed under one of the other two shore protection programs.

Under authority provided by the Disaster Relief Acts of 1970 and 1974 (P.L. 91-606 and P.L. 93-288), the Corps can provide shore restoration where there has been no federally authorized project if the President has declared the damaging storm event a major disaster.

With the Presidential major disaster declaration following the great storm of March, 1962, the Corps participated in emergency assistance including inspection, damage and soil surveys, and construction. A brief description of the construction work for emergency shore protection and rehabilitation, together with estimated Federal costs (at 1962 price level) of major work, is included in Table III.C-2. The work was funded in part by the Corps, under the authorization of the Federal Disaster Act of 1950 (P.L. 81-875) which was later amended by the Disaster Relief Act of 1970 (P.L. 91-606) and the Disaster Relief Act of 1974 (P.L. 93-288). The only work performed in New Jersey under P.L. 84-99 after the March 1962 storm was the rehabilitation of the Federal flood protection dike at Gibbstown, Greenwich Township, on the Delaware River (USACOE, Philadelphia District, August 1963).

The Corps of Engineers has been investigating methods of shore protection since 1930. Continuing investigations by the Corps' Coastal Engineering Research

TABLE III.C-2

MAJOR CORPS EMERGENCY SHORE PROTECTION AND REHABILITATION FOLLOWING MARCH 1962 STORM
(1962 Price Levels)

Location	Total Cost	Work Performed
East Keansburg	$50,000	An emergency beach rehabilitation project was started in this community on August 21 and completed on September 26, 1962. Approximately 60,000 cubic yards of sand fill was placed along a beach front of about 1500 feet.
Keansburg	$60,000	Placement of an emergency sand fill on the beach at this locality commenced on August 20 and was completed on September 11, 1962. About 60,000 cubic yards of material was place along a 3000-foot stretch of beach.
Sea Bright to Monmouth Beach	$1,350,000	This major beach rehabilitation project required 1,440,000 cubic yards of sand fill along a section of beach totalling about 5 miles. The project was begun early in April 1962 and was completed in January 1963.
Harvey Cedars – Loveladies Area	$585,000	Emergency work to plug four major breaches in the barrier beach was started on March 9 and completed on March 11, 1962. While 3.6 miles of emergency sand dunes were being constructed, a storm on March 21-22 eroded 30 to 40 percent of the completed work. The dunes were finally constructed on May 31, 1962.
Brigantine – Absecon Inlet	$507,000	Construction of over 3.3 miles of emergency sand dunes and beach fill was completed on August 15. In addition, placement of 353 feet of timber bulkhead was completed on August 4. Construction of over 3.3 miles of sand fence was completed on August 30, 1962.
Sea Isle City	$1,052,600	Major breaches in the barrier beach were plugged promptly after the storm. Over 6.6 miles of emergency sand dunes were completed by September 1, 1962.
Cape May Area	$365,000	Over 1.5 miles of emergency sand dunes were completed by August 15, 1962. In addition approximately 1.7 miles of sand fence was erected.

Source: USACOE, North Atlantic Division (1967).

Center (CERC) contribute to understanding of the physical phenomena, principles, techniques, and procedures related to the protection and restoration of our beaches and shores. The results of much of the CERC research are published and widely distributed. Annotated bibliographies of CERC publications have been published by Szuwalski (1978 and 1979). Many of the pertinent CERC publications are listed in the Bibliography of this volume.

(b) Program Requirements and Cost Sharing. All shore protection projects must demonstrate positive net benefits to be eligible for Federal assistance. A summary of existing cost-sharing rules and program requirements for shore erosion control and hurricane and emergency coastal storm and flood protection are provided below. A more detailed treatment of cost sharing for shore protection is provided by Marshall (1974).

The Corps' participation in shore protection and beach restoration projects can be basically categorized into two programs. The first includes those projects for which individual authorization by Congress is not required. This category of projects is limited to those for which the Federal share of construction cost will not exceed $1 million. If the project is proposed to control erosion attributable to Federal navigation works, mitigating measures costing not more than $1 million can be constructed entirely with Federal funds.

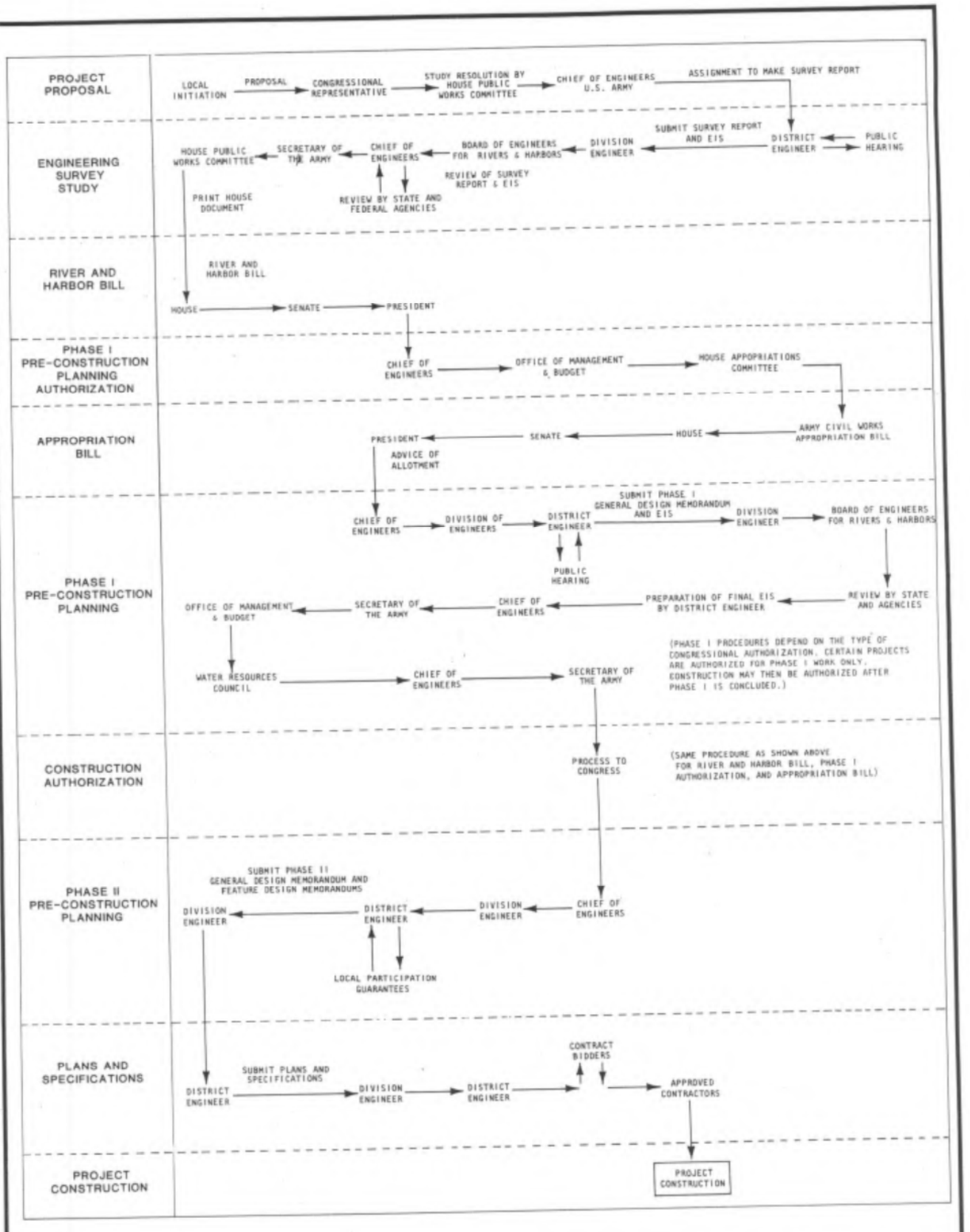
The second category of projects includes those for which the Federal share of construction cost will exceed $1 million. These projects require individual authorization by Congress. The general procedures for Federal participation are presented schematically in Figure III.C-1, beginning with the local request for help.

The Federal law places limitations on the Corps' financial participation in a project depending on whether it is for beach erosion control, hurricane and flood protection, or emergency protection. The Corps' financial participation in shoreline protection projects, where the Federal cost share exceeds $1 million, is presented in Table III.C-3 which shows the maximum Federal shares to be paid under different programs and for different categories of shore-front ownership, with varying degrees of public benefits or use. Under the same participation terms, the Chief of Engineers, in conjunction with the Secretary of the Army, can also approve Corps participation in authorized beach erosion control projects when the total cost of a project does not exceed $1 million. Traditional Federal cost-sharing programs are described below.

o Shore Erosion Control. Federal participation in any shore erosion control project is based on shore ownership, use, and type of benefits. In accordance with policy set forth in legislation discussed in this section, an applicant for aid must demonstrate public ownership or public use to be eligible for assistance. As indicated in Table III.C-3, the maximum Federal share of construction costs varies from 0 to 70 percent for shore erosion control projects depending on the category of ownership of shore frontage and the degrees of public benefits and use.

Prior to Corps of Engineers participation in funding construction of any authorized erosion control project, the project cosponsors (State of New Jersey and local agencies) must also agree to the following terms:

- Contribute in cash the non-Federal share of the first cost of any construction, maintenance of jetties and groins, and periodic nourishment to be accomplished by the Corps of Engineers.



PROCEDURES FOR FEDERAL PARTICIPATION IN SHORE PROTECTION PROJECT

SOURCE: USACOE, PHILADELPHIA DISTRICT, MAY 1980

DAMES & MOORE

FIGURE III.C-1

TABLE III.C-3
TRADITIONAL COST SHARES (PERCENTAGES) FOR THE CORPS' SHORE PROTECTION PROGRAMS

Program/Ownership and Use Category		Percentage of Costs: Construction[a] — Maximum Federal Cost Shares	Construction[a] — Non-Federal Shares	Lands, Easements, and Rights-of-Way	Operation and Maintenance	Preauthorization Surveys
Shore Erosion Control						
I	Federally owned[b]	100	0	100	100	100
II	Publicly owned, non-Federal parks and conservation areas	70	30	0	0[c]	100
III	Publicly owned, non-Federal shores other than parks and conservation areas	50	50	0	0[c]	100
IV	Privately owned – publicly used will result in public benefits	50[d]	50[d]	0	0[c]	100
V	Privately owned; protection will not result in public benefits susceptible of evaluation	0	100	0	0	0
Hurricane and Abnormal Tidal Protection						
	Single purpose	70	30[e]	0[e]	0[f]	100
	Combined with beach erosion control	70[f]	30[f]	0	0[c]	100
Emergency Protection		100	0[g]	0[g]	0[g]	100
	Mitigation of damages caused by navigation projects	100	0	100	100	100
	Mitigation of damages caused by shore protection projects	(h)	(h)	(h)	(h)	(h)

Notes:

(a) Construction costs include post-authorization engineering and design and interest costs during construction.

(b) Costs or work specifically to protect lands controlled by a Federal agency other than the Corps are borne by the agency concerned.

(c) Where periodic beach nourishment is a principal technique used in a shoreline protection project, the costs of periodic nourishment can be federally shared, for a specified period, usually 10 years. This nourishment is defined as construction by law, with cost sharing the same as with construction.

(d) The cost share varies directly with the degree of public ownership and public use. The 50 percent Federal share is multiplied by the ratio of public benefits to total benefits along the subject private shore. The local share includes the cost allocated to private benefits.

(e) Costs for determination of local share include costs of lands, easements, right-of-way, and relocation.

(f) Corps has discretionary authority for 70 percent participation of construction cost of shore projects which include hurricane protection as well as beach erosion control. Normally combination project costs are allocated among the various purposes so that cost shares can be determined by purpose according to the prescribed rules for that purpose.

(g) Under certain circumstances the true costs of operation and maintenance to local interests may be altered or eliminated by the Federal government.

(h) Cost sharing is the same as for the purposes causing the damages (causative purposes). The entire costs of mitigation including construction, lands required for mitigation, and computed present worth of further operation and maintenance are cost shared on the same basis as for the purpose causing the damage. Responsibility for actual performance of operation and maintenance is normally assigned to non-Federal interests.

Source: This table is based on information taken from Cost Sharing for Shoreline Protection; Marshall (1974); and 33 CFR (July 1, 1979), p. 282.

- Provide without cost to the United States all lands, easements, right-of-way, and relocation required for construction of the project, including that required for periodic nourishment.

- Hold and save the United States free from all claims for damage that may arise before, during, or after prosecution of the work, except damages due to the fault or negligence of the United States or its contractors.

- Prior to the commencement of any work, obtain approval of the Chief of Engineers for detailed plans and specifications for the project or suitable sections thereof and also for the arrangements for completing the work.

- Ensure continued public ownership of public and private shores upon which the amount of Federal participation is based and their administration for public use during the economic life of the project.

- Ensure the maintenance and repair of structures and the local share of periodic nourishment, where appropriate, as required to serve the project's intended purpose during the useful life of the work.

- Provide and maintain necessary roads, parking areas, and other public use facilities open and available to all on equal terms.

Specific cases may also warrant assigning additional responsibilities such as providing minimum land use controls or appurtenant facilities required for realization of recreational benefits.

No Federal contribution toward operation and maintenance of a complete shore erosion control project is authorized unless such a program (e.g., periodic beach renourishment or recycling) is found to include a more suitable and economical remedial measure for beach erosion control than other construction. If beach nourishment is considered the most suitable method for shore protection, the Chief of Engineers may recommend Federal aid for the life of a project.

o Hurricane and Emergency Storm Protection. In accordance with the President's 1978 Water Resources Policy Reform Message, proposed cost sharing for hurricane and tidal flood protection projects would require the local sponsor to contribute 20 percent of the construction cost. Traditionally, it was Corps policy to limit the Federal share of project cost to a maximum of 70 percent including the cost of lands, easements, rights-of-way, and relocation and alteration of utilities. Operation and maintenance cost for the life of the project is generally a non-Federal responsibility. Public shore ownership and use are not normally required for hurricane or emergency protection programs.

For emergency protection, the maximum Federal cost share is 100 percent for existing Federal projects. Local interests are usually required to bear the costs of lands, easements, rights-of-way, operation and maintenance, and relocation and alteration of utilities. Under certain circumstances, the Chief of Engineers can eliminate any of the local cooperation requirements upon adequate justification. Under authorizing legislation (P.L. 84-99 and P.L. 87-874), emergency assistance by the Corps is intended to supplement state and local interests and does not provide explicit cost-sharing rules.

o Combination Projects. Some shore protection projects provide beach erosion control as well as hurricane protection. For these multi-purpose combination projects, total costs are normally allocated among the various purposes so that cost shares and benefits can be determined by purpose according to the prescribed appropriate rules. For multiple-purpose hurricane protection and beach erosion control projects, the Flood Control Act of 1970 provides discretionary power to the Secretary of the Army, acting through the Chief of Engineers, to authorize a Federal share up to 70 percent of the project cost (exclusive of land cost).

Congress has recognized the complexity and problems of cost sharing for shore protection and for shore damage due to erosion of privately owned property on U.S. shorelines. As a result, numerous bills were introduced in the 91st, 92nd, and 93rd Congresses to amend the cost-sharing responsibility of the Federal Government. If passed, these bills would have amended the River and Harbor Act of August 13, 1946, to provide for Federal participation in the cost of protecting privately owned property from erosion, increased Federal cost shares for shore protection, and increased eligibility for Federal contributions or emergency work for non-federally authorized and constructed projects. None of those bills were enacted.

Although the costs of erosion control projects to Federal, state, and local governments have been high, few projects have successfully effected permanent or long-term protection to the shoreline. Costly and continued efforts have been required or proposed to combat the often aggravated erosion conditions that persist along New Jersey's Atlantic coast.

At present, there are authorized Federal programs for shore protection along the Raritan Bay shore and the entire Atlantic coast of the State. Many problems, listed below, contribute to delays or lack of implementation, and some also influence local choices of alternative shore protection programs:

- Inability or reluctance of Federal, State, and local agencies to provide the necessary funds.
- Requirements that public access be provided to beaches developed or improved with Federal funds.
- Inability to agree on the Federal cost-sharing rules.
- State laws or policies and local requirements which conflict with Federal requirements.
- Short-term variations in environmental conditions (e.g., storm frequency or erosion trends) which lessen the public's sense of urgency for project implementation.
- Long and uncertain gestation periods between the initial request for help and project completion, which often cause non-Federal interests to feel that they should carry on the project alone.
- From the national viewpoint, the optimal project plan might be much larger and more expensive than non-Federal interests feel is necessary for their needs.

The delays in scheduling and completing authorized Federal shore protection projects in New Jersey have resulted in increased construction costs, the loss of additional shoreline property, the need for projects to be restudied, and an increase in the need for temporary mitigation measures.

The cost-sharing rules for existing Federal shore protection programs provide an incentive for public access to shore areas where access was previously denied. In fact, the Federal Government cannot participate in any shore protection project without the guarantee that the public will have access to that shoreline. The cost-sharing rules do, however, result in certain conflicting trends. The outcome of the local-Federal interaction on a particular program depends on the bargaining process between the two groups. Since state and local government funds are usually limited, there is the tendency to seek the best "buys" among shore protection alternatives. The present Federal cost-sharing policies and rules tend to induce local interests to choose costly techniques of protection (e.g., engineering rather than management techniques).

Generally, where given the choice, local interests are attracted to the least-cost option regardless of its total program cost or size. Federal cost-sharing rules and policies are not specified by technique, but by program and ownership and use. Since specific cost-sharing percentages are identical for established shore protection techniques, there is no incentive for the local interests to select one established technique over another, except total cost. However, differences in operation and maintenance cost-sharing rules between programs may encourage local interests to choose techniques where these costs are relatively lower. If management or nonstructural alternatives are considered, cost-sharing differs since there is little or no Federal assistance or authority for these techniques. For this reason, local groups have a built-in bias against management techniques and nonstructural alternatives.

With respect to choosing between structural and nonstructural shore protection alternatives, affected local interests tend to feel more secure with heavy structures which appear as tangible barriers against the sea. This approach, in turn, tends to encourage development in the protected areas and raises the damage potential from major storms that breach the barriers. Management techniques, on the other hand, restrict or control development in hazard zones.

Due to the differences in cost-sharing rules between shore erosion control and hurricane and emergency protection programs, the actual cost shares incurred by state and local governments tend to be higher under the beach erosion control programs than programs which include some or all hurricane protection. In effect, the local interests tend to favor the more costly and more massive project programs when offered the choice since their cost share will tend to be lower.

Recognizing the problems inherent in existing cost-sharing policies, in 1970 and 1972, Congress introduced legislation to make all shore protection programs fundable on equal terms — thus eliminating the bias for oversized projects. None of these proposed bills were passed by Congress.

(2) Regulatory Functions (Permits) Program. The Department of the Army, acting through the U.S. Army Corps of Engineers, is responsible for administering various Federal laws that regulate certain types of activities in specific classifications of waters and wetlands of the United States. Legislative provisions authorizing the Corps to issue permits, together with related legislation requiring interagency consultation and coordination in is permit review process application, are summarized below. There are six basic types of activities that require Department of the Army permits:

- o Dams or dikes in navigable waters of the United States;
- o All other structures or work including excavation; dredging, and/or disposal activities in navigable waters of the United States;
- o All activities that alter or modify the course, condition, location or capacity of a navigable water of the United States;
- o Construction of fixed structures and artificial islands on the outer continental shelf;
- o All discharges of dredged or fill material into the waters of the United States; and
- o All activities involving the transportation of dredged material for the purpose of dumping it in ocean waters.

The general policies and procedures pursuant to the Corps regulatory functions program are set forth in the the Rules and Regulations, Title 33 of the Code of Federal Regulations, Parts 320 to 329 (33 CFR 320-329) issued July 19, 1977.

The authority of the Corps to issue permits for activities in water bodies and wetlands derives from several statutory sources. Key legislative provisions authorizing the Corp's involvement in activities which alter waters of their adjacent wetlands include:

- o The River and Harbors Act of 1899 (Sections 1, 9, 10, 11, 13, and 14);
- o The Federal Water Pollution Control Act Amendments of 1972 (Section 404); and
- o The Marine Protection Research and Sanctuaries Act of 1972 (Section 103).

Depending upon the type, magnitude, and location of a regulated activity, several forms of permit authorization are possible. These include letters of permission, individual permits, general permits, and nationwide permits. The Corps' "General Policies for Evaluating Permit Applications "are contained under Title 33 CFR 320.4. In exercising its permit authority, the Corps is required to undertake a "public interest review" of each proposed project. The basic premise of this review is that "No permit will be granted unless its issuance is found to be in the public interest" (CFR 320.4(a)). The following two passages, abstracted from 33 CFR 320.4, describe the general review process and indicate the specific criteria employed in the Corps' public interest review:

> The decision whether to issue a permit will be based on an evaluation of the probable impact of the proposed structure or work and its intended use on the public interest. Evaluation of the probable impact which the proposed structure or work may have on the public interest requires a careful weighing of all

those factors which become relevant to each particular case. The benefit which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of the general balancing process.

That decision should reflect the national concern for both protection and utilization of important resources.

All factors which may be relevant to the proposal are considered; among those are conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production, and, in general, the needs and welfare of the people.

In reviewing permit requests, the following additional criteria are considered in the evaluation of every permit application:

- The relative extent of the public and private need for the proposed structure or work;
- The desirability of using appropriate alternative locations and methods to accomplish the objective of the proposed structure or work;
- The extent and permanence of the beneficial and/or detrimental effects which the proposed structure or work may have on the public and private uses to which the area is suited; and
- The probable impact of each proposal in relation to the cumulative effect created by other existing and anticipated structures or work in the general area.

Under the Corps' permit review process, interagency consultation is required in the determination of whether specific wetland areas may or may not be altered, and, if so, in which ways. Participants in the evaluation of wetland development applications generally include representative of the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the U.S. Environmental Protection Agency. Other Federal agencies are consulted as appropriate. The requirement for intergovernmental permit review is further extended to include representatives of other governmental authorities such as the State. The Corps' responsibility to provide consultation and coordination with other agencies and governmental units is as follows:

- Heads of agencies shall consult with appropriate Federal, State, and local agencies in carrying out their activities as they affect the quality of the environment;
- Permits shall not be issued where authorization of the proposed work is required by State and/or local law and that authorization has been denied; and
- Permits shall not be issued without first considering the State, regional or local land use policies, plans, and ordinances which apply to the land and water areas under review.

(3) Navigational Dredging. The main impact of navigational dredging in coastal areas is related to the environmental effects of the disposal of dredge spoil material. Additionally, inlet dredging can change natural coastal processes in shoreline areas adjacent to the inlet. Natural inlets function as traps of littoral material, but some of the material normally passes from one coastal component to another through inlet shoals. Dredging of inlet channels removes some of the littoral material from the system and, along the migrating edges of a barrier island, eventually results in loss of a portion of the island as it migrates into the inlet, is dredged out, and disposed of elsewhere.

The Corps maintains the Atlantic intracoastal waterways, inlets, and small-craft navigation channels (dredged through the shallow backbays) that separate the barrier islands from the coastal mainland. The need to constantly remove sediment from the channel creates dredge material, which is disposed of in the least expensive manner that is environmentally sound. The practice has been to dump much of the dredged material offshore or in disposal areas along the waterway route. It is not the maintenance policy of the Corps to keep all projects at their full, authorized dimensions, but to provide depths consistent with the reasonable needs of existing traffic. In certain troublesome shoal areas, the Corps has found it economical to dredge overdepth as advanced maintenance to prevent having to return to the same project two or more times in the same dredging season.

In planning new navigation projects, the present Federal policy is to require that local interests provide, without cost to the United States, all suitable areas for initial and subsequent disposal of dredged material and all necessary retaining structures or the costs of such retaining works. Where the placement of dredged material results in land enhancement, as with beach fill, non-Federal interests are usually required to provide 50 percent of construction costs for placement of the dredged material. The net tangible benefits attributable to a navigation dredging project are measured in terms of the net increased market value or the cost of equivalent fill, whichever is less, exclusive of development costs and any additional costs of depositing the dredged material. If, for harbor projects, the enhanced lands will benefit the project sponsor or users, a contribution of 100 percent of the cost allocated to that enhancement is required. Under this cost-sharing policy, if New Jersey elects to have suitable dredge material from Federal projects used for beach nourishment in lieu of offshore disposal, it would normally be required to provide a contribution to cover the cost difference between the two methods.

b. Federal Coastal Zone Management

In response to intense pressures, and because of the importance of the coastal areas of the United States, Congress passed the Coastal Zone Management Act (CZMA), P.L. 92-583, which was signed into law on October 27, 1972. The CZMA authorized a Federal grant-in-aid program to be administered by the Secretary of Commerce, who in turn delegated this responsibility to the National Oceanic and Atmospheric Administration's (NOAA) Office of Coastal Zone Management (OCZM). CZMA and amendments of July 26, 1976 (P.L. 94-370), affirm a national interest in the effective protection and development of the coastal zone. Section 303 of the CZMA declares that it is the national policy:

> (a) to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations, (b) to encourage and assist the states to exercise effectively their responsibilities in the

> coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone giving full consideration to ecological, cultural/historic, and esthetic values as well as to needs for economic development, (c) for all Federal agencies engaged in programs affecting the coastal zone to cooperate and participate with state and local governments and regional agencies in effectuating the purposes of this title, and (d) to encourage the participation of the public, of Federal, state and local governments and of regional agencies in the development of coastal zone management programs.

The CZMA provides funds for states to develop and implement rational programs for managing their coastal zones. Funding of state programs is based in part on the ability of the state to meet broad guidelines and basic requirements of the CZMA, contained in Section 305 of the Act. Specifically, the CZMA requires that:

> The management program for each coastal state shall include a planning process for (a) assessing the effects of shoreline erosion (however caused), and (b) studying and evaluating ways to control, or lessen the impact of such erosion, and to restore areas adversely affected by such erosion.

New Jersey's Coastal Zone Management Program for the Atlantic Ocean and Raritan and Delaware Bays was approved by NOAA in September 1978. Pertinent details of that plan are discussed in Section B.1 of this chapter. Under Section 315(2) of the CZMA, financial assistance may be provided to enable states to acquire and maintain estuarine sanctuaries, preserve islands, and provide for access to public beaches and other coastal areas.

c. National Flood Insurance Program

(1) Introduction. For decades, the national response to flood disasters was generally limited to building flood control works (dams, levees, seawalls, etc.) and providing disaster relief to flood victims. In the face of mounting flood losses, Congress created the National Flood Insurance Program (NFIP) to reduce annual flood losses through more careful planning and to provide property owners with affordable flood protection. NFIP is administered by the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA) — formerly FIA was under control of the U.S. Department of Housing and Urban Development (HUD).

The NFIP stated goals are: "To...encourage State and local governments to make appropriate land use adjustments to constrict the development of land which is exposed to flood damage and minimize damage caused by flood losses," and to "guide the development of proposed future construction, where practicable, away from locations which are threatened by flood hazards" (National Flood Insurance Act of 1968, P.L. 90-448, as amended). There is evidence that neither of these goals is being met.

The NFIP principally exists to enable property owners in flood hazard areas to obtain Government-subsidized insurance as a means of securing some measure of protection against direct flood loss and losses resulting from land collapse (erosion) caused by water and activity in excess of established levels. Almost every type of walled and roofed building that is principally above ground can be insured, including a

mobile home on a foundation. Also eligible are the contents of a fully enclosed building. However, gas and liquid storage tanks, wharves, piers, bulkheads, growing crops, shrubbery, land, livestock, roads, motor vehicles, etc., are not insurable under the program.

The National Flood Insurance Act of 1968 requires that minimum floodplain management standards be met by communities participating in the NFIP to protect lives and new construction from future flooding. The minimum required coastal floodplain management standards are described below by program phase.

(2) Emergency Program. A floodplain community qualifies for the NFIP in two separate phases —the Emergency and Regular Programs. Under the initial emergency phase, limited amounts of flood insurance become available to local property owners from the time a community is accepted into the program. A community's efforts to reduce flood losses are in many cases guided only by preliminary flood data. A map published by FEMA at this stage is called a "flood hazard boundary map," which outlines the flood-prone areas (labeled "special flood hazard areas"). The special flood hazard areas are subject to inundation from an intermediate level of flooding also referred to as the "base flood" (the 100-year flood height or stillwater depth), which appears as an "A"-zone area on the initial flood hazard boundary map. Over a 30-year period (the life of most mortgages), there is about one chance in four (26 percent) that the 100-year level of flooding will occur in a given area.

Under the Emergency Program, subsidized rates are charged for all existing and new structures regardless of their flood risk. Community eligibility for having flood insurance available to property owners is based on the community's response in meeting the Federal requirements for floodplain management regulation. Requirements are necessarily rather minimal because of legal restraints until the regular phase is reached (100-year flood frequency is accurately determined).

The minimum floodplain management requirements necessary for a community to qualify for the Emergency Program include:

- Building permits for all proposed construction or other development in the community.
- A review of the permit to ensure that sites are reasonably free from flooding.

For flood-prone areas, the communities must also require:

- Proper anchoring of structures.
- The use of construction materials and methods that will minimize flood damage.
- Adequate drainage for new subdivisions.
- The location and design of new or replacement utility systems to prevent flood loss.

(3) Regular Program. After FEMA completes a detailed onsite survey to establish the 100-year flood frequency flood level, the community qualifies for the Regular Program by adopting more comprehensive floodplain construction management measures. Most often on the community's "flood insurance rate map" (the second map the community receives), the "A" zone is refined into numbered zones (A1, A2,

A3, etc.) that reflect the degree of flood risk for that area. Mapped zones may also include "B" and "C" zones. The "B" zone normally denotes areas between the limits of the 100- and 500-year floods, while a "C" zone designates higher ground areas of minimal flooding. These zones are used by insurance agents to rate new properties to be insured under the Regular Program. Also, a community enrolled in the Regular Program must use the flood elevations shown on the rate map as the minimum building levels for new construction.

Under the Regular Program, where actuarial rates have been determined, the full limits of flood insurance coverage become available locally. The premiums charged for new construction vary according to its exposure to flood damage. A structure's exposure is based on the elevation at its lowest floor above or below the "base flood elevation" (or 100-year flood). Where a zone of high velocity wave action ("V" zone or coastal high hazard area) has been identified, the program requires that a community take whatever additional steps are necessary — such as the use of breakaway walls — to prohibit development within the reach of mean high tide and to regulate construction so that minimal stress is placed on supports below the lowest floor by abnormally high tides or wind-driven water.

To enter the Regular Program, a community must require that all new construction and substantial improvements to existing structures in FEMA-identified flood-prone areas ("A"- and "V"-zone areas) meet additional standards. At a minimum, a community must uniformly administer the following requirements:

- The lowest floor of residential structures must be elevated to or above the 100-year stillwater flood level (base flood).
- Nonresidential structures must be flood proofed to the 100-year level.
- Additional features must be designed to minimize flood damage to or movement of structures and water and sewer systems.

Substantial improvement includes any repair, reconstruction, or addition of a structure, the cost of which equals or exceeds 50 percent of its market value either before the improvement is started or before the damage has occurred. It does not, however, include such actions taken to comply with existing state or local codes and ordinances or alterations to a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

Land management criteria also require that coastal communities prohibit manmade alterations of sand dunes which would increase potential flood damage within coastal high hazard areas. Most coastal communities respond to the FEMA land management and use requirements by adopting a model ordinance recommended by FEMA.

By law, flood insurance is required if:

- The community is in the flood insurance program.
- A FEMA flood map is in effect for the community in question.
- The property which is the subject of a loan is located in a FEMA flood-prone area.
- Financing is through the Federal government or a federally connected lender.

Flood insurance is not required by law outside of "A"- or "V"-zone areas.

The status of New Jersey reach communities in the NFIP as of January 1981 is presented in Table III.C-4. All 94 of the New Jersey reach communities are involved in the NFIP — 65 percent in the Regular Program and 35 percent in the Emergency Program. Statewide, 540 communities are involved — 50 percent in the Regular Program and 50 percent in the Emergency Program.

At present, "V" zones will only be evaluated for Atlantic coastal communities and selected communities on Raritan Bay. Delaware Bay and River communities are not presently under consideration for "V"-zone delineation (Personal Communication, FIA, Region II Office, New York). Whenever changes are warranted, the FIA reviews technical data and revises its flood boundary maps or flood insurance rate maps as required. An example of the delineation of flood hazard zones on a hypothetical barrier island reach rate map is provided on Figure III.C-2. Sample FIA flood hazard boundary maps for coastal boroughs in Monmouth, Ocean, and Cape May Counties are provided on Figures III.C-3, III.C-4, and III.C-5, respectively.

The FIA released a document entitled Report of Current Practice (Dames & Moore et al., 1979) that describes the development of design and construction standards for residential buildings in coastal high hazard areas ("V" zones). The report indicates that throughout the United States, the following key elements have been common in all attempts to resist coastal flooding damage to residential buildings:

- A trend toward deep foundations which penetrate below anticipated erosion elevations.
- The structural integration of the roof, frame, and foundation of coastal structures to lessen the likelihood of total failure.
- Attention to provisions for shutters, elevated utilities, and breakaway construction beneath the base (100-year) flood elevation to enhance flood resistance.

In 1981, the FIA published a design and construction manual for residential and related scale structures in coastal high hazard areas (U.S. Department of Housing and Development, FEMA, January 1981). The manual incorporated five major elements — (1) loading, forces, and construction details; (2) design of posts and columns; (3) anchoring for posts, piles, and columns under various subsurface conditions; (4) data presentation; and (5) suitability of fill as a means of elevating coastal structures.

(4) Problems. The methods used to determine the 100-year flood frequency line or the areas subject to high velocity wave action ("V" zones) and the Federal enforcement of established management standards are two problem areas associated with administration of the NFIP.

The "A" zone distinguishes those areas where the 100-year flood height is based on stillwater depth. The "V" zone identifies those areas which are subject to the additional factors of wave setup and wave runup (refer to Figure III.C-6). Various methodologies have been or are being used by FEMA for flood frequency analysis to establish insurance rates in "A" and "V" zones based on the degree of risk (e.g. 10-, 50-, 100-, etc., year floods). The following classes of methodologies have been developed by the principal Federal agencies (the National Weather Service (NWS), the U.S. Geological Survey (USGS), NOAA, and the Corps) contributing at one time or another to the FEMA flood mapping program — (1) those based on historical data, and (2) those

TABLE III.C-4

STATUS OF NEW JERSEY REACH COMMUNITIES IN NATIONAL FLOOD INSURANCE PROGRAM AS OF JANUARY 31,1981

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Flood Insurance Program Status*	Date of Entry Regular or Emergency Program	"V" Zone Special Coastal Hazard Area Mapped
1	Raritan Bay	Middlesex	Perth Amboy City	R	12/18/79	X
			South Amboy City	R	12/4/79	X
			Sayreville Borough	E	1/21/74	—
			Old Bridge Township	E	8/13/71	—
		Monmouth	Aberdeen Township	E	4/12/74	—
			Keyport Borough	R	7/2/79	X
			Union Beach Borough	R	6/15/74	—
			Keansburg Borough	E	5/26/72	—
			Middletown Township	E	5/20/74	—
			Naval Weapons Station Earle (Leonardo)	NA	NA	—
			Atlantic Highlands Borough	E	6/19/75	—
			Highlands Borough	R	9/3/71	—
2	Sandy Hook to Long Branch		Gateway National Recreation Area and U.S. Coast Guard Station	NA	NA	—
			Sea Bright Borough	R	10/8/71	X
			Monmouth Beach Borough	R	5/16/77	X
3	Long Branch to Shark River Inlet		Long Branch City	R	5/5/76	X
			Deal Borough	R	3/5/76	X
			Allenhurst Borough	R	3/15/79	X
			Loch Arbour	R	3/15/79	X
			Asbury Park City	R	2/15/79	X
			Neptune Township	R	2/16/77	X
			Bradley Beach Borough	R	8/1/79	X
			Avon by the Sea	R	3/15/79	X
4	Shark River Inlet to Manasquan Inlet		Belmar Borough	R	5/12/72	X
			Spring Lake Borough	E	9/15/72	X
			Sea Girt Borough	R	3/5/76	X
			State Arsenal and Camp Ground	NA	NA	—
			Manasquan Borough	R	5/12/72	X
5	Manasquan Inlet to Mantoloking	Ocean	Point Pleasant Beach Borough	R	6/15/79	X
			Bay Head Borough	R	8/13/71	X

*E - emergency; R - regular; NA - not applicable.

TABLE III.C-4 (Continued)

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Flood Insurance Program Status*	Date of Entry Regular or Emergency Program	"V" Zone Special Coastal Hazard Area Mapped
6	Mantoloking to Barnegat Inlet	Ocean	Mantoloking Borough	R	9/30/77	X
			Brick Township	R	8/4/72	X
			Dover Township	R	3/24/72	X
			Lavallette Borough	R	6/11/71	X
			Sea Side Heights Borough	R	7/16/79	X
			Sea Side Park Borough	R	8/13/71	X
			Berkeley Township	E	7/2/71	—
			Island Beach State Park	NA	NA	—
7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)		Barnegat Lighthouse State Park	NA	NA	—
			Barnegat Light Borough	R	4/2/71	X
			Harvey Cedars Borough	R	4/2/71	X
			Surf City	R	4/2/71	X
			Ship Bottom Borough	R	4/2/71	X
			Long Beach Township	R	3/26/71	X
			Beach Haven Borough	R	4/2/71	X
			Brigantine National Wildlife Refuge	NA	NA	—
8	Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island)	Atlantic	Brigantine National Wildlife Refuge	NA	NA	—
			North Brigantine State Natural Area	NA	NA	—
			Brigantine City	R	6/18/71	X
9	Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)		Atlantic City	R	6/18/71	X
			Ventnor City	R	6/18/71	X
			Margate City	R	6/19/71	X
			Longport Borough	R	6/18/71	X
10	Great Egg Harbor Inlet to Corson Inlet (Peeks Beach)	Cape May	Ocean City	R	11/27/70	X
			Corson Inlet (Ocean Crest) State Park	NA	NA	—
11	Corsons Inlet to Townsends Inlet (Ludlam Island)		Strathmere State Natural Area	NA	NA	—
			Upper Township	R	12/10/76	X
			Sea Isle City	R	12/31/70	—
12	Townsends Inlet to Hereford Inlet (Seven Mile Beach)		Avalon Borough	R	12/31/70	—
			Stone Harbor Borough	R	12/31/70	—
13	Hereford Inlet to Cape May Inlet (Five Mile Beach)		North Wildwood City	R	3/5/71	—
			Wildwood City	R	12/31/70	—
			Wildwood Crest Borough	R	2/26/71	—
			Lower Township (East)	E	8/9/74	—
			U.S. Coast Guard, Wildwood Electrical Engineeing Center	NA	NA	—

TABLE III.C-4 (Continued)

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Flood Insurance Program Status*	Date of Entry Regular or Emergency Program	"V" Zone Special Coastal Hazard Area Mapped
14	Cape May Inlet to Cape May Point	Cape May	U.S. Coast Guard Receiving Area	NA	NA	—
			Cape May City	R	2/26/71	—
			Cape May Point State Park	NA	NA	—
			Lower Township (South)	E	8/9/74	—
			Cape May Point Borough	R	12/31/70	—
15	Delaware Bay Cape May Point to Stow Creek		Lower Township (West)	E	8/9/74	No "V" Zones Mapped
			Higbee Beach State Wildlife Mgt. Area	NA	NA	
			Middle Township	R	5/16/77	
			Dennis Creek State Wildlife Mgt. Area	NA	NA	
			Dennis Township	E	7/28/75	
		Cumberland	Maurice River Township	R	1/19/78	
			Corson Tract State Fish and Wildlife Mgt. Area	NA	NA	
			Heislerville State Wildlife Mgt. Area	NA	NA	
			Commercial Township	E	7/23/75	No "V" Zones Mapped
			Downe Township	R	2/15/78	
			Egg Island-Berrytown (Turkey Point) State Wildlife Mgt. Area	NA	NA	
			Fortescue State Wildlife Mgt. Area	NA	NA	
			Lawrence Township	E	7/21/75	
			Fairfield Township	E	6/23/72	
			Dix State Wildlife Mgt. Area	NA	NA	
			Greenwich Township	E	9/29/75	
16	Delaware River Stow Creek to Crosswicks Creek	Salem	Lower Alloways Creek Township	E	5/20/75	
			Mad Horse Creek State Wildlife Mgt. Area	NA	NA	
			Artificial Island Federal Disposal Area	NA	NA	
			Elsinboro Township	E	5/28/74	
			Supawna Meadows National Wildlife Refuge	NA	NA	
			Fort Mott State Park	NA	NA	No "V" Zones Mapped
			Killcohook National Wildlife Refuge	NA	NA	
			Killcohook Federal Dredge Disposal Area	NA	NA	
			Pennsville Township	E	8/5/74	
			Carneys Point Township	Not Listed	—	
			Penns Grove Borough	E	8/7/75	
			Oldmans Township	E	7/15/75	
			Pedricktown Federal Disposal Area	NA	NA	
			U.S. Military Reservation	NA	NA	

TABLE III.C-4 (Continued)

Reach Number	Reach Description	County	Political Subdivision (Municipalities/Parks, etc.)	Flood Insurance Program Status*	Date of Entry Regular or Emergency Program	"V" Zone Special Coastal Hazard Area Mapped
16 Cont.	Delaware River Stow Creek to Crosswicks Creek	Gloucester	Logan Township	E	6/29/76	
			Greenwich Township	E	4/18/73	No
			Paulsboro Borough	E	5/13/75	"V"
			West Deptford Township	E	12/22/72	Zones
			National Park Borough	E	1/3/75	Mapped
			Westville Borough	R	5/1/80	
		Camden	Gloucester City	R	9/14/79	No "V"
			Camden City	E	5/16/75	Zones
			Pennsauken Township	R	4/15/77	Mapped
		Burlington	Palmyra Borough	R	6/1/78	
			Riverton Borough	R	4/15/77	
			Cinnaminson Township	R	5/15/78	
			Delran Township	R	5/2/77	
			Delanco Township	R	9/28/79	
			Beverly, City of	R	12/23/77	No
			Edgewater Park Township	R	5/25/78	"V"
			Burlington Township	E	7/29/75	Zones
			Burlington City	R	7/23/71	Mapped
			Florence Township	E	9/5/75	
			Mansfield Township	E	7/24/75	
			Fieldsboro Township	E	5/1/75	
			Bordentown Township	E	8/8/75	
			Bordentown City	E	5/16/75	

Note:

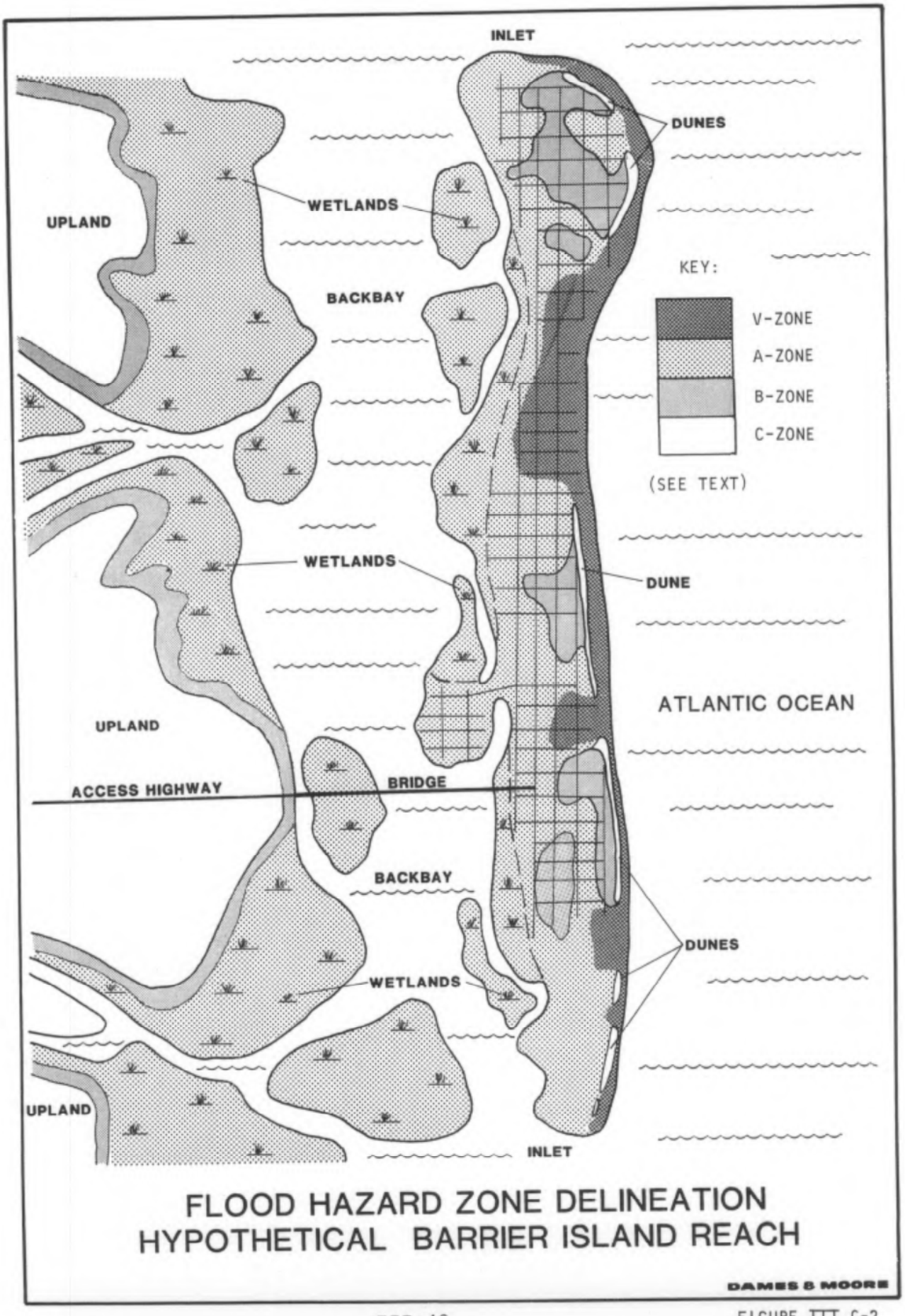
Reach Community Totals

Total communities	94
Communities in Regular Program	60
Communities in Emergency Program	33

Overall State Totals

Total communities in program	540
Communities in Regular Program	270
Communities in Emergency Program	270

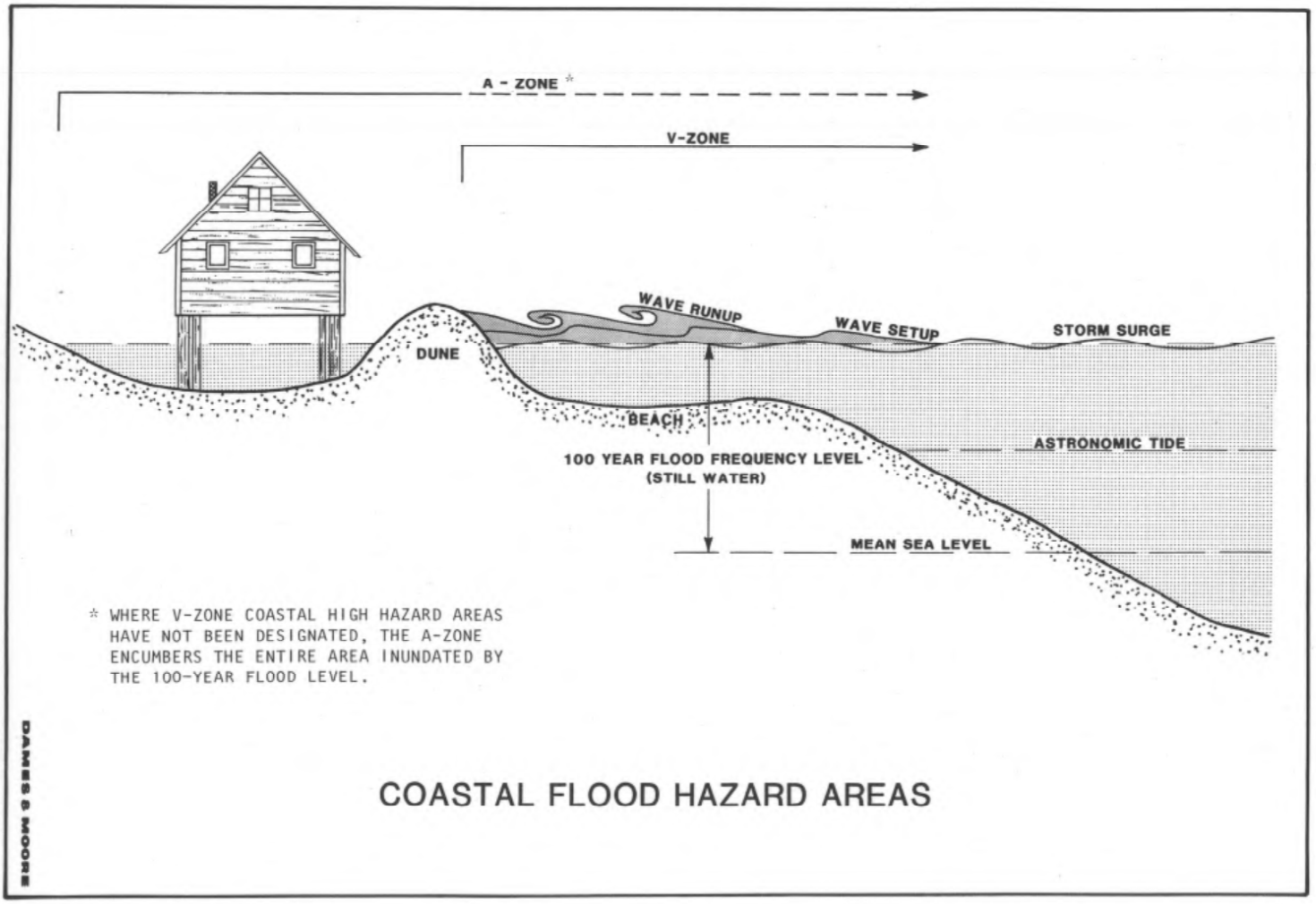
Source: FEMA, FIA Program Community Status Book – New Jersey (January 31, 1981).



FLOOD HAZARD ZONE DELINEATION
HYPOTHETICAL BARRIER ISLAND REACH

DAMES & MOORE

FIGURE III.C-2



COASTAL FLOOD HAZARD AREAS

DAMES & MOORE

FIGURE III.C-6

based on numerical simulation (synthetic), including joint probability methods. Several agencies have conducted studies of the major methodologies for storm frequency analysis. Details of the various key methodologies have been published by NOAA (Pore et al., 1974), the Department of Commerce (Myers, 1970), and FIA (Stone and Webster, 1978; Chen et al., 1977).

The application of storm flood frequency analysis methodologies is generally restricted to open coastal areas since flood hazard analysis for estuaries (e.g., backbays, open bays, and tributaries) is more complex due to the combined influence of tides, storm surge, and river flooding. The secondary effects of intense coastal storms eroding beaches and reducing dune height cannot be accurately predicted using the available models.

Each flood prediction method varies in relative complexity, sophistication, degree of confidence, and accuracy. For New Jersey, flood frequency models have been evaluated for both the hurricane and northeaster storms. Also, the methodologies of flood frequency analysis for different coastal communities have varied — depending on the time of the evaluation and the complexity of the situation. The differences in techniques and their resolution have resulted in considerable controversy over delineating coastal flood-prone areas, thus complicating the State and local governments' attempts to manage coastal areas.

The NFIP has had difficulty in establishing regulatory standards to accommodate the severe wave action and storm surge typical of the open ocean shoreline ("V" zones). The basic problem with existing methodologies for delineation of "V" zones is that they account for wave setup and wave runup on 100-year stillwater flood elevations, but do not consider wave height which may account for a flood level increase of as much as 50 percent over stillwater flood levels. Due to the omission of wave height in flood elevation computations, "V"-zone insurance rate structures probably do not reflect true risk due.

After investigating various methods for incorporating the wave height factor into its program, FEMA is currently reevaluating "V"-zones in 20 of New Jersey's 80 oceanfront municipalities. In order to more accurately reflect the anticipated effect of a major coastal storm, the "V"-zones are being redrawn utilizing a methodology which incorporates consideration of wave heights that would accompany flood tides. Although the changes in rate map zone boundaries will vary from municipality to municipality, it is expected that the western boundary of the "V"-zone will move inland. FEMA is also considering delineation of "V"-zones for some bayfront and riverfront municipalities in Cape May County. These represent areas susceptible to serious damage from major storms coming from the west.

Subsidized actuarial rates provide an artificial stimulus to construction, but do not reflect the real risk of building in coastal high hazard areas. This, along with the rather minimal requirements for construction safeguards contributes to additional problems in meeting NFIP-established floodplain management goals. There are, however, differing opinions as to the effect of NFIP on development. According to a report prepared by Miller (1977), the availability of flood insurance tends to increase the pressure for development in some flood-prone areas. This has happened in states such as Rhode Island, where the availability of Federal flood insurance has led banks to reverse their previous policies of denying loans for construction in hazardous areas. Nevertheless, it does not appear to be a widespread phenomenon. The main

issue is not whether the flood insurance program increases the pressures for development, but whether Federal tax dollars support the process of insuring and subsidizing redevelopment in hazardous and ecologically fragile areas.

Although FIA minimum building requirements have encouraged construction in such a way as to reduce a building's vulnerability to flood damage, the requirements are more concerned with design than location. Thus, buildings can be designed to meet the structural requirements, but at the same time be clustered in areas that are hazardous or highly exposed to wave runup. An example of this type of criticism of the NFIP comes from the Maine Audubon Society policy statement (MAS, 1979), which focuses on keeping new development off the 100-year floodplain by eliminating Federal Government subsidies of environmentally unsound development along the coast. It also seeks to remove existing development especially if previously damaged by storms. This approach is seen as an attempt to protect and preserve beaches, dunes, and coastal wetlands and lessen the public costs associated with disaster relief in the coastal zone.

The MAS Policy regarding the effect on beach ecosystem protection is based on the assumptions that development presumably on the barrier island has caused (or will necessarily cause) destruction of natural systems and that floodproofing techniques probably will not be effective in coastal areas of high velocity wind and wave impacts ("V" zones).

The MAS contends that the NFIP is not an insurance program as such, but rather a formalized procedure for disaster relief aimed at those who made unwise decisions or were misled. Although its primary focus is disaster relief, Congress incorporated the requirement for selective regulation of flood-prone areas. The regulation element is perceived by FIA as a compromise position between property rights ("You can't tell me what to do with my land.") and public interest ("I am paying for your shorefront damages."). The FIA compromise does not prohibit development (except below mean high water), but does require minimum standards of flood-plain management, such as construction measures to minimize flood damage (first floor above the 100-year flood level and anchoring of the structure). In 1980 hearings on the CZMA, the FIA Administrator told the House oceanography subcommittee that the difficulty in establishing that coastal development would harm others, and the fear that outright prohibition of coastal development could induce many communities to drop out of NFIP, led FIA to reject a ban on development in the velocity zone.

At the heart of this debate is the question of whether the construction schemes being proposed by FIA for the 100-year flood zone will be successful and whether they will further induce erosion and restriction of the tendency for dunes and beach to migrate and develop a natural buffer system. The degree of success of such a structural approach has yet to be demonstrated. In addition, the potential exists for damage not only from wave action, but also from debris such as breakaway walls. The high, open aspect of these individual designs would not appear to result in a significant impact on the natural systems, provided that – as the inevitable landward migration of the system occurs – bulkheads, rip-rap, seawalls, etc., are not thrown in the way in an effort to maintain an oceanfront site or position.

Even if properly designed coastal development was not enclosed in seawalls, etc., and survived the series of storms, migration of the barrier system landward would eventually locate these structures in the beach zone where they would obstruct the full use of the zone. The political compromise position represented by the NFIP is

understandable from a Federal perspective, but it is not responsive or supportive of the more stringent and environmentally protective state regulatory efforts.

Section 1362 of the National Flood Insurance Act allows the Federal Government to purchase insured properties in flood hazard areas that have sustained major or frequent damage. The legislation further authorizes the Federal Government to raze such acquired structures and turn them over to the affected state or local government for management and use. For the first time, Congress has appropriated monies for Section 1362; for fiscal year 1980, $5.4 million has been appropriated for the nationwide purchase of storm-damaged property from willing sellers.

There are provisions in the flood insurance program that are designed to control development in flood zones to some degree. Communities participating in the program are required to adopt floodplain management or land use restraints. However, by January 1981, more than 1500 communities nationwide had received the final flood insurance rate map and had entered the Regular Program. In New Jersey, 270 of the 540 participation communities have entered the Regular Program. In addition to the slow rate of entry, a further limitation of the Regular Program is that communities may choose not to participate, thereby escaping the need to adopt floodplain management or land use restraints. By choosing not to participate, a community also looses its eligibility for Federal flood insurance.

d. Disaster Relief

(1) Introduction. FEMA (formerly the Federal Disaster Assistance Administration) administers the Federal Disaster Relief Act of 1974 (P.L. 93-288), which encourages states to develop plans, programs, and capabilities for disaster preparedness prevention and mitigation, and authorizes the President to grant to each state funds for the preparation and updating of such plans and programs. The primary purpose of Federal disaster relief appears to be that of post-disaster recovery rather than predisaster planning to reduce the effects of potential disasters. The Act prohibits the use of authorized funds for major reconstruction or rehabilitation of damaged private property. However, there appears to be no such limitation on the repair, reconstruction, or restoration of Federal or public facilities, which include water and public power, airports, and any other public buildings, structures, or systems, including those used for education or recreation. Emergency assistance is not considered "a major Federal action significantly affecting the quality of the human environment" and may be exempt from the Environmental Impact Statement (EIS) process.

(2) Program Details. Under a Presidential "major disaster declaration," funding may be approved for a variety of projects, including but not limited to:

- Clearance of debris on public or private lands or waters.
- Emergency protective measures for the preservation of life and property.
- Repair or replacement of roads, streets, and bridges.
- Repair or replacement of public buildings and related equipment.
- Repair or replacement of public utilities.
- Repair or restoration to predisaster condition of public facilities damaged while under construction.
- Repair or restoration of recreational facilities and parks.

- Repair or replacement of private nonprofit educational, utility, emergency, medical, and custodial care facilities, including those for the aged or disabled, and facilities on Indian reservations.

Other forms of assistance which may be made available under a Presidential declaration of a major disaster include:

- Disaster loans from FEMA to those communities that may suffer a substantial loss of tax and other revenues and have demonstrated a need for financial assistance to perform their government functions.

- Repairs and operating assistance to public elementary and secondary schools by the Office of Education, Department of Health, Education and Welfare.

- Use of Federal equipment, supplies, facilities, personnel, and other resources (other than the extension of credit) from various agencies.

Assistance which may be provided under a Presidential "declaration of an emergency" is more limited in scope. It is specialized assistance to meet a specific need and is generally limited to those actions which may be required to save lives and protect property, public health, and safety or to lessen the threat of a more severe disaster. Examples of emergency assistance are:

- Emergency mass care, such as emergency shelter and emergency provision of food, water, and medicine.

- Clearance of debris to save lives and protect property and public health and safety.

- Emergency protective measures, including search and rescue, demolition of unsafe structures, warning of further risks and hazards, public information on health and safety measures, and other actions necessary to remove or to reduce immediate threats to public health and safety, public property, or private property when in the public interest.

- Emergency communications support to state and local government officials.

- Emergency repairs to essential utilities and facilities to provide for their continued operation.

Federal disaster assistance without a Presidential major disaster declaration may be obtainable through the Corps of Engineers emergency assistance program or through a tax refund. The U.S. Department of Treasury, Internal Revenue Service, allows individual tax refunds for losses resulting from natural disasters. Under a "disaster loan area" declaration, the Small Business Administration (SBA) can provide both direct and bank-participation disaster loans or guaranteed insured loans to qualified homeowners and businesses to repair or replace damaged or destroyed private property. Economic injury loans are available to help a variety of institutions and individuals suffering economic losses as a result of a disaster.

Federal disaster relief provides the mechanisms to allow communities and individuals to perpetuate past errors at general taxpayer expense. Since P.L. 93-288

was put into effect, about $15 million has been allocated to counties and communities along the Atlantic and Gulf coasts for disaster relief.

e. Other Relevant Programs

The Federal programs summarized in this section include those relevant to coastal development and preservation. These programs are supplementary to the major Federal programs discussed above. Much of the discussion presented herein is taken or adapted from the Heritage Conservation and Recreation Service Draft Environmental Impact Statement on Alternative Policies for Protecting the Barrier Islands (HCRS, 1980).

The first five programs discussed primarily affect coastal preservation; the remaining programs primarily influence coastal development.

(1) Environmental Impact Statement Review Process. The National Environmental Policy Act of 1969 (NEPA) requires all Federal agencies to take into account the value of environmental preservation in their activities, and it prescribes certain procedural measures to ensure that such values are fully respected. An important aspect of the law is the requirement for preparation of Environmental Impact Statements (EIS) for all legislation and other major activities significantly affecting the quality of the human environment. The NEPA process is regulated by the Council on Environmental Quality (CEQ), Office of Environmental Quality.

EIS's and Environmental Assessments (EA) may be required for permits (Corps of Engineers, Coast Guard, Environmental Protection Agency), grants of money (Federal Highway Administration, Economic Development Agency, Office of Coastal Zone Management), and new housing (Department of Housing and Urban Development). Environmental review must also be undertaken for direct Federal projects and for land use management or disposal proposals (Department of Interior, Department of Defense, General Services Administration). NEPA processes serve to alert the public and other agencies on proposed actions affecting the environment and are a means of coordinating various Federal decisions and viewpoints. Where problems exist, NEPA review can bring to the highest levels of the Federal Government any proposal that might have serious adverse impacts.

(2) Floodplain Management and Wetland Protection — (Executive Orders 11988 and 11990). The Floodplain Management Executive Order of 1977 (Executive Order 11988) directs all Federal agencies to "...avoid to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative..." Each Federal agency has the responsibility of evaluating the potential direct and indirect effects of any action it may take in a floodplain and ensuring that its programs and budget requests reflect adequate consideration of flood hazards and floodplain management.

Executive Order 11988 applies specifically to agencies that acquire, manage, or dispose of Federal lands and facilities; undertake, finance, or assist construction and improvements; and conduct activities and programs affecting land use, including planning, regulation, and licensing. However, its effectiveness and impact on coastal occupancy and shore protection programs is not yet fully apparent. As a minimum, it includes areas subject to inundation by a flood with a 1 percent chance of occurring in any year (i.e., 100-year or base flood), regardless of whether these areas are located by or near rivers, streams, oceans, ponds, or related water

bodies. The critical action mentioned in Executive Order 11988 refers to the area having a 0.2 percent chance of flooding in any year (500-year flood). As stated within the Order, "these determinations shall be made according to a Department of Housing and Urban Development (now FEMA-FIA) floodplain map or a more detailed map of an area, if available."

A review of the NFIP maps for New Jersey indicates that the shore areas of nearly all of the oceanfront, bay-shore, and backbay communities are included to some extent in the 100-year coastal floodplain regulated by Executive Order 11988. For the New Jersey barrier island reaches and associated backbay wetland areas, only the highest coastal sand dunes protrude above the 100-year flood level. The shores of the northern and southern headland coastal components are also encumbered, but to a lesser degree because of the higher upland elevations that occur in proximity to the shoreline.

The Floodplain Order requires agencies to amend or issue regulations and procedures to avoid hazardous use of riverine and coastal base floodplains if at all possible; to provide alternatives to minimize adverse impacts in the base floodplain if development cannot be avoided; and to keep the public informed of proposed actions in the base floodplain and encourage participation in floodplain decision making.

As directed by the Floodplain Order, the Water Resource Council issued Floodplain Management Guidelines on February 10, 1978, to assist agencies in meeting their responsibilities. Seven of the 12 departments and three of seven major independent agencies have published draft or interim procedures in the Federal Register. Several entities such as the Army Corps of Engineers, Soil Conservation Service, and Fish and Wildlife Service have also published proposed procedures. The procedures clearly state the Federal Government's policy prohibiting the degradation of floodplains. The President's statement in the June 6, 1978, Water Resource Policy Reform Message should provide additional impetus to agency compliance.

A recent controversy with regard to Federal agency compliance with Executive Order 11988 involves EPA's review of proposed expansion plans for a wastewater treatment facility in Cape May County, New Jersey. The need for facility expansion is predicated on present and future new development in the county, including floodplain areas. In its interpretation of Executive Order 11988, EPA has chosen to limit new sewer hookups in the 100-year coastal floodplain in order to prevent the further unwise development of that hazard area. This decision in Cape May has significant implications for the continued development of New Jersey's coastal floodplains since many such areas are already served by treatment plants.

The Wetlands Protection Executive Order of 1977 (Executive Order 11990) was issued at the same time and contains many provisions identical to those of Executive Order 11988. The Wetlands Order directs Federal agencies to provide leadership in minimizing the destruction, loss, or degradation of wetlands. It differs from the Floodplain Order by specifically delineating the following major factors that agencies must consider when proposing an action in a wetland area – public safety, health, and welfare, including water supply, water quality, and recharge and discharge; pollution; flood and storm hazards; sediment and erosion; maintenance of natural ecosystems; and recreational, scientific, and cultural uses.

The Wetlands Protection Order does not apply to any Federal activity as does the Floodplain Order, but rather only to new construction undertaken in or affecting wetlands. It does not apply to private permits for activities involving

wetlands on non-Federal property, but does require that Federal leases, easements, or deeds involving non-Federal interests reference restricted uses as identified by any Federal, state, or local wetlands regulation.

Because so much of the New Jersey coast is located on floodplains or wetlands, Executive Order 11988, in combination with the Wetlands Order, could have significant effects on future Federal activities. (In New Jersey, all coastal wetlands are included within the 100-year floodplain, but all areas within such floodplains are not wetlands.) Neither order constitutes a prohibition of Federal activity when floodplains or wetlands are involved, and such a prohibition is not feasible or likely. Although the Wetlands Order is not as broad as the Floodplain Order, it directs Federal agencies to seek all practicable alternatives to new construction and could tend to reduce Corps of Engineers dredge and fill operations, beach restoration, and structural shore erosion control programs in or near wetlands.

(3) National Park System. The National Park Service's (NPS) primary responsibility in preservation of the New Jersey shore areas is associated with its stewardship of the Gateway National Recreation Area – Sandy Hook Unit, authorized under the 1916 Organic Act (P.L. 64-235), the Park, Parkway and Recreation Act of 1936 (P.L. 47-770), and the National Park Service Administration Act of 1976 (P.L. 94-458). Sandy Hook receives long-term protection and preservation of natural and cultural resources to facilitate recreational opportunities consistent with preservation of its natural values.

The NPS has undertaken and sponsored a nationwide multi-faceted program of research which continually expands our understanding of coastal processes and the barrier island environment in particular, and the unique constraints this environment places on development and use. The research findings have demonstrated the inability of barrier island areas to support the amount of permanent development and public use typically envisioned at the time the shore parks were authorized. Management objectives are continually being revised to point future use of the national seashore and recreation area in the direction of less permanent development, less manipulation of natural process, and increased opportunities for unstructured recreation related to appreciation of the natural environment. Evolving management plans reflect a generally conservative approach to barrier island development and public use that was born of an awareness of the fragility and vulnerability of these resources and the dynamic nature of the forces acting upon them.

Until recently, the national seashores were managed under NPS guidelines for recreation areas, as opposed to natural or historic areas. This generally promotes the construction of roads, utilities, visitor centers, campgrounds, and other facilities. Like other owners of barrier island property, NPS took measures to protect its investment against the natural erosional processes. However, after nearly three decades of unsuccessful attempts to stabilize the dunes at Cape Hatteras, as well as less ambitious efforts at Sandy Hook and elsewhere, the NPS recognized the ultimate futility of its efforts to arrest the forces of nature on dynamic barrier island systems.

The NPS has recently adopted a "Management Policy for Shoreline Processes" which states that – as far as possible, and cognizant of NPS responsibilities that accrue from its previous policy and actions – there will be no further attempts to restrain the natural processes of erosion, deposition, dune formation, and inlet formation. The policy further states that:

> In development zones, management should plan to phase out, systematically relocate, or provide alternative developments to facilities located in hazardous areas. New facilities will not be placed in areas subject to flood or wave erosion hazard unless it can be demonstrated that they are essential to meet the park's purpose, that no alternative locations are available, and that the facilities will be reasonably assured of surviving during their planned lifespans without the need of shoreline control measures.

Presently being reviewed by the Congress is a bill (HR 5981) which would establish as units of the National Park System, all or portions of certain undeveloped, unprotected barrier islands on the Atlantic and Gulf coasts. The bill would give the Interior Secretary authority to acquire lands or interest in lands within those units. In addition, the bill proposes the prohibition of Federal aid or permit approvals for structures, roads, access facilities, shoreline erosion stabilization projects, and post-disaster assistance for private properties on such barrier island units.

Because of the extensively developed character of New Jersey's barrier islands, only a few areas remain undeveloped – many of which are already in State or Federal ownership. The only area in New Jersey which appears on the barrier island maps accompanying HR 5981 is Stone Harbor Point. HR 5981 appears to be most appropriate for the larger, contiguous areas of undeveloped and unprotected barrier islands that still exist on the southeast Atlantic and Gulf coasts.

Although HR 5981 was still before Congress at the time of printing of the Master Plan, it was not expected to receive as much attention as other Legislation (HR 3252, S 2686, and S 1018) proposing curtailment of the Federal government's role in subsidized commercial and residential development on fragile barrier island systems.

(4) Soil Conservation. Under the U.S. Department of Agriculture, the Soil Conservation Service (SCS) provides resources for erosion management nationwide. The SCS with its component soil conservation districts has been instrumental in providing several communities in Cape May and Atlantic Counties with technical and financial assistance after major storms to install sand fencing and revegetate severely eroded dune areas. An important program in many coastal communities in the Cape-Atlantic Soil Conservation District has been the 4-H Green Dike Program responsible for extensive dune grass planting.

Under the South Jersey Resource Conservation and Development (RC&D) Program, technical and financial assistance for coastal erosion protection and dune stabilization is available to all coastal communities under the RC&D area plan. The SCS also operates a Plant Materials Center at Cape May Courthouse where various species of plants are assembled and evaluated for effectiveness in combating erosion problems. Of special note is the development of a more effective variety of dune grass, American Beach Grass "Cape" variety.

(5) Fish and Wildlife. The Fish and Wildlife Service (FWS) of the Department of the Interior has primary responsibility for implementation of the Endangered Species Act (ESA) of 1973. Section 7 of the ESA requires all Federal agencies to take whatever action is necessary to ensure that their activities will not further jeopardize an already endangered species of plant or animal, or result in the destruction or modification of essential habitat. This is a particularly powerful statute that may be used to protect fragile ecosystems which nourish and sustain scarce species of flora and fauna. Further, the Fish and Wildlife Coordination Act, as amended, requires each Federal agency to submit to FWS any development plans that would modify water bodies.

The FWS also draws authorities for coastal-related activities from the Fish and Wildlife Act of 1956, the National Wildlife Refuge System Act, the Migratory Bird Conservation Act, the Wilderness Act of 1964, and the Refuge Recreation Act of 1962. Under the Refuge System Acts, the FWS is empowered to acquire and administer National Wildlife Refuges, preserving valuable breeding, nesting, rearing, and migratory areas and permanent habitats of many species of fish, shellfish, and wildlife. In these refuge areas, the recreational activities that are encouraged include those that are wildlife-oriented — such as fishing, use of nature trails, bird watching, and natural history interpretation. In New Jersey, the FWS administers four refuge areas — two on the Atlantic coast (Barnegat and Brigantine National Wildlife Refuges) and two on the Delaware River (Killcohook and Supawana Meadows National Wildlife Refuges).

(6) Air Quality. The Clean Air Act of 1971 established a two-phase strategy to maintain ambient air quality standards. The first phase is the regulation of new indirect or complex sources such as those facilities likely to generate substantially increased vehicular traffic. Such facilities might include new ports or marinas, recreational beaches, waterfront recreational complexes, and large industrial plants. Under the Clean Air Act, assurance would have to be provided that such facilities would not result in the violation of air quality standards. In the second phase — still largely unformulated — the EPA air quality maintenance strategy calls for the development of growth plans and of a long-term control strategy where such growth may lead to air quality deterioration.

(7) Wastewater Treatment Facilities Grants. Planning and construction of wastewater treatment facilities is primarily funded by grants from Federal agencies such as EPA, the Department of Housing and Urban Development, the Farmers Home Administration in the Department of Agriculture, and the Economic Development Administration in the Department of Commerce.

Under Section 201 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500), EPA is authorized to grant up to 75 percent of the construction costs of new wastewater treatment facilities. One of the problems with EPA's facilities grant program is that inadequate areawide planning has typically preceded construction of treatment facilities. Therefore, 201 projects often contribute to growth without adequate controls and may lead to unplanned and unwanted coastal development.

As discussed previously with respect to Executive Order 11988, EPA is now giving consideration to unwise coastal floodplain development in its review and approval of proposed plans for expansion of a wastewater treatment facility in Cape May County, New Jersey.

(8) Bridge and Highway Construction Programs and Permits. The Federal Government authorizes the construction of bridges over navigable waters and authorizes the development of road systems. If the bridge or road is part of a planned primary or secondary highway system, the Government may contribute financially to its construction. The determining factor is often simply whether the bridge or road is on an approved state or county plan. Both the bridge and highway construction programs, which are administered by the Department of Transportation (DOT), may influence development by facilitating access.

The bridge permit program is administered by the U.S. Coast Guard and the highway construction grant program by the Federal Highway Administration. In cases in which an area is already developed, transportation facilities are considered necessary to serve the needs of residents as well as to permit expanding development. However, decisions regarding access and transportation facilities are of special importance where an area is undeveloped and unprotected and where the owners or local public agencies are seeking improved access to facilitate development.

Controls vary extensively from case to case. Grants and bridge permits generally require preparation of appropriate environmental documentation. Where a significant impact is anticipated, a full EIS ordinarily will be processed. In such cases, appropriate environmental terms and controls may be imposed as a condition of the grant or permit. For example, in the past, DOT approval has sometimes been conditioned on the requirement that facilities be constructed on structure rather than on fill to minimize the impact on wetland or tidal areas. There is nothing within the administrative procedures, however, that would allow programs on barrier islands, for example, to be treated in a different manner than those on any mainland area.

Bridges can be considered essential to barrier island development because without the easy access they provide, development costs would be extremely high, if not prohibitive. The Coast Guard has had statutory authority to review proposals to build bridges over all navigable waters since 1966. During the past 5 years, the Coast Guard has granted 24 bridge permits for barrier island-related projects (not all new bridges) and, as of February 1978, had six applications pending permit and processed and approved in accordance with the bridge statutes, Code of Federal Regulations, and case law. According to the Coast Guard, the issuance or denial of a bridge permit depends on whether the proposed work will provide for the reasonable needs of navigation, subject to specific statutes governing environmental impacts. NEPA requires the Coast Guard to consider the potential impact of a proposal on the future development of an island and to seek public comment and expert testimony from Federal, state, and local agencies. These comments are formally obtained through the NEPA EIS review process.

It appears that the Coast Guard has never denied a bridge permit on environmental grounds. It has been the general practice of the agency to issue bridge permits unless the structure would interfere with navigation. It should be noted, however, that bridges to barrier islands have not been a controversial issue until recently; the agency may, therefore, not have had an opportunity to deal with the issue. The Coast Guard has no regulations that specify the regulatory tests which a bridge proposal must pass or that set forth the burden of proof which a permit applicant must satisfy.

A recent development in this regard involves the Sierra Club and the National Resources Defense Council (NRDC), which recently filed suit in Federal district court to challenge Government action which encourages the private develop-

ment of environmentally sensitive coastal areas (Environmental Reporter, April 4, 1980). The suit specifically challenged the actions of Federal agencies in granting permits and authorizing funds for construction of a new highway access bridge between Dauphin Island, a small barrier island near Mobile, Alabama, and the mainland. The proposed construction, at a cost of more than $30 million, is for replacement of a bridge that was destroyed by Hurricane Frederic in 1979. The Sierra Club and NRDC consider the litigation a test case of the policies and practices of the Federal Government regarding the coastal zone. They contend that a variety of Federal programs encourage private development in high risk areas despite the mandate of Executive Orders 11988 and 11990, which direct Federal agencies to avoid aiding the development of floodplain and wetland areas "wherever there is a practicable alternative."

DOT has adopted a wetlands protection policy (DOT Order No. 5660.1, 1975), and though wetlands are usually found in association with barrier islands, the Coast Guard has yet to decide how it will apply the DOT policy to bridge permits and construction of bridges. Similarly, a provision of the DOT Act of 1966 prohibits the agency from sponsoring or approving projects that would use publicly owned land that is important for wildlife, recreation, and historic preservation, unless there are no feasible alternatives and all planning measures have been established to reduce the impact of the project on publicly owned wildlife refuges and recreational and historic resources. This is often overlooked in cases of de facto wildlife sanctuaries or recreation areas (e.g., publicly owned wetlands, or important natural fisheries).

The Federal Highway Administration, with its multi-billion dollar per year highway construction program, plays an important role in determining land use patterns. The availability of Federal financial assistance for transportation improvements also makes it practical and more economically rewarding to convert from low- to high-density developments. Construction of a major access road or highway may result in serious alteration of the natural features in a given area. Roads improve access and increase pressures for residential, recreational, commercial, and industrial development.

There are, however, environmental constraints on all federally funded highway construction. When important resources are involved, EIS's must be prepared under applicable NEPA and Federal Highway regulations.

(9) Federal Surplus Property. The General Services Administration (GSA), under the provisions of the Federal Property and Administrative Services Act of 1949, as amended, currently leases a number of properties for various purposes, mostly Federal agency space needs. However, GSA is also responsible for disposal of Federal surplus property. Not all future development plans are known to GSA at the time of a disposal action; unanticipated uses that might involve increased development could occur with the sale or transfer of title to real property in shore areas.

Cities, counties, and states may purchase Federal surplus property for development purposes, ranging from parks and recreation to economic development (commercial and industrial). Although many surplus properties are converted to recreational or wildlife uses by state or local governments, many are also assigned to the Department of Health, Education and Welfare for conveyance to local governments for public health or educational purposes. GSA has an environmental assessment and impact statement program for its lease and disposal actions.

(10) Interstate Land Sales. The Interstate Land Sales Full Disclosure Act (P.L. 90-448), administered by HUD, may inadvertently contribute to the development of barrier islands and other shore areas. Although the Act was not designed by Congress to influence the patterns of land use or the rate or timing of development of barrier islands, neither was it designed to discourage such development. To meet statutory requirements, land developers (sellers) must make a property report available to each buyer, which discloses information on various aspects of the property involved. However, because of the volume and cost of printing, developers usually make the reports available to HUD, and potential buyers must obtain the information from that agency.

The disclosure requirements apply to subdivisions without regard to the geographical location of the land. According to HUD officials, the fact that a subdivision is located on a barrier island would not by itself be sufficient to require disclosure. However, lack of access by road or bridge would probably require disclosure. Properties on barrier islands and other erosion hazard areas could thus be made to appear extremely attractive if the hazardous nature of occupation was not revealed.

(11) Economic Development Administration Grants. The Economic Development Administration has primary responsibility for the Economic Development Grants program under the provisions of the Public Works and Economic Development Act of 1965. Technical assistance is provided to help distressed areas evaluate and understand their problems and economic potential. This assistance may be in the form of studies to identify area needs or solve industrial and economic problems; grants-in-aid amounting to 75 percent of the cost of planning and administering local economic development programs; and management and operational guidance for private firms.

Grants of up to 50 percent of the development cost can be used for such public facilities as water and sewer systems, access roads to industrial parks or areas, harbor facilities, railroad sidings and spurs, public tourism facilities, vocational schools, flood control projects, and site improvements for industrial parks. Severely depressed areas that cannot match Federal funds may receive supplementary grants to bring the Federal contribution up to 80 percent of the project cost.

Loans also are available for public works and development facility projects. A community that is unable to raise its share or the eligible project cost may receive a grant for 50 percent or more of the project's cost and a Federal loan for the remainder.

(12) Urban Planning Assistance. HUD provides grants to assist comprehensive urban development planning programs in small communities, states, and metropolitan areas. Activities eligible for grants include preparation of comprehensive development plans, development of capital improvement programs, coordination of intergovernmental urban planning activities, and preparation of regulatory and administrative measures (e.g., general plans, zoning, ordinances).

Certain studies for overall economic development programs under the Department of Commerce are also eligible under this program. Grants may also be made to cover the cost of studies and research to develop and improve planning methods.

(13) Federal Home Mortgage Insurance. Home mortgage insurance programs are administered by the Farmers Home Administration and by the Federal Housing Administration (FHA). The FHA, by insuring commercial lenders against loss, encourages them to invest in the home mortgage market. FHA insures loans made by private financial institutions for up to 97 percent of the property value for terms of up to 30 years. The loans may finance homes in both urban and rural areas (except farm homes).

Farmers Home Administration loans may be used to construct, repair, or purchase housing; provide necessary and adequate sewage disposal facilities for the applicant and family; purchase or install essential equipment which, upon installation, becomes part of the real estate; or buy a site on which to place a dwelling for the applicant's use.

(14) Mineral and Petroleum Exploration and Extraction. The International Convention on the Continental Shelf, which went into force in 1964, added more than 1 million square miles to the public lands of the United States. However, the distribution, richness, and extraction costs of oil, gas, and mineral deposits on barrier islands and, particularly, on the continental shelf are still under investigation.

In accordance with the CZMA of 1972, as amended, any federally licensed or permitted activity, such as the outer continental shelf (OCS) mineral and petroleum exploration, development, and production plans, must be reviewed and approved by the State of New Jersey (DEP). For State approval, OCS activities (such as the construction and operation of pipelines or support bases) must be in compliance with, and carried out in a manner consistent with, the approved Coastal Management Program. Such activities are also subject to Federal consistency certification, licensing, or permitting by appropriate agencies, including the Army Corps of Engineers, Bureau of Land Management, USGS, and EPA.

Thus, there is a mechanism to identify and resolve potential conflicts between future OCS operations and the Shore Protection Master Plan.

(15) Land and Water Conservation Fund Grants. The Heritage Conservation and Recreation Service (HCRS), formerly the Bureau of Outdoor Recreation, of the Department of Interior is responsible for administering the Land and Water Conservation Fund (LWCF) program. The Land and Water Conservation Fund Act of 1965 (P.L. 88-578), as amended, established a fund to increase outdoor recreational opportunities for the American people. The program provides for acquisition of lands for federally administered parks, wildlife refuges, and recreation areas (the "Federal side") — and for matching grants for state recreation planning and state and local land acquisition and development (the "state side").

The Federal side, not less than 40 percent of the total LWFC, provides money only for the acquisition of national recreation lands, which must be approved by Congress. No funds are provided for development, operation, or maintenance. These areas are administered by the Department of Interior's National Park Service, Bureau of Land Management, and Fish and Wildlife Service, and the Department of Agriculture's Forest Service.

The state side, about 60 percent of the total LWCF, provides grants to states and through states to their political subdivisions (cities, counties, towns, etc.) for the acquisition and development of public outdoor recreation areas and facilities. Again, no funds are available for operation or maintenance.

To receive grants from the LWCF, a state must develop a Statewide Comprehensive Outdoor Recreation Plan (SCORP) and update and refine it on a continuing basis. The LWCF provides matching planning grants and technical assistance to states to help develop and update comprehensive outdoor recreation plans. These plans identify capital investment priorities for acquiring, developing, and protecting all types of outdoor recreation resources within a state. The NJDEP submitted its SCORP in October 1977. The present HCRS guideline for preparation of these plans does not contain special provisions to promote protection and environmentally compatible uses of coastal areas.

Although the HCRS does not directly manage or administer lands, its program responsibilities under the Historic Sites Act of 1935, the National Historic Preservation Act of 1966, and the Archeological and Historic Preservation Act Amendments of 1974 have significant potential for influencing use of coastal areas. Under these programs, HCRS evaluates and designates significant natural, historic, and cultural areas for inclusion in the National Registry of Natural Landmarks (due to be completed in 1980) and the National Register of Historic Places. Listing of a resource on one of these registries highlights its significance but does not ensure its total protection.

f. Program Coordination

At least 20 Federal agencies are involved in more than 30 Federal programs that influence the degree and extent of shore protection and coastal development. Insufficient coordination among agencies appears to be a major problem. On the one hand, some Federal programs and policies encourage development that is incompatible with natural process and values of the shore, barrier islands, and beaches; on the other, some Federal programs and policies are designed to promote the conservation of coastal zones and their resources. These programs often work at cross purposes, resulting in confusion, wasted dollars, and lost or misused resources.

In response to the President's Environmental Message of 1977, the Secretary of Interior has conducted a review of these Federal programs and has identified recommended policy and program changes related to protection of barrier islands. These are reviewed in the following section.

2. New Directions in Federal Policy

a. Barrier Island Protection/1977 Presidential Message

(1) Introduction. New direction in Federal policies on shore protection comes from directives and reviews of existing policy in the coastal zone as a result of the President Carter's first (May 1977) and second (August 1979) Environmental Messages. The first message identified the unique aspects of the barrier islands of the Gulf and Atlantic, and called for a review of existing and conflicting Federal policies that affect these ecosystems, and directed the Secretary of Interior – in consultation with the Secretary of Commerce, the Council on Environmental Quality (CEQ), and State and local officials in coastal areas – to develop a plan to protect the barrier islands from unwise use and development. The President's second message outlined three initiatives aimed at achieving comprehensive and wise management of the coastal zone:

- o Reauthorization of the Coastal Zone Management Act for 5 more years at current levels;
- o Development of new amendments to the Act which would establish a national coastal protection policy; and
- o Conducting a systematic review, by the Secretary of Commerce, of Federal programs that significantly affect coastal resources.

The objective was to provide a basis for specific recommendations to improve Federal actions affecting the coastal zone and develop additional legislation needed to achieve the national coastal management goals.

In his May 1977 Environmental Message, President Carter stated:

> Coastal barrier islands are a fragile buffer between the wetlands and the sea. The 189 barrier islands on the Atlantic and Gulf Coasts are an integral part of any ecosystem which helps protect inland areas from flood waves and hurricanes. Many of them are unstable and not suited for development, yet in the past the Federal Goverment has subsidized and insured new construction on them. Eventually, we can expect heavy economic losses from this shortsighted policy.
>
> About 68 coastal barrier islands are still unspoiled. Because I believe these remaining natural islands should be protected from unwise development, I am directing the Secretary of the Interior, in consultation with the Secretary of Commerce, the Council on Environmental Quality, and State and local officials of coastal areas, to develop an effective plan for protecting the islands.

In an information supplement issued following his May 1977 Environmental Protection Message, the President added:

> Most of the barrier islands are ...targets of intense real estate and development activity. The development of these resources has often been encouraged by federally permitted or subsidized roads, bridges, and sewers, with the result that millions of people have been subjected to the hazards of hurricanes, and to property losses from the erosion and other physical changes that are characteristic to barrier formations. These hazards and losses have, in turn, invited substantial Federal spending for seawalls...and beach restoration projects that perpetuate more settlement and then more Federal investment, while causing the continuous loss of valuable and unique resources.

In January 1980, in response to the President's directive, the Heritage Conservation and Recreation Service (HCRS), in conjunction with the National Park Service (NPS), the Fish and Wildlife Service (FWS), and CEQ published a Draft Environmental Impact Statement (DEIS) on Alternative Policies for Protecting the Barrier Islands. In that document, a number of options are presented according to specific levels of protection, which would allow decisionmakers to determine the most desirable and feasible plan of action for barrier island protection. The key aspects of this analysis are presented below.

(2) Findings (Policy Objectives). The unique character of each island, combined with the national interest in protection of barrier islands in general, represents a special opportunity for cooperation between Federal and state governments in formulating future barrier island policy.

Several significant conclusions were developed from a review of the HCRS statement. These are:

- o Barrier islands need special recognition.
  - — Barrier islands are unique, discrete components of the coastal zone which merit special action and attention. The dynamic and fragile character of barrier islands has often not been recognized by the governmental jurisdictions whose programs affect them.
  - — The responsibility for the development of a consistent Federal policy related to barrier islands is not well defined; as a result, Federal programs have unanticipated and conflicting impacts.
- o Review of existing Federal authorities related to barrier islands reveals the need for a clear Federal barrier island policy.
  - — The CZMA of 1972 (as amended, 1976), the Floodplains Management Executive Order 11988 and Wetlands Protection Executive Order 11990, the National Flood Insurance Program, the Flood Disaster Protection Act, and the Fish and Wildlife Coordination Act could be amended to positively address aspects of barrier island protection. Properly implemented and enforced, these programs have the potential to promote the wise use of barrier islands. However, new legislative initiatives specifically directed toward barrier island preservation will be required to achieve the highest levels of protection.
- o Information on which to base the formulation of barrier island policy must be made available to planners and other public and private officials.
  - — Federal, state, and local growth management decisions concerning barrier islands often have been based on insufficient impact analysis.
  - — The information necessary and appropriate for management planning of barrier island resources is just beginning to become widely available. The dissemination of this information has not been widespread.
- o Private enterprise must continue to play a valuable role in barrier island protection. Private commitment ranges from large national and regional conservation organizations to small groups and concerned citizens.
  - — Private conservation groups have taken a lead in monitoring Federal, state, and local barrier island related activities and in the drive for an evaluation of Federal barrier island related policies. Some also have acquired significant portions or numbers of barrier islands for preservation purposes.
- o The roles of the states and localities are critical to any barrier island protection program.

- States and local units of government have the first opportunity to protect their barrier islands or provide for their orderly development. States and their subdivisions have the tools by virtue of the authorities and roles granted them by the U.S. Constitution, as a result of various Federal programs, and through land development controls traditionally exercised by local governments.

- The decisions made by the states and localities will be affected by the extent to which Federal programs can be redirected, implemented, and enforced; the "trickle-down" effect of the redirected Federal programs; and the increasing public awareness of barrier island dynamics and values as storm buffers, fish and wildlife habitats, and public recreation sites.

Federal programs and authorities have, in many ways, encouraged development of barrier islands, resulting in potential problems of public health and safety, increasing costs, and loss of important public benefits provided by unspoiled barrier islands.

The belief that Federal programs are encouraging and assisting development of barrier islands with resulting losses of natural, cultural, fish and wildlife, and recreational values is well founded. The programs of nearly 20 Federal agencies were identified as having an impact on barrier islands. Although about one-fourth of the agencies administer programs which directly or indirectly provide protection for barrier islands, over one-half administer grant, loan, permit, or construction programs that have had adverse impacts on the study units; the remainder administer property, insurance, and relief programs that have encouraged or perpetuated unwise use of the islands.

This situation is not the result of any directed Federal policy to encourage barrier island development. Rather, it results from a general lack of knowledge and understanding of barrier islands as unique resources warranting special attention and protection. While a broad range of Federal and state authorities address aspects of barrier island land management, barrier islands as a whole are treated only as a peripheral concern. Thus, the development on many barrier islands is the product of inadequate planning policy.

Three alternative levels of effort for barrier island protection — low, moderate, and high — are presented in the HCRS DEIS. The low level alternative describes existing Federal programs which already are working to protect barrier islands from unwise development and those which are being redirected toward protection of barrier islands. The moderate and high level alternatives focus on identification of which development-oriented programs can be modified to effect conservation rather than unwise development of these narrow and valuable landscapes. Highlights of the HCRS unified Federal policy objectives for alternative barrier island protection are provided in Table III.C-5.

The moderate level of effort builds on the low level by describing existing authorities which could contribute to barrier island protection, but which, because of a lack of direction, delegation, or appropriation, are not moving as effectively as they could toward barrier island protection. The options are designed to make these authorized programs more effective in protecting barrier islands. The high level of effort requires new program action. New and amendatory legislation and strong executive directives will be required.

TABLE III.C-5

HIGHLIGHTS OF UNIFIED FEDERAL PROGRAM POLICY OBJECTIVES FOR ALTERNATIVE BARRIER ISLAND PROTECTION

Moderate-Level Protection Alternative

I. Development Project Evaluation

To ensure that strict environmental review is given to all projects on barrier islands proposed or assisted by Federal agencies.

II. Flood Insurance

To promote wiser use of barrier islands through prompt identification and mapping of the high hazard areas and reflection of those hazards in federally sponsored flood insurance programs affecting barrier island properties.

III. Disaster Mitigation and Recovery

To promote the use of disaster assistance and coastal protection programs to guide future uses of barrier islands so as to minimize the loss of natural values, reduce the loss of human life and property, and lessen costs to the general taxpayer resulting from unwise development of high hazard areas on barrier islands.

IV. Resource Evaluation and Planning

To increase emphasis by Federal agencies in identifying and evaluating barrier island resources possessing high natural, cultural, or historical values, and to ensure that the greatest degree of protection feasible can be provided to these values.

V. Permit Process

To ensure that all permits or rights-of-way awarded for activities related to barrier islands will not alter or destroy existing natural resource values.

VI. Executive Orders 11988 and 11990

To provide maximum support to the enforcement of Executive Orders 11988 and 11990.

VII. Public Information and Education

To undertake an extensive public information and education effort to highlight resource values and hazards frequently encountered on barrier islands.

VIII. Acquisition

To emphasize acquisition of barrier islands through existing Federal programs and to encourage application of appropriate less-than-fee acquisition methods when feasible.

High-Level Protection Alternative

I. Development Project Evaluation

To restrict Federal government initiated or assisted development projects on barrier islands unless they can be shown to be in the national interest.

II. Flood Insurance

To encourage FIA to give higher priority to barrier islands than to other flood-prone areas in implementing its authorities and responsibilities which have barrier island application.

III. Disaster Mitigation and Recovery

To encourage the consideration of barrier island values and hazards in the administration of Federal disaster assistance programs.

IV. Resource Evaluation and Planning

To provide mechanisms for identifying, classifying, and planning the protection of barrier island values.

V. Permit Process

To restrict approval of Federal permits and rights-of-way for development on barrier islands.

VI. Executive Orders 11988 and 11990

To place emphasis on the barrier island floodplains and ensure a consistent and comprehensive implementation of the two orders.

VII. Public Information and Education

To undertake an extensive public information and education effort to highlight resource values and hazards frequently encountered on barrier islands.

VIII. Acquisition

To emphasize Federal and state acquisition of barrier islands and encourage donations of barrier island property by private land owners.

(3) Discussion of Selected Proposed Alternatives. This subsection briefly describes the options for a number of issues of particular relevance to alternative erosion management policies.

(a) Flood Insurance. From the outset of the NFIP, the minimum floodplain management requirements have been construction requirements; that is, guidance to reduce flooding impacts has been directed primarily to structural rather than locational considerations.

Section 1360 of the National Flood Insurance Act of 1968, as amended, allows Federal authorities to identify and publish information with respect to all floodplain areas; to establish flood risk zones; to develop comprehensive criteria to encourage, where necessary, the adoption of adequate state and local measures which will improve the management of flood-prone areas; and to assist states and local governments in acquiring properties that are located in flood risk areas and are severely damaged by floods. NFIP considerations are very important in any plan to protect barrier islands from unwise development, particularly since a majority of islands are located in the 100-year floodplain and coastal high hazard areas.

o Moderate Level Protection Options

- The FIA should place higher priority on floodplain mapping for barrier islands. Although the FIA has placed emphasis on completing coastal floodplain mapping, the fact remains that substantially increased efforts will be required to meet the congressionally mandated completion date of 1983. Once the mapping and precise delineation of flood hazard areas is completed, insurance rates and construction standards for many barrier island communities will be established.

- The height of wave crest and runup should be included in calculation of the 100-year flood coastal high hazard areas on barrier islands.

- To adequately reflect these unique hazards, FIA should consider modifying its regulations to differentiate between the types and degrees of hazard. Incorporating this information into rate structures may reduce risk to life and property and further protect the natural resource values on the islands.

- Upon completion of floodplain mapping for barrier islands, FIA should consider developing actuarial rates specifically related to barrier islands which reflect the true risks of development. These revised insurance rates would undoubtedly be higher. Hopefully, decisions on where and how to build would be affected by the higher rates; the islands' natural features would be protected; and cost to the general taxpayer from insurance subsidies would be reduced.

- Once the true risks are reflected in the actuarial rates and construction standards, FIA should ensure adequate levels of inspection and enforcement of approved building codes as a qualification for flood insurance eligibility. Building codes and other regulations affecting development on barrier islands are only as effective as the quality of inspection and enforcement. FIA should establish minimum quality standards for inspectors and require certification of inspectors as a requirement for flood insurance eligibility.

- FIA regulations for insurance eligibility should include local requirements that new construction or reconstruction be located landward of the reach of mean high tide.

o High-Level Protection Options

- FEMA should consider exercising its authority under the NFIP to prepare flood insurance rate maps for all barrier islands; to designate all appropriate barrier islands as "coastal high hazard areas"; and to develop erosion setbacks to ensure that new construction is not undermined during the terms of federally insured mortgage.

- FEMA should also consider amending the Flood Disaster Protection Act to deny federally subsidized flood insurance for new construction in areas designated as "coastal high hazard areas" or which are seaward of the erosion setback line.

Since the Janaury 1980 release of the HCRS DEIS on Alternative Policies for Protecting the Barrier Islands, several new developments have occurred with respect to the NFIP. First, due to an operating deficit of about $230 per policy between 1978 and 1980 for flood insurance policies sold in coastal "V"-zones, in January 1981, FEMA increased the actuarial rates for these policies. This increase amounted to 1.75 times more than the corresponding rates for inland flooding areas. Other actions to improve the fiscal soundness of the program in coastal "V"-zones include: an October 1981 43% increase in flood insurance rates for existing construction; delineation of storm wave heights in communities along the Atlantic and Gulf coasts to reflect the true flood risk for flood plain management and actuarial rating purposes; and on October 1, 1981, complete mapping of all "V"-zones and institution of a new actuarial rating system to include the wave height risk factor in "V"-zones.

In its final regulations for implementation of Floodplain Management Executive Order 11788 (see Federal Register, Vol. 45, No. 176, September 9, 1980, pp. 59520-59538), FEMA set forth policies and procedures designed to avoid direct or indirect support of flood plain development and construction wherever practicable and to promote the use of non-structural flood protection methods. In an attempt to shift development patterns away from high hazard areas, in situations where a storm disaster has occurred, it appears that FEMA will selectively apply a policy of designating the affected area a total loss and relocate people out of the area to prevent future disasters.

Federal legislation (H.R. 3252, S 2686, and S 1018) now before Congress would deny Federally subsidized flood insurance for development in certain undeveloped, unprotected coastal barrier island sectors.

(b) Disaster Mitigation and Recovery. As discussed earlier in Sections C.1.a and C.1.d, several Federal disaster relief programs are designed to provide assistance to states, local governments, individuals, and owners of selected nonprofit facilities to alleviate suffering and damage which result from natural disasters. These programs also assist in the reconstruction and rehabilitation of devastated areas including those located in hazardous locations on barrier islands.

Federal disaster mitigation and recovery programs should be redirected to ensure that they do not simply perpetuate past mistakes by encouraging or subsidizing reconstruction or restoration of storm damaged structures in high hazard areas.

- Moderate Level Protection Options

  - The Federal Disaster Assistance Administration (FDAA) and Small Business Administration (SBA) should consider developing regulations by which to condition receipt of predisaster planning assistance and post-disaster loans or grants on established state disaster recovery plans which would – (1) incorporate the state's disaster legislation and require its full implementation; (2) require a recognition that barrier islands are particularly vulnerable to disaster; (3) be adequate to protect human life by discouraging development of high hazard areas; and (4) require state preparation of "contingency redevelopment plans" to encourage reconstruction away from barrier islands.

  - The role of the Corps of Engineers in coastal protection should be strengthened by emphasizing the natural protective capabilities and the need to preserve the ecological integrity of wetlands, beaches, and dunes.

  - The Corps should be encouraged to shift from increasingly expensive structural control of erosion and flooding to cooperative land management.

  - Development of erosion and flood control structures on undeveloped barrier islands should be restricted except in exceptional circumstances and then allowed only where it can be demonstrated that the proposed structure will not adversely affect other barrier island areas.

  - The concurrence of the Secretary of the Interior should be required for any erosion or flood control structure which may adversely affect an island administered by the Department of the Interior.

  - Issuance of permits to dredge or fill in wetlands on a barrier island should be restricted except in extreme cases of overriding national interest.

  - The Office of the Chief of Engineers should be required to develop and issue specific criteria and guidance regarding the significance of barrier islands, to prepare a uniform method for each Corps District to carry out its program operations on the islands, and to define regulatory boundaries for District and Division Offices by which to identify jurisdictional control and to ensure consistency within the flood control and disaster assistance programs as they relate to barrier islands.

- High-Level Protection Options. Existing legislation authorizes or permits a range of mitigation activities as related to major disasters on barrier islands. Grants and loans are expeditiously provided for reconstruction or restoration of facilities to pre-storm conditions; areas are cleared of debris; and utilities are restored to working condition.

The following options would establish mechanisms for identifying and delineating areas and types of facilities in coastal high hazard zones which, when severely damaged by storms, would not be eligible for Federal assistance to reconstruct or restore in the same location. However, relocation assistance would be provided to help individuals and businesses move from the high hazard areas.

- The Flood Disaster Protection Act of 1973 could be amended to restrict disaster assistance from being used for reconstruction in coastal high hazard areas and to provide relocation assistance for businesses and residents who voluntarily elect to move to safer areas.

- The Disaster Relief Act of 1974 could be amended to:

  Require disaster preparedness plans and programs, including specifications and standards for determining the areas where, and conditions under which, development would or would not be allowed (Section 201). Post-disaster recovery assistance could be dependent on the inclusion of such standards and specifications in the state's plan.

  Prohibit the reconstruction of any Federal facility on a barrier island that is substantially damaged by a storm unless there are no prudent or feasible alternatives and the facility is required for public health or safety, is related to the enhancement of fish and wildlife values or provides public recreation opportunities, and will not adversely affect the natural values on the island (Section 401).

  Authorize the establishment of Recovery Planning Councils prior to a major disaster to assist in developing and gaining approval of predisaster contingency plans for barrier islands.

(c) Acquisition and Conservation. In addition to acquisition programs of NPS, FWS, and HCRS, two other Federal agency acquisition programs that could provide a measure of protection to specific barrier island areas have been authorized by Congress. To date, neither of these programs has been adequately funded.

The first is a program to be administered by the OCZM (Section 315(2) of the CZMA) to assist states in purchasing access to beaches and other coastal areas. The other program is to be administered by FIA (Section 1362 of the National Flood Insurance Act) to assist communities in acquiring properties in flood-prone areas once they have been damaged substantially beyond repair by a flood.

o Moderate-Level Protection Options

- As a means of managing and regulating inholdings, the NPS and FWS could develop cooperative agreements and other authorities with local governments to promote compatible development and use of peripheral lands. Searching for common points of concern and interest in leaving certain areas for open space (e.g., to promote the wisest use of resources in watershed areas) should result in better land use practices on a regional and area basis.

- Dependent on existing authorities, the Federal Government could purchase or seek donations of scenic and open space easements on adjacent lands wherever it is economically and programmatically practical. Although

these easements sometimes may cost almost as much as fee-simple acquisition, significant long-range savings to the Federal Government and to local government tax collections may result because the land is not removed from tax rolls and the Federal Government does not become directly responsible for its management.

- Dependent on existing authorities, the Federal Government could consider purchasing certain adjacent lands in the marketplace and later reselling such lands with deed restrictions permanently limiting the type of activity that can occur. It may be legally necessary for one Federal Government agency to deed enforcement of such a restriction (e.g., an open space or scenic easement) to another Federal agency to avoid having it considered an unreasonable restraint on the alienation of land. Legislative authority for such activities may be necessary.

- The Government should consider restricting issuance of special-use permits and rights-of-way to inholders, adjacent land owners, or state and local governments for activities on Federal lands such as refuges and seashores.

- OCZM should analyze the merits of implementing Section 315(2) of the Coastal Zone Management Act which would provide funds for states (on a 50 percent matching basis) to acquire shorefront access and islands. If Section 315(2) is implemented, OCZM should consider earmarking a substantial proportion of these funds for protecting and preserving barrier islands through innovative techniques which could include less than fee-simple acquisition.

- OCZM should revise its estuarine sanctuary regulations to give high priority to the inclusion of portions or all of a barrier island as part of an estuarine sanctuary.

- FIA should be delegated that authority created under Section 1362 of the National Flood Insurance Act of 1968 to assist communities in acquisition of flood-prone areas. If Section 1362 is implemented, FIA should consider acquiring barrier island properties located in a flood risk areas which are covered by the flood insurance program and are damaged beyond reasonable repair. These properties could then be transferred, leased, sold, or donated to public agencies which agree to use them for conservation or recreation purposes.

- HCRS should encourage contributions of barrier island properties by the private sector to public agencies and work to ensure that private groups continue to have an active role in barrier island protection efforts.

- GSA should consider limiting the disposal of Federal surplus properties on barrier islands for recreation, conservation, and open space purposes and incorporating reverter provisions in leases and deeds of sale on Federal surplus transfers to restrict changes in use patterns and densities.

o High-Level Protection Options

- NPS should consider amending the specific National Seashore Acts which prohibit acquisition of state and local lands within established boundaries except by donation. Where management conflicts exist, the Secretary

should be able to acquire those lands by other means, including condemnation, when it is necessary to protect the natural values of the federally administered public lands. Authority to purchase land outside of established boundaries after disasters or where serious conflicts with private holdings exist should also be considered.

- HCRS should consider amending the Land and Water Conservation Fund Act of 1965, as amended, to change the currently imposed match ratio of 50 percent Federal – 50 percent project sponsor to 70 percent Federal –30 percent project sponsor for any state or locally proposed barrier island acquisition even though the primary purpose of the proposed acquisition is conservation rather than recreation.

- If it is determined that a problem exists due to insufficient funds or inflexibility in the Federal portion of the LWCF consideration should be given to establishing a Barrier Island Trust Fund. Using some of the funds received from OCS leasing in excess of that appropriated to LWCF, islands should be purchased using less than fee-simple acquisition wherever possible.

- OCZM should consider extending Section 315(2) of the CZMA when it expires.

- The Department of Treasury and HCRS should jointly consider the development of a comprehensive conservation tax law which, among other things, would increase tax benefits for charitable gifts of easements, deed restrictions, or other types of donations which would provide protection for barrier islands; and discourage speculation and development of barrier islands by imposing a speculation tax, increasing taxes on capital gains realized on barrier island property transactions, and prohibiting claims of accelerated depreciation of barrier island properties.

b. New Direction in Federal National Coastal Policy/1979 Presidential Environmental Message

In August, 1979, President Carter outlined three initiatives to continue and improve coastal zone resource protection policy. As of August 1981, the status of these initiatives under President Regan's administration is unclear.

(1) National Coastal Protection Policy. In addition to reauthorization of Federal assistance to states under CZMA for another 5 years at the present level, the President called for enactment of amendments to the CZMA to establish "a clear national coastal protection policy," the goals of which will be to:

- o Protect significant natural resources such as wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife.
- o Manage coastal development to minimize loss of life and property from floods, erosion, saltwater intrusion, and subsidence.
- o Provide predictable siting processes for major defense, energy, recreation, and transportation facilities.
- o Increase public access to the coast for recreational purposes.
- o Preserve and restore historic, cultural, and aesthetic coastal resources.

- o Coordinate and simplify government decisionmaking to ensure proper and expedited management of the coastal zone.

(2) Federal Coastal Program Review. The President's Environmental Message also called for a review of all "Federal programs that significantly affect coastal resources" to identify conflicts with our national coastal management goals and to recommend legislation and other improvements in Federal administration of such programs. In particular, the President asked that consideration be given to whether Federal funds, programs, licenses, and permits affecting coastal areas are employed in a consistent or coordinated fashion; whether Federal actions contribute to wasteful, uneconomic, or environmentally unsound development in coastal areas; and the effect of Federal programs and activities on critical natural systems, unique and scenic recreation areas, and erosion-prone or hazardous areas.

The Federal Government plays a substantial role in the protection, development, and use of the Nation's coastal zone. This role is varied, with agencies representing the full range of interests from wilderness preservation to economic development. In some instances, this myriad of missions is guided by singular national policy. In most cases, however, agencies are left to fulfill program objectives within the context of numerous congressional or administrative mandates. Improved coordination among the many Federal programs is a continuing challenge, especially for programs affecting areas as diverse and valuable as the coastal zone.

Pursuant to this President's directive, NOAA, along with other Federal agencies, completed the Federal Coastal Programs Review in January 1981. The Review examines the role of Federal agencies including programs for development and reconstruction assistance, and programs for infrastructure development in coastal areas. The following summary recommendations were made in these two areas:

- o Programs for Development and Reconstruction Assistance.
  - – Increased emphasis should be placed on nonstructural measures in the planning process for water resources projects; and impediments to this objective – such as imprecise treatment of nonstructural flood control measures in the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources, methodological biases in cost/benefit analyses in favor of structural measures, and insufficient use of grant or loan conditions to require adoption by local communities of nonstructural measures – should be removed.
  - – Legislation should be enacted that codifies the essential policies of Executive Order 11988.
  - – Administrative changes in the National Flood Insurance Program should be adopted to assure that all new development in flood-prone areas is actuarially rated (rather than provided subsidized rates) and to strengthen local floodplain management requirements by limiting new development in high hazard areas and assuring that development does not exceed community ability to evacuate.
  - – Section 1362 of the National Flood Insurance Act should be amended and adequately funded to make relocation more effective as a hazard mitigation tool.

- The Disaster Relief Act of 1974 should be amended to provide stronger incentives for predisaster hazard mitigation planning by requiring the availability of such plans as a condition of eligibility for nonemergency postdisaster relief, prohibiting all Federal assistance inconsistent with an adopted hazard mitigation plan, and making available funding and increased technical assistance to state and local governments to prepare such plans.

- The Consolidated Farm and Rural Development Act and the Small Business Act should be amended to improve targetting of development away from high hazard areas and to assure consistency of assistance under those Acts with hazard mitigation plans prepared under the Disaster Relief Act.

o Federal Programs Supporting Development Support Programs.

- The Council on Enviornmental Quality should convene an interagency task force to design and recommend a system for collecting and sharing information on the impacts of infrastructure projects on coastal resources.

- Federal agencies should require that Federally approved project selection mechanisms incorporate national coastal objectives so that such policies are applied as early as possible in the design of infrastructure projects and conflicts are thereby avoided.

- Additional effort should be devoted by Federal agencies to improving procedures and methodologies for evaluating secondary and cumulative effects of infrastructure project decisions. Once identified with reasonable certainty, secondary, and cumulative effects should be given the same weight as direct impacts in evaluating project alternatives.

- Legislation should be enacted codifying the essential policies of Executive Order 11988 (Floodplain Management), and Executive Order 11990 (Wetlands Protection) should be amended to remove certain exemptions which have limited its effectiveness.

- The President should issue a coastal resource executive order setting forth decision guides designed to ensure that Federal investments in infrastructure and other projects with significant adverse effects on coastal resources are made only where the public benefits clearly outweigh the costs and all reasonable mitigating measures have been adopted.

- Federal agencies supporting infrastructure projects should be directed to adopt and implement clear and specific policies designed (a) to minimize adverse growth impacts on significant coastal resources, (b) to establish limits on acceptable losses of coastal resources which, if exceeded, will require project denial, and (c) to identify when mitigation will be required as a condition of project approval and what mitigation measures are appropriate and sufficient.

- Federal agencies should be directed to develop, implement, and report annually on the results of postconstruction project monitoring programs.

- Federal agencies should be directed to consolidate their policies and procedures for protecting coastal resources in a single document which is readily available to the public, project applicants, and other interested persons.

c. New Federal Barrier Island Legislation

The first action taken by Congress with respect to Barrier Island was the inclusion of a provision in the FY 1982 budget banning Federal flood insurance on undeveloped barrier islands after October 1, 1983. At the time this document was prepared, however, broader barrier island protection bills were under consideration.

A proposed Coastal Barrier Resources Act was introduced in the Senate (S 1018) and the House (HR 3252) in April 1981. Similar bills had been introduced in 1979 in the 96th Congress (S 2682 and HR 5981). The bills would establish a barrier island protection system consisting of unprotected, undeveloped barrier islands and the unprotected undeveloped portions of developed islands. The bill would prohibit Federal expenditures or financial assistance for construction, the sale of flood insurance, or the understanding of shore protection projects on units within the system. Presently the only area in New Jersey large enough for inclusion in the bill is Stone Harbor Point.

D. CHOICES

A discussion of the various shore protection alternatives, including both engineering, and non-engineering techniques and concepts, is presented in the next chapter. Given the policy review provided in this chapter, and the alternative adjustments to coastal erosion presented in Chapter IV, the stage is set for a decision regarding which approach, or combination of approaches – engineering alternatives or land management tools – should be the guiding policy for the State in the years to come. The proposed shore protection plans and costs for New Jersey are outlined in Chapter VI. A comparative evaluation of the preferred engineering alternatives and the evolving land management approaches is developed in Chapter V to identify the pro and cons, costs, and impacts associated with each.

CHAPTER IV

SHORE PROTECTION ALTERNATIVES

A. INTRODUCTION

A wide range of techniques have been implemented at various levels of government, and by individual, private shorefront property owners to adjust to coastal erosion processes. There are two basic approaches to shore protection. On the one hand are the engineering techniques and concepts (structural and non-structural), designed primarily to reduce the direct adverse effects of erosion on shorefront property by controlling or mitigating the natural forces that cause the erosion. On the other hand, are the non-engineering approaches which seek to either avoid future erosion losses through land management programs, or to lessen or eliminate the direct social and economic costs and hardships incurred by shorefront property owners where erosion is occurring.

Sorensen and Mitchell (1975) have classified the alternative adjustments to coastal erosion into four major categories:

- Control and Protection Works (Engineering Alternatives)
- Land Use Management
- Warning Systems
- Public Relief, Rehabilitation, and Insurance Means

These four major approaches are introduced and summarized in Volume 1, Section II.A.1. In the remaining sections of this chapter, various alternative techniques and concepts under each of the major approaches above are presented. A discussion of the compatibility and interaction of alternatives is provided in Section D of this chapter.

B. AVAILABLE ENGINEERING TECHNIQUES AND CONCEPTS

1. Introduction

This section discusses engineering techniques for shore protection. These techniques are classified into two major categories — structural methods including breakwaters, seawalls, revetments, groins, and bulkheads; and nonstructural methods such as beach nourishment, intertidal vegetation, and dune stabilization. Generic methods and alternative forms of construction or material for each of the categories are provided in Table IV.B-1. General comments on problems, requirements, and applicability are provided, along with sample locations where the methods have been used. Structural and functional performance ratings of the methods are also shown in the table.

New Jersey's shores are broadly classified into four basic types — ocean front, inlet, open bay (including Raritan and Delaware Bay shores), and lower energy shores involving backbays, tidal tributaries, inland waterways, and major tidal rivers (e.g., Delaware River). The application of a specific engineering technique to mitigate an erosion problem normally requires systematic and thorough study. In particular, the selection of a technique for a given environment and location requires detailed site-specific consideration of needs, cause-effect dynamics, and cost and cost-benefit relationships. Detailed summaries of engineering methods, techniques, and data pertinent to the control of shore erosion problems are included in the Army Corps of

TABLE IV .B-1

CATALOG OF SHORE EROSION CONTROL METHODS

Structural Methods[1]	Requirements	Problems/Comments	Example Locations of Existing Methods	General Performance E-Excellent G-Good F-Fair P-Poor U-Unknown Structural	General Performance E-Excellent G-Good F-Fair P-Poor U-Unknown Functional	General Applicability by Shoreline Type[2] Oceanfront	Inlet	Open-Bay	Back Bays, Tidal Tributaries, Inland Waterways and Rivers
GROINS	Longshore transport or aritficial nourishment.	Can cause erosion downdrift, aesthetically unpleasing, can be harmful to swimmers. Erosion behind groins and tipping. Highly recommended for oceanfront beaches for erosion control.							
Concrete Sheet Piles P - Precast Conquick Prestressed	Good soil foundations to withstand forces.	May not be able to withstand large wave action. Cross of "T" not needed.	Presque Isle State Park, PA. Seal Beach, CA.	F U F	F U F	X	X	X	—
Concrete Forms Interlocking Block Precast Block Pipe Ero-Jacks Sta-Pod Sta-Bar T-Stone		Tend to move Cross of "T" not needed	Santa Barbara, CA. East Hampton, N.Y. Southshore Pk, Milwaukee, WI. Hallandale, FL East Hampton, N.Y. Fire Island St. Pk., N.Y. Wainscot, N.Y. Elberton, N.J.	F F F F G G E	F F F F F F G	X	X	X	—
Fabric Longard tube filled with sand Bags (with sand or grout) Sausage filled with sand	Proper foundation to prevent sinking into substrate.	Subject to vandalism and natural deterioration by ultraviolet rays.	Pontiac, MI. Virginia Beach, VA Hilton Head, S.C. Ocean City, N.J.	F P F P	F P F F	X	X	X	—
Metal Sheet Piles Cellular Steel sheet pile Corrugated metal Steel sheet piling (impermeable and permeable) Steel cantilever design	Good soil foundation to withstand forces.	May not be able to withstand large wave action. Subject to corrosion.	Presque Isle, PA. Savannah Beach, GA. Highland Pk., IL. Ludington St. Pk., MI.	G F F G	F F F G	X	X	X	—
Other Metal Forms Gabions filled with stone		Subject to corrosion. Hazardous to swimmers.	Mears St. Pk., MI.	G	G	X	X	X	—
Timber Du-Plat Taylor Timber adjustable (H Pile) Timber impermeable (cantilever design)	Requires protection from wood borers. Requires good soil foundations to withstand forces.	Subject to distruction from wood borers. High maintenance costs. Wood slats subject to damage.	English Shingle Beaches Jupiter Island, FL. Berrien Co. MI. Bay Head, N.J. Manasquan, N.J.	F F F P-F F	F F F F F	X	X	X	—
Other Types Rubble mound Crib or Bia Type H-Pile (concrete & wood)	Large source of rock nearby.	Expensive Wood slats subject to damage.	Long Island, N.Y. Ocean City, N.J. Harvey Cedars, N.J. Ft. Niagara, N.Y. Madeira Beach, FL.	E G F-G F F	G G F-G S P	X	X	X	—

TABLE IV .B-1 (continued)

Structural Method[1]	Requirements	Problems/Comments	Example Locations of Existing Methods	General Performance E-Excellent G-Good P-Poor F-Fair U-Unknown Structural	Functional	General Applicability by Shoreline Type[2] Oceanfront	Inlet	Open-Bay	Back Bays, Tidal Tributaries, Inland Waterways and Rivers
BULKHEADS & SEAWALLS	Availability of material.	No protection to area forward of structure, can in fact speed erosion. Can cause erosion to adjacent areas. Scour can undermine the structure itself. Access to beach can be difficult. Good protection for eroding and unstable beaches. Loss of foundation support, inadequate penetration, flanking can cause failure of structure.							
Fabric	Adequate supply of sand if used as filler.	May not be able to withstand earth force behind structure. Subject to vandalism. Subject to deterioration. Subject to movement. Usually considered as the low-cost alternative.				X	X	X	X
Nylon Bags (with sand or grout)			Hatteras, N.C.	P	P				
Acrylic Bags (sand or grout)			New Orleans, LA.	P	P				
Fabricast			Lake Erie	F	F				
Longard Tubes			Moran Twp., MI.	G	F				
			Stinson Beach, CA.	F	F				
Concrete						X	X	X	X
Concrete vertical or curved		Expensive.	Long Port, N.J.	G	G				
			Sherwin Bay, Lake Ontario	G	G				
Concrete Permeable			Quincy, MA.	G	F				
Corrugated Asbestos' Cement	Semi-protected warm area.	Vulnerable to carbonic acid attack in canals and estuaries.	Ogunquit, ME.	F	F				
Milliken Z wall	Suitable soil foundation to withstand the forces.		Stevensville, MI.	F	F				
Precast Concrete Sheet Pile	Suitable soil foundation to withstand the forces.		Virginia Beach, VA.	G	G				
			Daytona Beach, FL.	U	U				
Precast Concrete Tiesacks and Panels			Vail Pass, CO.	F	F				
Rubberoid Corrugated Bulkheading			Ocean City, MD.	F	F				
Stepped Concrete Seawall		High initial costs.	San Francisco, CA.	G	G				
			Harrison County, MS.	U	U				
Whittle Precast Concrete Seawall			Oakland, CA.	G	G				
Miami Rings		Tend to move under wave action.	Little Girls Pt., MI.	F	F				
Concrete Blocks Precast Impermeable			Presque Isle, PA.	F	F				
Tetrahedron/Hexapod Concrete Blocks			Ogallala, NE.	G	F				
"Ero-Jacks"			Golden Beach, FL.	F	P				
Sta-Wall Concrete Units			63rd Str. East River, N.Y., N.J.	G	G				
Sta-Pods and Sta-Bars Precast Concrete Units			Islip, N.Y.	G	G				
			East Hampton, N.Y.	U	U				
Tri-Bars Precast Concrete Units			Rincon Island, CA.	G	G				
			Nawiliwili, HA.	U	U				
Metal Units		Subject to corrosion. Aluminum is more durable and of lower maintenance cost.				X	X	X	X
Aluminum Bulkhead			Cleveland, OH.	G	G				
Gabions with stone	Available supply of stone.		Potomac River Entrance	G	G				
Milliken Steel Bulkhead			Unknown	F	F				
Steel Sheet Pile	Sufficient soil foundations to withstand the forces.		Nantucket Island, MA.	G	G				
			North Wildwood, N.J.	F	F				
Corrugated Galvanized Bulkhead			Grand Haven, MI.	G	G				
Timber Units	Protection from wood borers.	Wood borers can cause destruction.				X	X	X	X
Timber Sheet Pile	Sufficient soil foundation to withstand the forces.		Avalon, N.Y.	G	G				
			Long Branch, N.J.	G	G				
			North Wildwood, N.J.	G	G				
Stone, Riprap, etc.	Supply of suitable stone.		Sea Bright, N.J.	F-G	F-G	X	X	X	X
			Monmouth, N.J.	F	F				
Bin or Crib Structures			Palisades Park, NJ.	F	F				
Rubblemound	Supply of stone close by.	High initial costs.	Fernandia Beach , FL.	E	E				
Other Type Units						—	—	X	X
Wire Mesh Wood Pile Sandbag Combination		Wire mesh subject to corrosion. Wood subject to destruction by wood borers. Sandbags subject ot vandalism and deterioration.	Great Lakes	G	G				

TABLE IV .B-1 (continued)

Structural Method[1]	Requirements	Problems/Comments	Example Locations of Existing Methods	General Performance E-Excellent G-Good F-Fair P-Poor U-Unknown Structural	Functional	General Applicability be Shoreline Type[2] Oceanfront	Inlet	Open-Bay	Back Bays, Tidal Tributaries, Inland Waterways and Rivers
REVETMENTS		No protection to area in front of structure, in fact it can speed erosion. Can cause erosion to adjacent area.							
Fabric	Available source of sand if sand is used to fill fabric containers.	Subject to vandalism. Usually considered as the low-cost alternative.				—	—	X	X
Acrylic bags filled with sand or grout			Red River, Morganza, LA.	F	F				
Fabricast (nylon bags)			Ocean City, N.J.	F	F				
Longard Tubes	Toe protection for scour	Subject to horizontal and vertical movement. Design wave height = unknown; run-up approximately 80% to 90% compared to smooth surface.	Erie, PA.	F	F				
			Empire, MI.	G	F				
Nylon Bags		Wave height depends on strength of the material.	Singer Island, FL.	F	F				
			Hatteras, N.C.						
Miraft Fabric			Long Beach, N.J.	U	U				
Tire Mat (bolted and filled with sand cement)	Cover of compacted aggregate.	Design wave height = 3 to 5 foot waves; run-up 60% to 70% compare to smooth surfaces.	Unknown	U	U				
			Unknown						
Concrete						—	X	X	X
Articulated Concrete Mattress		Subject to scour and settlement damage. Cracks in the surface.	Lower Mississippi	F	F				
Monoslabs	3 or more layers to withstand large waves.	Subject to scour and settlement damage.	Red Bank Paving Island #63	F	F				
Cellular concrete blocks (open cell type)	Toe protection for scour.	4 to 5 foot waves; run-up 70% to 90% (smooth surface)	Ann Arbor, MI.						
Concrete Interlocking (Shiplap) Blocks	Toe protection for scour.	Stable for approximately 5 foot waves; also depends on weight of unit and interlocking characteristics.	Buffalo Creek, N.Y.	G	G				
Concrete Interlocking Blocks-DYTAP and DYMEX types			Benedict, MD.	F	F				
Gobi Blocks	Filter cloth.		England	F	F				
Packaged Concrete Bags	Toe protection for scour.		Holly Beach, LA.	F	F				
"Ero-Jacks"			Oak Harbor, WA.	F	F				
Nami Rings			Hallandale, FL.	F	F				
		Rings moved and broke under storm wave action. 6 to 7 foot waves; run-up 60% to 70% compared to smooth surfaces.	Little Girls Pt., MI.	F	F				
Tetrahedron/Hexapod Concrete Blocks			Ogallala, NE.	F	F				
Building Blocks		3 to 5 foot waves; run-up 70% to 90% of smooth surfaces.	Unknown	U	U				
Stone, Gravel, Riprap		Excessive settlement. Increased voids and loss of filter material. Rip-rap stability changes with slope and wave period.				—	X	X	X
Gravel Stone Blanket			Yakima Project, WA.	F	F				
Groute Stone Rip-rap Mat			Scituate, MA.	F	F				
Rip-rap, Stone	Availability of stone.	5 foot waves; run-up approximately 50% compared to smooth surfaces.	Ft. Story, Cape Henry, VA.	E	E				
			Longport, N.J.	G	G				
Earth Structure						—	X	X	X
Chemical Soil Solification	Special pumps for injection.		North Shore, Lake Michigan	F	F				
Reinforced Earth mechanical or chemical		Forces can be too great for structure to withstand.	Incarville, France	F	F				
Soil Cement		Subject to corrosion.	Jackson, MS.	F	F				
Patch Asphalt		Wave heights depend on asphalt thickness; run-up 60% to 70% of smooth surface	Unknown	U	U				
Metals						—	X	X	X
Gabions									
Stacked	Stone to fill baskets.	Broken wires, excessive movement. 6 to 8 foot waves; run-up 50% to 60% of smooth surface	Singapore Island, Republic of Singapore	G	G				
Matted		3 to 5 foot waves							
Landing Mats (aluminum and steel)			Brittany Coast, France	F	F				
Woven Wire Netting (formerly submarine nets)		2 to 3 foot waves; run-up 50% to 60% of smooth surface	San Felippe Creek, MA.	F	F				

TABLE IV .B-1 (continued)

Structural Methods	Requirements	Problems/Comments	Example Locations of Existing Methods	General Performance E-Excellent G-Good F-Fair P-Poor U-Unknown Structural	Functional	General Applicability by Shoreline Type[2] Oceanfront	Inlet	Open-Bay	Back Bays, Tidal Tributaries, Inland Waterways and Rivers
BREAKWATERS	Needs longshore drift of sufficient strength to accumulate behind the breakwater without causing down-drift erosion.	Can form a tombolo and completely block the drift causing downdrift erosion. Can be a hazard to swimmers. Can be a navigational hazard.							
Fabric	A supply of sand to fill units.	Subject to vandalism and fabric deterioration.				X	—	X	X
Longard Tube			Lake Port St. Pk., MI.	G	F				
Low Profile Nylon Sand Bags			Singer Island, FL.	F	F				
		Also used as the 'offshore sills.'	Atlantic City, N.J.	P	P				
Concrete Units						X	X	X	X
Campbells Concrete Modules			Cedar Point, OH	G	F				
Conquick Offshore		Unknown		U					
Concrete Pipe			South Haven, MI.	F	F				
Z-Wall Concrete		Strong wave action can cause damage cause damage and tipping.	Pere Marquette Twp., MI.	F	F				
Rubblemound	Large quantities of suitable stone nearby.	High initial first costs.	Winthrop Beach, MS.	E	E	X	X	—	—
Metal Units		Subject to corrosion.				—	X	X	X
Caisson Type (perforated type)			Baie Comeau, Quebec Canada	F	F				
Cellular Steel Sheet Pile	Soil foundations of sufficient strength to withstand the forces. Helicopter to install.		Port Sanilac, MI.	G	G				
Shoreprotector		May not be able to withstand large wave action.	Virginia Beach, VA.	F	F				
Gabions	Adequate supply of stone.		Nahariya, Israel	G	F				
Other Units						—	X	X	X
Surgebreaker	Helicopter for installation.			U	U				
Hydro-Air Electric		Operating cost are very high.		U	U				
Underwater Fence		Wood subject to destruction; by wood borers.	Lake Michigan	F	P				
Sabellarid Reefs			Various reefs in FL.	F	F				
Water Jet		Could be expensive.		U	U				
Sandgrabber System	A permeable structure dissipates wave energy, traps sand particles from water and stops erosion.	Does not cause toe scouring and starve the downdrift beaches. Low maintenance costs and easily repaired. Suitable for most shorelines and stabilized the backshore.	Unknown	U	U				
Floating or Mobile Units		Anchorage systems strong enough to withstand the forces exerted are difficult to achieve. Usually of lower construction (initial) cost than other types of breakwater.				—	—	X	X
"A" Frame				U	U				
Bowley Wave Barrier		Functions as a reflector, not as an energy adsorber.	Duxbury, MA.	F	F				
Catamaran Pontoon			Friday Harbor, Puget Sound, WA.	F	F				
Concrete Modules filled with Styrofoam			Tenakee Springs, AK.	F	F				
Flexible Porus "Log Raft"				U	U				
Floating Slab			Staines, G.B.	F	F				
Harris Floating Breakwater			Stokes Bay, G.B.	F	F				
Hermaphrodite Breakwater-Using Hydrotoils				U	U				
Pneumatic and Hydraulic		Could have high maintenance costs.		U	U				
Seabreaker		Subject to corrosion.	Stokes Bay, G.B.	F	F				
Scrap Tires Breakwaters			Dunkirk Harbor, N.Y.	U	U				
Tenakee-Sitka (reinforced, precast concrete units)			Tenakee, AK.	F	F				
			Sitka, AK.	F	F				
Tethered Floats (anchored spheres)		Foul lag is a problem but "wipers" are being developed.	Pt. Loma, CA.	U	U				
Waveguard			Pt. Hueneme, CA.	F	F				
			Galveston Bay, TX.	F	F				

TABLE IV .B-1 (continued)

Non-Structural Method[1]	Requirements	Problems/Comments	Example Locations of Existing Methods	General Performance E-Excellent G-Good F-Fair P-Poor U-Unknown Structural	Functional	General Applicability by Shoreline Type[2] Oceanfront	Inlet	Open-Bay	Back Bays, Tidal Tributaries, Inland Waterways and Rivers
Beach Fill (Beach Nourishment)	Large amounts of suitable sand nearby. May require periodic renourishment.	Has to be done on a periodic basis. May require structures to help hold in place for longer periods.	Orchard Bay, N.Y. Key West, FL. Manasquan, N.J. Ocean City, N.J.	NA NA NA NA	E E G G	X	X	X	X
Intertidal Vegetation	Needs protection from large wave action area clear of pesticides and defoliants.	Will not work in areas with large wave action, water fowl find young plants quite tasty. Vegetation needs continual care and maintenance.	GSA Camp, Beaufort Co. N.C. Chesapeake Bay, VA.	NA	P-E	—	X	X	X
Artificial Sea-Weed	A number of slender fronds having a specific gravity between 0-1 and 0.2 to be attached to nylon bags which can be filled with weighting material to anchor the unit.	Seaweed does not significantly attenuate wave action. Tends to attenuate currents to decrease the rate of scour.	Tested by Coastal Engineering Research Center, 1976 N.A.S.A., Wallops Island, VA.	NA NA	P P	—	X	X	X
Sand Dunes	Space for dunes, supply of sand, vegetation to stabilize.	Very easily disturbed, right proportions are difficult to achieve.				X	X	X	—
Formation by Mechanical Equipment	Protection for vegetation while it is getting started.	Need to know original contours or lines.	Long Beach Island, N.J.	NA	U				
Formation by Sand Fences	Large amounts of fencing and continual monitoring to achieve maximum results, interplanting with vegetation.	Splinters are a problem in handling the fencing. Fences may not be aesthetically pleasing. Dunes tend to be more angular.	Foredunes, Avalon, N.J. Chincoteague Nat. Seashore, MD.	NA	E				
Formation by Vegetation	Adequate supply of healthy plants suitable to area.	Take considerable time. Proper care must be taken of plants. Large amounts of fertilizer and labor are required.	Padre Island, TX. Waterford Town Beach, CT. Florida Beaches Bodega Bay, CA. Florence, OR.	NA	U				

Notes:

(1) For particular structural or non-structural method categories listed in this table, combinations of the various generic alternatives (e.g., combination timber and stone groins), are often used to satisfy local conditions and needs.

(2) Control of an erosion problem utilizing a specific applicable method requires detailed site specific consideration of needs, cause-effect dynamics, and cost and cost/benefit relationships.

NA - Not Applicable

Engineers Shore Protection Manual (USACOE, CERC, 1973), as well as other Corps publications listed in the bibliography of this report. A detailed bibliographical listing of research related to many of the engineering alternatives listed in Table IV.B-1 has been published by Sperling and Edge (November 1978).

Properly applied, the methods summarized in Table IV.B-1 can aid in controlling erosion of New Jersey shores; but improperly used, the methods may accelerate or aggravate existing erosion conditions and increase the short-term erosion damage associated with storms. Some general comments regarding various traditional shore protection methods are provided below.

2. Engineering Cost Considerations

The basic factors that determine the in-place unit cost of an erosion control device include unit material cost, total quantity of materials required, availability of materials, construction labor and equipment costs, and transportation costs. Several of the cost factors are interrelated; for example, transportation cost is controlled by the quantity of materials to be transported and by the distance to the material source location. Labor and equipment costs depend largely on the degree of difficulty of the construction stages.

Due to recent inflationary trends in material, transportation, and construction costs, and the inherent short-term variability in costs as controlled by the various factors discussed above, it is not practical to provide unit in-place costs for the numerous alternatives presented in Table IV.B-1. However, the relative costs of various alternatives are discussed below.

As indicated in Table IV.B-1, a variety of materials can be used for the construction of structural devices. They include timber, stone, concrete, metal (e.g., steel, aluminum, and gabions), and fabrics (e.g., nylon bags and tubing). Certain low-cost structural methods are appropriate in sheltered waters such as backbays and estuaries. A low-cost shore erosion control method is one which meets one of the following criteria defined by the Shoreline Erosion Advisory Panel (Edge et al., 1976):

- Less than $50 per foot for materials and requiring no heavy construction equipment.
- Less than $120 per foot for materials plus placement using heavy construction equipment.

It is anticipated that a low-cost device will function, with minimal maintenance, for approximately 10 years and withstand storm action not exceeding a 1-in-25-year storm.

Available low-cost shore erosion control methods are included in each of the basic generic methods presented in Table IV.B-1. Since low-cost implies only low initial cost, in the long term the method may not offer the lowest cost protection available. In general, when State or Federal aid is difficult or impossible to obtain and the erosion condition is severe, the low-cost methods can be implemented on a scale within the ability of a municipality or independent property owner. Although in the long term a low-cost method may be higher in cost in comparison to other more durable low maintenance methods, a low initial cost permits immediate protection, whereas the higher initial costs of a more permanent solution may be prohibitive.

Timber and concrete blocks cost relatively less than other materials because of their ease of use. The largest group of low-cost methods are those that use fabric casings in the form of bags (e.g., acrylic or nylon bags), tubings (e.g., longard tubes -- nylon tubes with a sand filler), or a double-walled articulated sheet. Cement, grout, or sand can be used as the filler in fabric casings. The casings can easily adapt to the various formations of seawalls, groins, revetments, bulkheads, etc. Most fabric devices require special protection from vandalism and deterioration by sunlight, however. Proper design and installation should also consider preventing the movement and sinking of the device into the substrate.

Another commonly used low-cost structural device is the gabion. It is a wire mesh box filled with stone. Gabions have been used in structural erosion protection devices such as groins and revetments. However, corrosion and deterioration of the wire mesh is a problem in a salt water environment. In addition, the possibility of injury from exposed wires makes the use of gabions unsuitable on recreational beach areas.

Innovative devices such as floating or mobile breakwaters cost considerably less than the more traditional massive structures. Other low-cost innovative alternatives include artificial seaweed which can be used to slow the rate of scouring in areas of high currents. Many of the innovative devices fall into the category of low-cost techniques because of their ease of construction and low cost for materials, though some have not been tested adequately. Various innovative erosion control ideas are introduced and tested each year; some will certainly come into use in light of the escalating costs of conventional shore erosion control methods.

The purpose of beach fill projects is to place a sufficient quantity of suitable sand on the eroding beaches so as to provide a wide berm at an adequate elevation. Although alternatives such as intertidal vegetation, and dune and sand fence formation often meet the criteria of low-cost erosion protection, the costs for continuous maintenance are high. It is important to note that most beach fill and dune construction projects cannot be considered as even semi-permanent solutions — they continually require maintenance or renourishment.

3. Use and Problems of Engineering Methods

This section contains a summary of engineering techniques available for restoration and protection of the shore. Typical performance characteristics and implementation requirements are discussed.

a. Seawalls, Bulkheads, and Revetments. Seawalls, bulkheads, and revetments are structures placed parallel to the shoreline to separate a land area from a water area. The distinction among these structures is mainly a matter of purpose. In general, seawalls are built as a last resort and are the most massive because they are intended to resist the full force of the waves. Bulkheads are next in size; their function is to retain fill, and they are generally not designed for direct exposure to severe wave action. On the oceanfront, bulkheads are normally located above the ordinary water level so that they are not brought under direct wave attack except during storms or at times of very high water levels. Revetments are the lightest structures — designed to protect shorelines against erosion by currents or light wave action.

Seawalls, bulkheads, or revetments protect only the land immediately behind them. These structures provide no protection to either upcoast or downcoast

areas and have no effect on shoreline erosion updrift. Also, as erosion of the beach proceeds, wave forces will be directly acting on these structures during storm events. In these instances, erosion is likely to be intensified in the downcoast areas. Typically, waves diffracted and reflected by interaction with shore structures combine with incident waves to produce an erosive short-crested wave system, as shown in Figure IV.B-1 (Silvester, 1978).

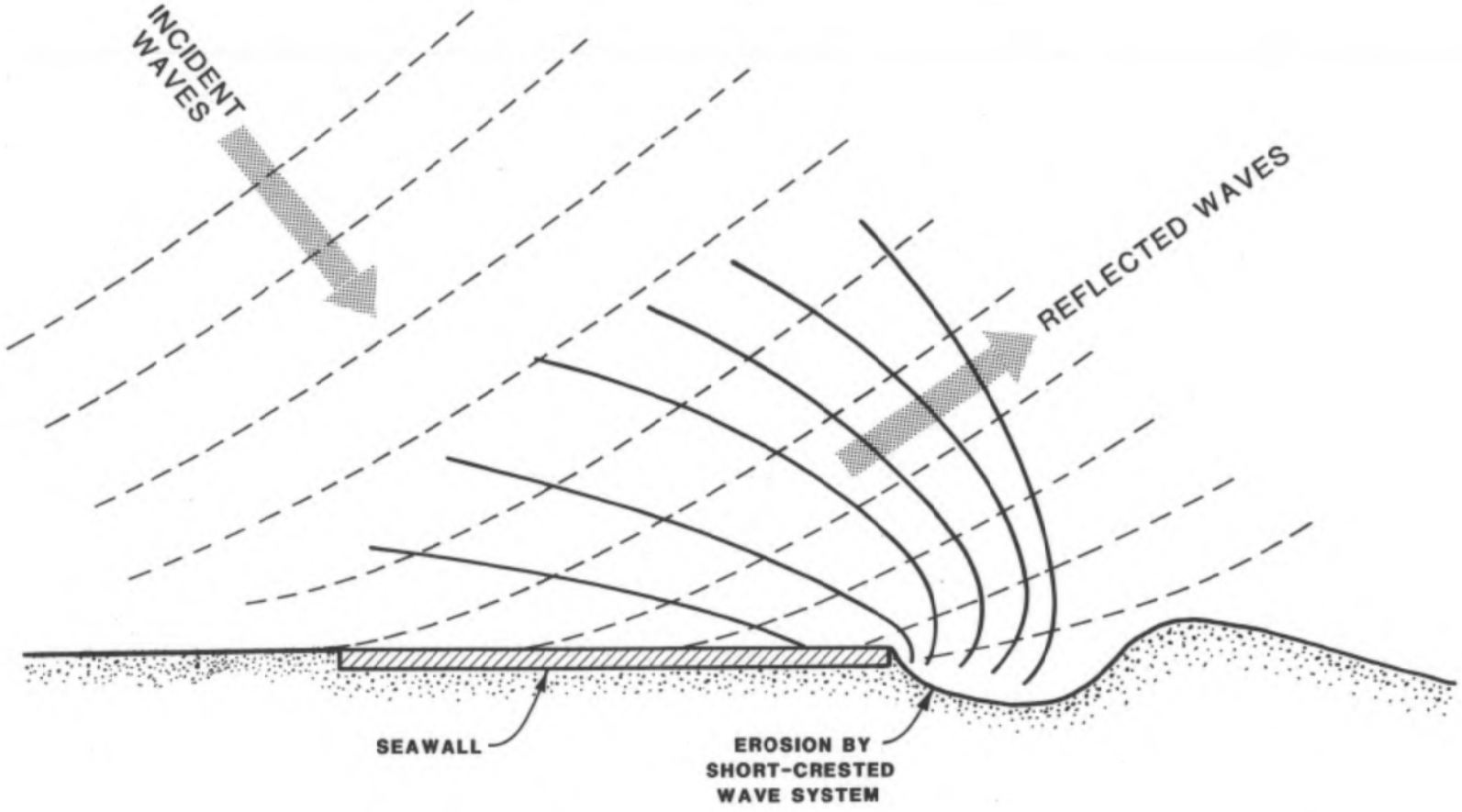
Seawalls, bulkheads, and revetments can also have an effect on seaward beach profiles. As illustrated on Figure IV.B-2, scour can be anticipated at the toe of the structure as an initial short-term effect. Scour will form a trough with dimensions governed by the type of structure face, the nature of the wave attack, and the resistance of the seabed material. At a rubble-mound seawall, scour may undermine the toe stone, causing it to collapse or sink to a lower stable position. It is safe to assume that these structures would not be effective in reducing loss of the seaward beach. Characteristic problems associated with seawalls are illustrated in Figure IV.B-3.

b. Groins. Groins are shore erosion control structures designed to retard erosion of existing or restored beaches. Groins are generally narrow structures placed perpendicular to the shore. They are designed to extend from a point landward of the predicted recession shoreline to an offshore point sufficient to trap the portion of littoral drift required by their design. Since most of the littoral drift moves in a zone landward of the normal breaker depth (about the 6-foot depth contour), extension of groins beyond that depth is generally unnecessary and uneconomical (USACOE, CERC, 1977).

The groin acts as a partial dam intercepting a portion of the normal longshore transport. As material accumulates on the updrift side, supply to the downdrift side is reduced, and the downdrift shore recedes. Accretion on the updrift side continues in accordance with the grain size characteristic of the littoral drift material and the height of the groin. At this point accretion stops, and all littoral drift passes the groin. If a groin is high enough to prevent the passage of sediment, then the littoral drift is diverted around the seaward end of the groin. Material in transport around a groin does not move directly shoreward after passing the groin. In fact, longshore transport characteristics do not return to normal for some distance downdrift of the groin. Thus, a system of groins (or groin field) too closely spaced would tend to divert sediment offshore rather than create a widened beach, and the loss of sediment would worsen erosion problems on downdrift beaches.

Groins are usually considered for application in areas where the supply of littoral drift is less than the capacity of the littoral transport forces. In these areas, a shoreline adjustment resulting from the installation of a groin or a groin system may not reduce the actual transport rate, but result only in a reduction of the expected additional losses from beach fills within the groin system. However, for this to occur, the groins must extend to the surf zone – in the case of high profile groins some of the littoral material is thereby diverted to the offshore zone, resulting in adverse erosion effects to downdrift beaches.

Where the littoral drift supply satisfies the capacity of the transporting forces, the adjustment in the shore alignment from a groin system may reduce the capacity of longshore transport forces at the groined site. Thus, less material is transported longshore than prior to the construction of the groins, and a permanent adverse effect to the downdrift shore would occur. Adverse effects on adjacent shores described above are not necessarily a measure of the effectiveness of the groin or



INTERACTION OF INCIDENT AND REFLECTED WAVES AT A SEAWALL

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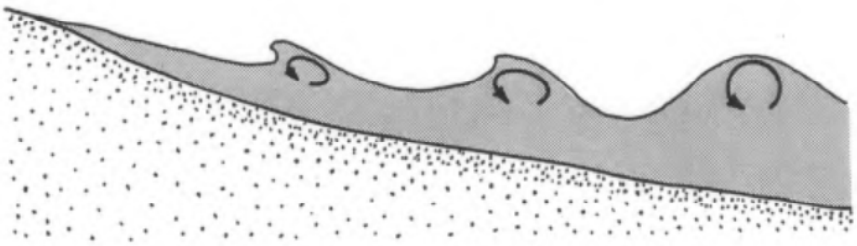
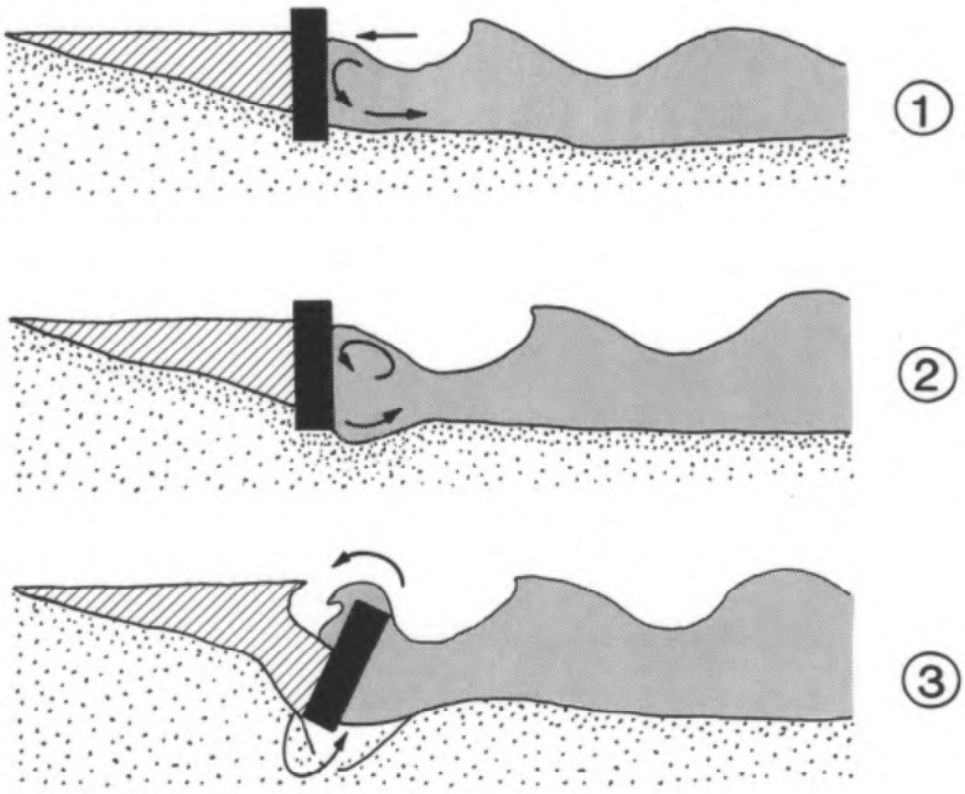
FIGURE IV.B-1

NATURAL BEACH



"PROTECTED" SHORE



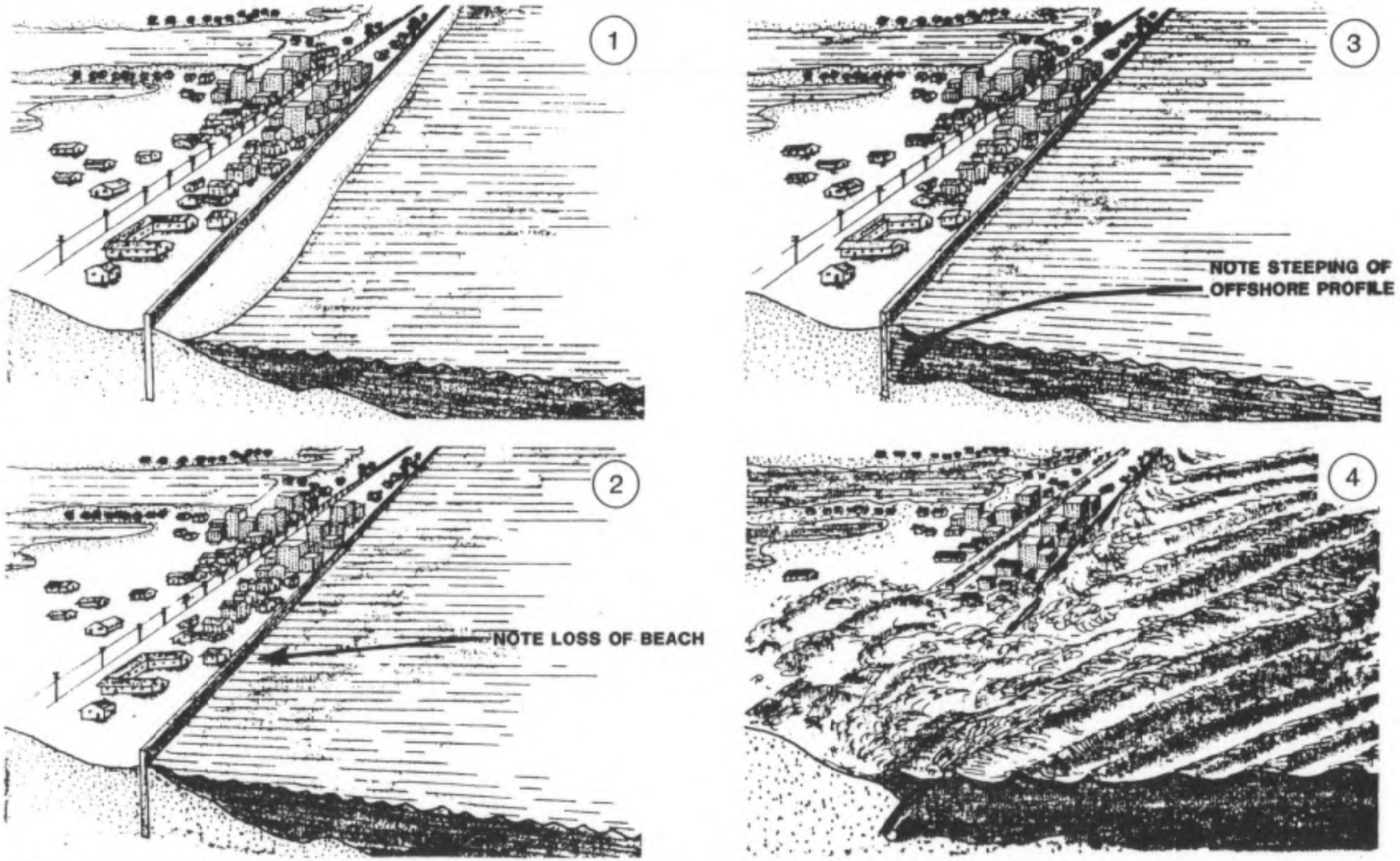
A NATURALLY SLOPING BEACH DISSIPATES WAVE ENERGY. SEAWALLS BULKHEADS, REVETMENTS, OR BUILDING FOUNDATIONS, HOWEVER, REFLECT THE ENERGY ALMOST COMPLETELY. THE REFLECTED ENERGY CREATS A SCOURING ACTION NEAR THE TOE OF THE STRUCTURE ① AND MAY CAUSE THE UNDERMINING ② AND EVENTUAL COLLAPSE ③ OF THE STRUCTURES.

EFFECT OF SHORE PARALLEL STRUCTURES

ADAPTED FROM CONSERVANCY FOUNDATION (JUNE 1980)

DAMES & MOORE

FIGURE IV.B-2



THIS SEQUENCE DEMONSTRATES THE INEVITABLE PROBLEMS ASSOCIATED WITH THE EMPLACEMENT OF A SEAWALL ALONG AN ERODING SHORELINE. WITHOUT ARTIFICIAL SAND NOURISHMENT, THE BEACH WILL BE EVENTUALLY LOST, AND SEAWALL FAILURE DURING A STORM CAN RESULT IN CATASTROPHIC LOSS OF LIFE AND PROPERTY.

PROBLEMS ASSOCIATED WITH SEAWALLS.

SOURCE: TAKEN FROM LEATHERMAN (1979).

DAMES & MOORE

FIGURE IV.B-3

groin system since these groins might well have diverted some of the longshore transport to deep water depriving the downdrift beaches from receiving a full amount of longshore transport (USACOE, CERC, 1977).

The construction sequence for groin fields, which depends on littoral drift material for filling, is important in minimizing the detrimental effects on downdrift areas. Any natural filling after construction tends to reduce the supply of sediment to downdrift beaches (littoral starvation). The time required for an entire system to fill and for the littoral drift to resume its downdrift movement may be so extensive that downdrift beach areas will be severely damaged. To reduce such effects, construction should begin at the downdrift end of the planned system. Construction of subsequent groins is not recommended until the first groin has filled and sand passing around or over the groin has again stabilized the downdrift beach. As an alternative, the groin field should be artificially filled as they are constructed. Such an operation minimizes the disruption of littoral transport to downdrift beaches.

Groins are structurally and functionally different from jetties, which are larger structures with more massive components and are used primarily to confine the tidal flow at an inlet and to prevent littoral drift from shoaling the channel. Jetties and inlet stabilization are not directly considered in the planning efforts of this study.

c. Offshore Breakwaters. Offshore breakwaters are structures designed to protect shore areas from direct wave action. In this study, they are proposed to create littoral reservoirs which can be used as sand sources for beach nourishment. They also provide a protected calm area where a dredge can operate effectively. Breakwaters function by dissipating and reflecting incident wave energy. Some wave energy finds its way into the lee or geometric shadow of the breakwater through diffraction around the ends of the breakwater. This wave energy generally represents a small percentage of the incident wave energy. The lack of wave energy which drives the littoral transport system results in a deposition of sediment in the breakwater lee. As sand is deposited, a seaward projection of the shore is formed in the still water behind the breakwater. This projecting shore alignment in turn acts as a groin, which causes the updrift shoreline to advance. As the projection enlarges and the zone of longshore transport moves closer to the breakwater, it becomes increasingly efficient as a littoral barrier. In this situation there generally is accretion updrift of the breakwater and erosion downdrift (USACOE, CERC, 1977).

The effectiveness of an offshore breakwater as a sand trap and in providing a protected area is dependent on its height in relation to the wave action. To avoid the problems associated with a breakwater which acts as a complete littoral barrier, it may be desirable to design the breakwater so that a degree of wave overtopping is allowed. Such partial barriers need not extend above low water. Adequate markings are required, however, so as not to cause a navigation hazard.

d. Beach Nourishment. Beach nourishment can range from the periodic replacement of sand lost by erosion to the extensive placement of sand to construct large new beach areas suitable for recreation. Beach nourishment represents the replacement of a resource, but in and of itself does little to avoid the need for subsequent renourishment. In addition, beach nourishment costs have escalated rapidly in recent years. Continuation of this trend could result in more projects becoming uneconomical, even in high recreational demand areas. Thus, the use of nourishment as an erosion control technique requires continuous and potentially increasing financial commitment.

To evaluate the feasibility of using a given borrow area as a source of beach nourishment material, it is very important to estimate the behavior of that material before it is placed on the beach. Currently there is no proven method for computing the actual amount of overfill required to satisfy specific project dimensions. Recent studies of borrow material behavior by James (1975) and Hobson (1977) present criteria to indicate the probable behavior of borrow material on the beach. Use of these criteria in developing beach fill estimates is recognized as good engineering practices (USACOE, CERC, 1977).

The procedure requires enough core borings in the borrow area and samples from the beach and nearshore zones to describe the grain-size distribution of the borrow and beach material. Grain-size distributions determined from these representative samples from each zone are generally referred to as the composite grain-size distribution. Such grain-size analyses, obtained by sieving of the samples from the beach and the borings, are generally used to compute a composite-size distribution for the borrow and the native beach materials. The composite distributions (borrow area and native beach) are compared to assess the suitability of the borrow material as beach fill. Almost any borrow area near shore will include some fraction of material of suitable size. When sand is mechanically placed on the beach, waves immediately begin sorting and winnowing action on the surface layer of the fill, moving finer particles seaward and leaving coarser material. As compared to offshore sand sources, backbay borrow area materials generally consist of higher percentages of fine sands, silty sands, and silts. The silts and some of the finer sand particles are lost when placed on the beach. Therefore, additional borrow material must then be placed on the beach to compensate for the sorting and winnowing losses. The criteria of James (1975) provide a means of estimating this additional material requirement (also known as overfill factor) when the borrow material does not match the characteristics of native sand.

In a recent beach nourishment study for Ocean City, New Jersey (Dames & Moore, April 1980), a comparison of selected backbay and offshore borrow areas was done based on available grain-size data. For the backbay materials, estimates of overfill factor ranged from 2.1 to 4.0 with an average of 2.5. For offshore areas the factors ranged from 1.0 to 1.3 with an average of 1.17. Thus, on the average, about 2.5 times as much fill would be required from backbay borrow areas to obtain the same amount of in-place beach fill as when utilizing offshore sources.

As discussed in Chapter VI, Section A.1, for Master Plan reach engineering designs it is assumed that offshore borrow areas will be utilized for beach filling and an average overfill factor of 1.3 is recommended. For New Jersey, offshore and backbay areas containing reported workable quantities of suitable material are identified in Chapter VI, Table VI.A-1. The location of offshore source areas is shown on Figure VI.A-2.

The Federal beach erosion and hurricane protection project in Dade County, Florida, is an example of a recent beachfill operation. The project consists of placing 13.5 million cubic yards of sand on the shore along about 9 miles of Miami Beach. This plan provides dry beach berms between 130 and 250 feet in width, together with a dune system for hurricane protection. The 10-year program provides periodic nourishment to make up for erosion losses at an estimated rate of 211,000 yd^3/yr. The present estimated project cost, including the beach nourishment, is $56 million. The Federal share of the cost, as determined by ownership of adjacent land and public access to the beach, is 55 percent or about $31 million.

Physical effects of beach nourishment operations are most evident in the sand source or borrow areas. Sand dredging in backbay areas is generally avoided because of the potential for disturbance of sensitive productive biological assemblages. The loss of such sand source areas is not particularly significant because the fine sands typically found in such areas are generally of low suitability for ocean beach nourishment.

The exploitation of offshore sand resources is not without potential problems, which can include:

- Increasing the offshore transport of sand during storms and limiting its return as a result of excavations near enough to the shore to upset the beach dynamic equilibrium.

- Interruption of the supply of sediment to the shore due to the depression left from nearshore dredging which may trap a portion of the dredged material – if a beach is being fed from offshore by currents and wave action.

- Changes in offshore bathymetry by excavating sand from protective offshore banks or bars, which can result in changes in the refraction of incident waves and therefore changes in the next angle of wave attack (such changes may affect the rate of littoral drift along the shoreline, which can change erosion or accretion patterns).

The detailed study of each proposed dredging operation is required to estimate its actual effect on the beaches and the environment. Studies of wave refraction effects over dredged holes suggest that the beach erosion due to holes in water depths greater than half of the length of "normal" waves or a fifth of the length of extreme waves was negligible. Based on these results, the British Hydraulics Research Station considers that dredging should be limited to water depths of at least 18 meters (60 feet) to avoid beach erosion effects (Motyka and Willis, 1974). Based on preliminary estimates for the New Jersey coast, shallower limits on the order of 12 meters (40 feet) or greater may be possible. Further investigation would be necessary to confirm this.

Ebb tidal delta deposits at inlets (inlet shoals) have been identified as significant reservoirs of sand. Considering the present beach erosion rates in Florida, it has been estimated that over 200 years worth of sand resides in the outer shoals of inlets (Walton, 1979). Sand storage capacity estimates for New Jersey inlets, ranging from 7 million cubic yards at Brigantine Inlet to 45 million cubic yards at Little Egg Inlet (Walton and Adams, 1976), are also significant. Exploitation of these sources should only proceed with caution, however. The outer bar deposits and the ebb tidal current are important factors influencing wave refraction patterns in the vicinity of inlets. Significant modification of these factors can alter the wave refraction patterns, with resulting changes in erosion or accretion on adjacent beaches. Dredging of inlet shoals to increase the flood flow through the inlet into the bay can also increase the capability of the inlet to flush sand to its inner bay system. Sand in the interior of the bay systems cannot work its way out since there is only limited wave activity to agitate the sediments into suspension such that they can be flushed out by ebb currents. Losing additional sands to inlet flood tidal shoals would have adverse erosion effects on downdrift beaches. Thus, though the outer inlet shoals appear to

represent a nearshore source for significant volumes of suitable sand, detailed inlet-specific studies would be required to evaluate the nature of the effects on adjacent shore sectors.

Sands suitable for beach nourishment are often a byproduct of dredging for channel and inlet maintenance. For example, the proposed Naval facilities expansion project in Sandy Hook Bay would produce some 4 million cubic yards of suitable sand. Additional quantities are periodically available from dredging work at the improved inlets along the ocean coast. Problems in exploiting these sources are related to cost, timing, and coordination of activities. Inlet dredging and navigational improvements are not normally scheduled with beach nourishment in mind. Disposal of sand offshore allows for the expeditious completion of dredging activities, while disposal of dredged sand on the beaches can cause costly delays in coordinating its placement. Therefore, the usual course in dredging operations is to ignore the resource value of the sand and dispose of it quickly. Efforts should be made to reverse this practice, where practical, and use the dredged sands to the fullest possible extent for beach nourishment, as is encouraged by the New Jersey Coastal Management Program.

There are practical limitations to the use of inlet dredged sands. In most cases equipment capable of pumping dredged sands to beaches cannot operate in the shallow inlets. Therefore, costly rehandling of sand may be necessary if it is to be placed on the beaches. Inlet dredging also produces relatively small volumes of sand with respect to beach nourishment needs. The typical dredging project produces volumes on the order of only 100,000 cubic yards.

e. Sand Bypassing. Sand bypassing involves mechanically transferring sand around littoral barriers such as jetties and breakwaters. The basic methods of sand bypassing are via fixed bypassing plants, floating bypassing plants, and land-based vehicles.

Sand bypassing schemes are designed to relieve the erosion conditions which occur downdrift of littoral barriers (see Figure IV.B-4). Sand from the accretion area updrift of the barrier is used to nourish the eroded downdrift beaches. Sand bypassing at Shark River Inlet has been accomplished through the use of vehicles (Angas, 1960). The project involved the moving of 250,000 cubic yards of sand around the inlet jetties by crane-loaded dump trucks. Sand was dumped on the downdrift beach where it was distributed by wave action.

Problems in the implementation of bypass schemes include the legal arrangements and agreements required to remove sand from a valuable beach area of one municipality and transfer it to the beach area of another municipality.

Sand bypassing would do little to relieve the regional sand budget difficulties experienced in the northern headlands region of the New Jersey coast. Erosion losses from reach segments downdrift of Shark River Inlet and Manasquan River Inlet are typically several times larger than the expected bypass quantities currently considered practical for these inlets. Bypassing schemes would reduce the wide beach areas updrift of the inlets and provide only limited reduction of erosion losses for downdrift beaches. As indicated above, however, the local beach area immediately downdrift would experience significant erosion relief.

Sand bypassing and sand recycling costs were compared for the inlets of the northern headland prior to selecting the sand recycling approach in this study. The details of this cost evaluation are provided in Chapter VIII.



LITTORAL DRIFT STARVATION
DOWNDRIFT OF MANASQUAN INLET

DAMES & MOORE

FIGURE IV.B-4

Various types of sand bypassing systems have been developed and operated at Florida's tidal inlets. A description of Florida inlet bypass systems and a summary of pertinent performance and cost information is provided in Table IV.B-2. As indicated by the performance summaries in Table IV.B-2, inlet bypassing has had mixed results in reducing inlet shoaling and controlling shoreline erosion in the Florida examples. It should be noted that sand bypassing has only been of limited success in reducing erosion downdrift of Florida inlets.

f. Sand Recycling. The sand recycling basically involves beach nourishment operations which use deposition basins as sources of sand to nourish the updrift beaches. Sand is thus mechanically transferred to the eroding updrift beaches where, in time, wave action distributes it and moves it back down the beach to the deposition basin.

Sand recycling differs from conventional beach nourishment schemes in that it decreases environmental impacts associated with repeated sand mining for nourishment purposes and uses the beach as a self-source of sand. As discussed in Volume 1, Section I.C.3(2), for areas such as New Jersey, where there is a deficiency of sand in the littoral transport system, the reuse concept of recycling is attractive. Use of a sand recycling scheme thus preserves the beaches, rather than being allowed to pass through the system with loss to inlets and/or deposition in the offshore sand reservoirs.

Due to the potential for impacts on coastal inlet systems and adjacent downdrift coastal segments, detailed studies are required to assess the overall impacts of recycling schemes. A properly designed recycling system would provide an effective despositional basin and a stabilized beach, as well as contributing beneficially to the stabilization of adjacent inlets. However, cost feasibility studies are necessary to compare recycling schemes to conventional beach nourishment and sand bypassing programs. As discussed in Chapter VIII, in developing reach engineering plans for New Jersey, the costs of various beach nourishment schemes were compared. As a result of that analysis, periodic beach renourishment was selected over the recycling alternative for maintenance of design beaches.

g. Dune Stabilization. Dunes that form just behind the beach perform an important role in littoral processes. The foredunes function as reservoirs of sand to nourish eroding beaches during high water conditions and as levees to prevent wave damage to backshore areas. As such, they are valuable nonrigid, natural shore protection features. Well-stabilized inland dune ridges are a second line of defense against erosion if the foredunes are destroyed by storms. Use of native vegetation will stabilize dune sands that might otherwise migrate over adjacent areas and damage property. The vegetation helps to trap and hold sand on the dunes and therefore contributes to their growth and repair. For more rapid accumulation of sand, construction of dunes through use of sand fencing is recommended. Relatively inexpensive, slat-type snow fencing is used extensively in artificial dune construction.

Some research summarized by the Coastal Engineering Research Center (USACOE, CERC, 1977) suggests that development of large dune systems may have long-term effects on barrier island stability. Dolan (1972-1973) advances the concept that a massive, unbroken stabilized dune line restricts the landward edge of the surf zone during storms — causing narrower beaches and thus increased turbulence in the surf zone. The increased turbulence may lead to accelerated losses of fine sand.

TABLE IV.B-2

EXAMPLES OF INLET SAND BYPASSING SYSTEMS IN FLORIDA

System Location	Years Operated	Quantity Bypassed (cubic yard)	Unit Cost (dollars per cubic yard)	Description Of The System	Performance Summary
Ponce De Leon Inlet	1974-78	727,412	2.79	A weir jetty on the updrift beach with impoundment basin to be periodically bypassed to the downdrift beach.	The deposition basin is ineffective. Shoals on the downdrift beach causes inlet migration through the impoundment basin instead. The current practice has been dredging of the entrance channel and the downdrift shoal, placing materials on the updrift beaches.
Sebastian Inlet	1962-78	926,600	2.16	The physical characteristics of the inlet dictated the design of the bypassing system. Sand trap at low-current area captures littoral material to be dredged and placed on the downdrift beach.	The limited cross-sectional area of the inlet ensures strong currents through the inlet. Material not deposited in the sand trap is apparently bypassed naturally. Beach erosion continues at a moderate rate south of the inlet.
Jupiter Inlet	1966-79	809,000	1.33	Maintaining inlet dredging in sand trap area and bypassed to downdrift beach.	The bypassing system has been partially successful in reducing beach erosion and ensuring adequate navigation depth through the inlet.
Lake Worth Inlet	1967/68-1977/78	1,471,725	0.97*	A fixed sand transfer plant was constructed on the jetty at the updrift beach in 1957-58. With a 400 hp motor and pump, 12" pipe suction line and 10" discharge line. Estimated pumping rate approximately equal to 200 cu. yd./hour.	Maintenance dredging quantities in the entrance channel have decreased marginally.
South Lake Worth Inlet	1967/68-1977/78	837,645	1.25*	A fixed sand transfer plant was constructed at the updrift beach with jetty extension with 400 hp motor and pump, 12" suction line and a 10" discharge line, pumping rate 200 cu. yd./hour.	Beach erosion on the downdrift side of the inlet persists, despite the operation of the sand bypassing plant.
Boca Raton Inlet	1972/73 1977/78	523,045	1.13	Maintained as 8-inch hydraulic pipeline dredging the area between the inlet and outer bar to depth of 6 feet and deposit dredged material to the downdrift beach.	The stability of the inlet appears to have been enhanced by the jetty extension and sand bypassing system, though beach erosion on the downdrift side is still a problem.
Hillsboro Inlet	1965-1976/77	819,008	1.75*	Weir-type jetty constructed with sand deposition basin and also materials so the inlet was dredged and spoiled along the downdrift beach.	The rock reef weir jetty stabilized the north side of the inlet and bypassing system works well. However, beach erosion on the downdrift side persists.
Mexico Beach Inlet	1976 (6 months only)	26,850	0.51	Corps of Engineers tested a jet pump bypassing system at this location with 150 hp injector pump and a 50 hp booster pump.	It appears that the jet pump system works well for maintaining small and moderate-sized inlet channels.
East Pass	1970-78	637,751	1.17	A weir type jetty with a sand deposition basin. Materials dredged was spoiled in many locations. 40% of the total amount of materials has been placed west of the inlet or in shallow waters west of the west inlet (downdrift side) and considered as bypassed material.	Despite the ineffectiveness of the weir jetty and deposition basin, the sand bypassing scheme helps to retard erosion on the west side of the jetty (downdrift side).

Note: *Excluding construction and amortisation.

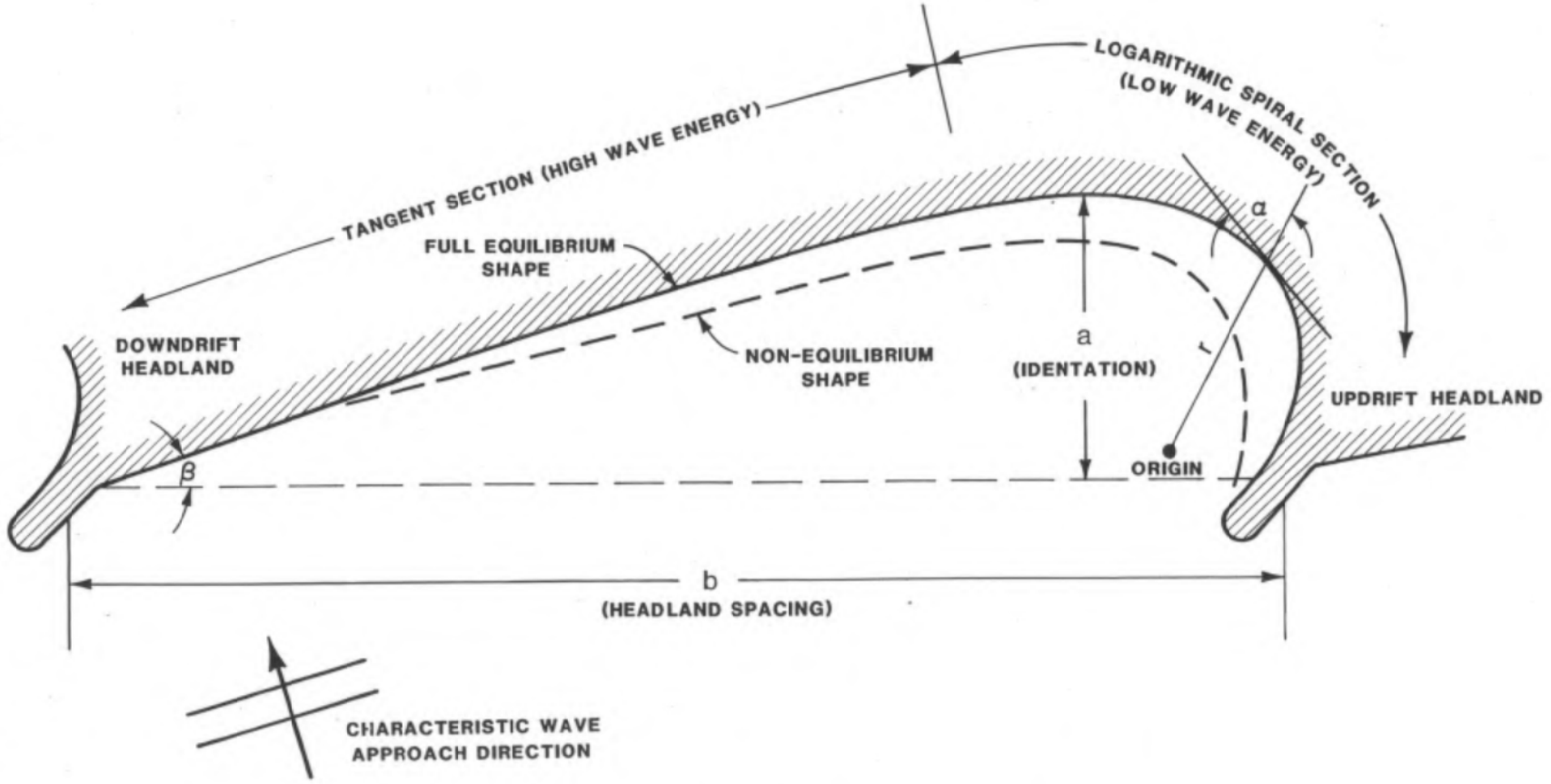
Source: Jones and Mehta, January 1980.

Godfrey and Godfrey (1973) discuss the effect of a foredune system on the long-term stability of the barrier islands of the Cape Hatteras and Cape Lookout National Seashores, North Carolina. Important assumptions of the discussion are that no new supply of sand is available to the barrier island system and that rising sea level is, in effect, creating a sand deficit by drowning some of the available island volume. Under such conditions, the islands must migrate landward to survive. "Oceanic overwash" (the washing of sand from low foredunes or from the beach over the island crest onto the deflation plain by overtopping waves) is described as an important process in the landward migration of the islands. Since a stabilized foredune system blocks overtopping and prevents oceanic overwash, stabilized dunes may be viewed as a threat to barrier island stability. Since this conclusion is highly controversial, continued research on the implication of these effects on the natural and man-modified barrier systems is needed.

The dune concepts presented in this Master Plan are designed to emphasize erosion control rather than flood protection benefits. The programs consist of maintenance of existing dune areas through sand fence installation and planting of stabilizing vegetative cover. Although beyond the scope of Master Plan designs, a larger degree of flood and overwash protection would be afforded through new dune development by artificial mounding of sand to create a massive unbroken stabilized dune line.

h. Headland Stabilized Bays. Crenulate-shaped bays are common natural shoreline features. These bays characteristically consist of sandy beaches strung between natural or manmade wave-resistant headlands. When in equilibrium with the predominant wave conditions which produce its outline, the crenulate-shaped bay is a stable form in that the net littoral drift within the bay is zero. This equilibrium shape is assumed when the shoreline along the entire stretch of bay is parallel to the characteristic wave approach direction at the shore. In this case, there is no longshore component of wave energy available to drive the littoral drift. Silvester (1976) reports on empirically derived characteristics of this stable form from natural equilibrium crenulate-shaped bays and from bays created in the laboratory. It is Silvester's contention that prior to reaching the final stable shape and position, the tangent (downdrift) section of the bay will be nearly parallel to the final tangent orientation (see Figure IV.B-5). Silvester assumes that the tangent section near the downdrift headland is parallel to some characteristic wave approach direction. With this approach direction and the headland spacing defined, the maximum indentation of the bay can be estimated from the relationships which Silvester has obtained.

Everts (1979b) has studied the crenulate-shaped embayment which has been forming since the construction of a large terminal groin at Cape May City in 1952 (Figure IV.B-6). Everts found that the estimated sediment volume loss rates for this area have been decreasing as the bay approaches the equilibrium form predicted using Silvester's (1976) data. As the embayment continues to develop, the shoreline erosion should also continue to decline. However, Everts (1979b) points out that Silvester's procedure is based on limited empirical data. In addition, differences in sediment composition between Lower Township conditions (sand and gravel) and Silvester's data (sand), the uncertainty in the magnitude of sediment losses as a result of the shore-normal sediment transport which generally occurs during storm events, and the exposure of this area compared to others studied by Silvester represent limitations which affect the accuracy in determining equilibrium shape. Because of the limitations of Silvester's method and the differences in sediment type in Lower Township, the loss of sediment needed to reach an equilibrium shape and position may be $\pm$50 percent from that calculated (Everts, 1979b).



DEFINITION SKETCH OF A CRENULATE-SHAPED BAY
USING SILVESTER'S (1976) SYMBOLS

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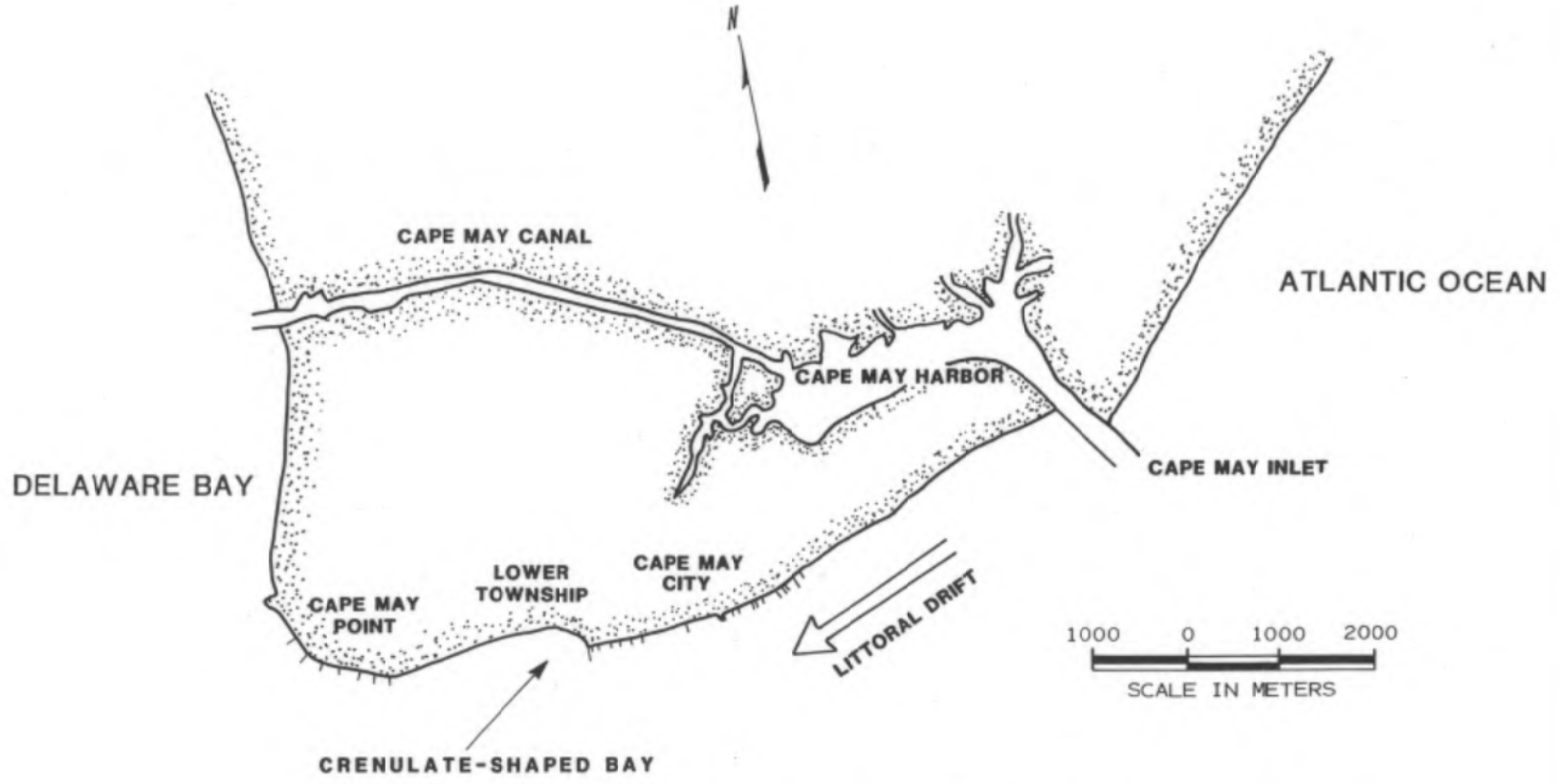
FIGURE IV.B-5



LOCATION OF CRENULATE-SHAPED BAY
IN LOWER TOWNSHIP, NEW JERSEY (REACH 14)

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FIGURE IV.B-6

Independent of the analysis difficulties in estimating the equilibrium shape at Lower Township, the concept of headland control of erosion remains attractive. A series of offshore breakwaters can serve as the artificial headlands required to anchor the crenulate-shaped bays. These artificial headlands would be positioned farther offshore than the tips of conventionally designed groins. Their spacing also would be great enough for the bays to be significant features on the coast. In this way, a new equilibrium shape can be developed which involves milder offshore bed slopes. A reserve of sand is not only stored on the beach but also under water. Less sand is taken from the beach during a storm, and what is taken can be replaced.

Typically, the only sand exchanged between the stabilized bays is the littoral drift entering the area from unstabilized updrift areas. This drift would still continue to move through the bay system. The amount of littoral drift passing downdrift would be less because of the absence of the drift construction eroded from stabilized bays. The advantage of such a stabilization system is that if all littoral transport into the bays is halted, the bays would indent to a predictable limit (Silvester, 1978).

Application of this stabilization concept is proposed for some of the alternative plans for Reach 14, as discussed in Chapter VI. Insufficient data on exposed ocean beaches prevent this concept from being recommended for the entire coast at this time. However, monitoring the behavior of the Lower Township area and other applications of this equilibrium beach form over time may provide sufficient experience to confidently apply this concept to the developed coastal areas of New Jersey.

C. NON-ENGINEERING TECHNIQUES

1. Land Management

The land management alternative involves the use of a variety of regulatory tools by local, state and federal governments for controlling development in erosion hazard areas. The land management alternatives generally flow from a government's authority under its police power to promote the public's health, safety and welfare by controlling or regulating the activities of individuals. Specifically, it enables governments to place limits on individual's uses of their own property (i.e., zoning). With regard to erosion processes, it enables governments to control and limit the amount of private and public investment in erosion hazard areas so as to limit or avoid future losses.

Land management alternatives are constrained by constitutional limits on how far private rights may be limited. Shorefront property is a scarce, and thereby a very valuable economic resource. Government imposed limitations on the use of this resource must be careful not to run afoul of the "taking" issue; that is, denying an individual reasonable use of his property.

A range of land management techniques and concepts that have been, or could be utilized as shore protection techniques, are presented below.

a. Zoning. Involves limiting land use type, intensity, and structural configuration within a clearly defined (mapped area) such as an erosion or flood hazard area. This limitation on, or prohibition of, development within an area must be designed to protect the public health, safety and welfare (e.g., prevent erosion-related losses), and/or promote the public welfare (preserve beach and dune areas, provide additional

open space). Zoning is generally implemented at the local government level. The extent of the regulated area can be tied to an observed erosion rate and its boundary can be periodically readjusted to account for continuing erosion.

An example of zoning would be the establishment of a dune and beach preservation district. This would involve the establishment of a regulatory zone that forbids further development or other specified activities in dune and beach districts. Such a program recognizes the natural protective function of the dunes and beaches in attenuating storm and long-term erosional forces. It would enable a maintenance or reestablishment of the natural integrity of the shore ecosystems.

b. Subdivision Regulation. Governmental regulation of the subdivision of property, with local or state government approval is usually predicated upon meeting certain conditions. Conditions can include the dedication of shorefront area as a public recreation area, the specification of required erosion control measures, or the provision of an easement retaining public access to beaches. In New Jersey, subdivisions with 25 units or more require a state permit under CAFRA. Local governments generally exercise subdivision regulatory authority.

c. Shifting or Rolling Easement. The maintenance of a public easement (either acquired or prescriptive) to a beach during periods of erosion or accretion. Under erosion, the easement would move inland preceding the advance of the mean high water line. Thus, private shorefront property would revert to public use.

d. Building Codes. The promulgation of design standards and materials specifications could be applied to structures located in erosion hazard areas. These regulations are designed to limit the probability of, or amount, of property damage that would accompany continuing erosion or a major storm. Common specifications include: 1) deep foundation standards, 2) minimum floor elevations, and 3) design standards for parts and columns. In New Jersey, the applicable building codes are those required as minimum standards under National Flood Insurance Program. These are presented in Chapter III, Section C.1.c.

e. Building Setbacks. The establishment of a line seaward of which new construction, excavation and other activities would be regulated or prohibited. Thus, additional construction in erosion hazard areas, or in areas which would preclude the maintenance or reestablishment of the natural beach and dune profile would be prevented. Setback lines have been in employed at the state level by Florida, Delaware, and Michigan. In New Jersey, some shorefront communities do have building setback lines in force. The extent of a regulated area can be based on historical erosion rates. In addition, its boundary can also be regularly adjusted to account for continuing erosion or changes in erosion trends.

f. Acquisition. The purchase of shorefront areas by state, Federal or local governments through the exercise of the eminent domain power. The acquisition must be for a valid public purpose (e.g., recreation) or promote the public's health, safety and welfare (e.g., prevent future erosion or storm related losses in hazard areas). Purchases may be on a pre- or post-storm basis. Purchases may be on a fee-simple basis or involve the purchase of easements. An easement involves the purchase, at less than fee-simple, of a portion of the total rights in a shorefront parcel. Provision for continued public access or limitations on future development rights can be obtained in this manner.

Properties may also be obtained through private donation whereby individuals give title to their shorefront properties to a state or local government. This is usually coupled with a provision allowing the donor to receive some kind of benefit, such as a tax deduction.

g. Preferential Taxation. The application of lower tax rates or assessed values to land which is kept in a natural, or in its existing condition (i.e., less than its best and highest use). Taxes are then based on the value-in-use of the land, and not on its development potential. Lower tax burdens serve as incentives to keep shorefront parcels from being further developed, or as compensation for value reductions caused by other regulatory programs (i.e., zoning). A precedent exists for such a program in New Jersey with the present Farmland Assessment Act of 1964.

h. Building Moratoriums. The prohibition of any additional development in erosion hazard areas. Ohio has adopted such a program along the shore of Lake Erie.

i. Transfer of Development Rights. Development rights (land use type, building height, bulk, lot coverage, etc.) are defined for shorefront parcels by applicable zoning laws. Shorefront property owners would be permitted to sell some or all of the development rights of their parcels to owners of properties not located in shorefront or erosion hazard areas would be permitted. This would generate declines in shorefront development intensity and still permit shorefront property owners to capture some of the economic value of their holdings. Transfer of development rights would usually be administered at the county or regional level.

j. Compensable Regulations. Under this scheme the government would compensate shorefront property owners for the decline in the value of their holdings caused by the imposition of a regulation effecting that property. This allows the promulgation of restrictive regulations limiting shorefront development without encountering the "taking" issue.

k. Permitting. Establishment of a regulatory framework whereby the undertaking of certain activities in a defined area contingent upon obtaining a governmental permit by meeting certain terms and conditions. These can include compatibility of the proposed activity in its desired location with established land use, environmental, and socioeconomic policies. In addition, they can also include site-specific design and engineering standards intended to minimize potential adverse economic, social, fiscal, and environmental impacts. Such a permitting system currently exists in New Jersey with the CAFRA, Waterfront Development and wetlands permit programs. In this instance, a State permit is required for certain defined activities desiring to locate within statutorily defined areas.

l. Utility and Infrastructure Siting. Governments plan the location of necessary utilities (e.g., sewers, water, electricity, etc.) so as to divert development away from erosion hazard areas. In addition, it would entail the location of various government facilities (schools, roads, municipal building, sewage treatment plants, etc.) away from erosion hazard areas. This alternative, particularly with regard to sewers and transportation routes, would need to be implemented at the regional, county or state level. For example, the avoidance of future erosion and major storm related property losses could be an explicit planning consideration in the preparation of regional 201 Facilities Plans, particularly those done on a regional level.

2. Warning Systems.

This group of non-engineering techniques primarily involves governmental agencies at various levels in providing the public with information concerning the projected short-term and long-term risks associated with development in erosion hazard areas. The activities can range from ongoing, year round educational programs to broadcast warnings immediately before major storm events. A range of different programs and activities that serve as warning systems are described below.

a. Public Education. This would encompass a range of programs and activities sponsored by local, state and Federal government agencies. These could include periodic workshops in major shore communities, dissemination of maps and pamphlets detailing erosion hazard areas and erosion probabilities, and speakers programs. Probable agencies for implementing such programs include the New Jersey Department of Environmental Protection, Division of Coastal Resources, and local county planning agencies.

b. Deed Disclosure. This would require the inclusion of a statement on all deeds of properties located in defined erosion hazard areas that such properties are subject to probable, erosion-related impacts. This would warn potential purchasers of shorefront properties of the erosion risk. The definition of the erosion hazard area would likely be done at the state level, and the primary recordkeeping responsibility would reside at the local or county government level (e.g. county clerk or county recorder's office).

c. Real Estate Disclosure. This is similar to the deed disclosure program above. In this instance, local real estate agents would be required to warn potential buyers of shorefront properties located in erosion hazard areas, that these properties face the probability of future erosion-related losses.

d. Erosion Forecasts. The National Weather Service currently issues estimates of short-term erosion expected to accompany the occurrence of coastal storms. This service usually provides advance notice only for the occurrence of major storms. The erosion forecasts could be supplemented with information on yearly recession rates and how these are being influenced by seasonal weather trends (e.g. prolonged winds).

e. Disaster Preparedness. State and local emergency planning officials would develop contingency plans for the evacuation of shorefront areas situated in critical erosion and flood hazard areas. In addition, evacuation plans would be developed for barrier islands with limited links to the mainland. The National Weather Service storm warnings would be quickly relayed to local emergency planning officials. State and local officials would inform shorefront residents residing in hazard areas that they face the high probability of severe erosion losses during major storms. Timely evacuation of erosion hazard areas would lessen human suffering associated with short-term erosion accompanying severe storms. This effort could be coordinated with the various public education and civil defense efforts.

3. Relief, Rehabilitation, and Insurance

In contrast to warning systems, this group of non-engineering techniques does deal directly with location of structures and public facilities in erosion hazard areas. These measures either offer aid to replace erosion-related losses of property, or create incentives and performance standards for avoiding or minimizing future erosion losses. Some of the important methods are noted below.

a. Insurance. The National Flood Insurance Program (NFIP) is a federally sponsored and operated program which currently provides shorefront property owners subsidized insurance protection against erosion-related losses and undermining caused by waves or currents exceeding specific levels. Thus, it applies only to short-term, erosion-related losses accompanying major storms. Local communities participating in either the emergency or regular programs of the NFIP must adopt minimum building codes and planning programs. The limitations of the program, as it relates to minimizing erosion losses accompanying severe storms, and to restricting development in flood prone areas, are discussed in depth in Chapter III, Section C.1.c of this Volume. Changes in the existing flood insurance program would have to come from the federal level. However, State support of such changes would be important.

b. Relief and Rehabilitation. Existing rehabilitation and post-disaster assistance is generally not available to cover erosion-related property losses. Aid is generally only available where erosion-related losses have occurred as the result of a major storm. It generally requires a presidential declaration of a "major disaster" or of an "emergency" for post disaster assistance to be made available. The available aid is generally targeted toward the reconstruction of public facilities, utilities and infrastructure. Low interest loans can be made available to private citizens. Rehabilitation and post-disaster assistance originate at the Federal level through the Federal Emergency Management Agency (FEMA).

c. Relocation Incentives. The offering of economic incentives by governments to shorefront property owners to relocate out of erosion hazard areas. These could be implemented on a pre- or post-storm basis. Incentives could include outright grants or low interest loans covering moving or reconstruction expenses. Reconstruction grants or loans could be made contingent upon relocation out of a coastal hazard area. Similarly, tax abatements could be granted on new construction located out of an erosion hazard area. Finally, government(s) could supply assistance in locating and purchasing suitable areas for relocation. These programs would likely be implemented at the State and Federal levels.

D. COMPATIBILITY AND INTERACTION OF ALTERNATIVES

The implementation of any one of the previously described alternatives will generate a unique set of direct and indirect impacts. These impacts will have widely varying physical, socioeconomic, spatial, and temporal characteristics. These effects may manifest themselves in unanticipated ways such that the adoption of other alternative techniques may be required to help minimize erosion-related losses. For example, the adoption of structural engineering methods could maintain or intensify development densities in shorefront areas. Over the long run, this would require larger, future expenditures for post-disaster assistance. In addition, there could be an increase in demand by shorefront residents for subsidized insurance programs to help distribute the costs of erosion-related losses of shorefront property among the society at large.

The effectiveness of adopting a particular shore protection technique can often be enhanced by simultaneously adopting, singly or in combinations, other techniques. However, the differing effects associated with the adoption of the various alternatives makes it certain that not all of the techniques would be compatible with one another. The various techniques often have opposite objectives (i.e. attenuation of natural erosion forces versus mitigation of future erosion-related losses) and opposite effects (i.e. decreases versus increases in shorefront development density in erosion hazard areas). There are combinations of the various alternative techniques that are particularly compatible with one another. The adoption of these specific combinations can be highly effective in reducing or avoiding future erosion-related losses.

Prior to the implementation of a group of shore protection techniques, the various direct and indirect benefits and costs of each of the alternatives should be considered to ensure that conflicts or offsetting impacts are not present. Sorensen and Mitchell (1975) have examined in some depth the degree of compatibility between varying shore protection alternative techniques. They assessed the interaction between the initial adoption of one of a set of nine techniques, and the subsequent likelihood that any of the remaining eight would also be adopted. They noted that the adoption of a particular shore protection alternative may increase, decrease, or leave unchanged, the probability that some of the remaining alternatives will also be adopted. Their discussion of these interactions are based on an assessment of the extent to which the impacts associated with adopting one alternative are compatible with or conflict with those associated with the subsequent adoption of another alternative. In instances where the direct and indirect effects of adopting two alternatives would directly conflict with one another, Sorensen and Mitchell conclude that the initial adoption of one alternative effectively diminishes the probability of adopting the other.

Figure IV.D-1 has been reproduced from Sorensen and Mitchell (1975). The cells in the matrix with upward pointing arrows identify those shore protection alternative techniques that are capable of being grouped into combinations or packages that could constitute a comprehensive approach to the problem of shore erosion. The major conclusions from this matrix comparison are summarized below.

- The adoption of seawalls, groins, and other barriers to coastal processes may strengthen reliance on relief and rehabilitation in the short run, and encourage the eventual development of long-range erosion forecasts, but it will retard the choice of non-structural protection programs and the implementation of land use regulations.

- The adoption of non-structural engineering alternatives (e.g. dune stabilization or beach nourishment) may not change, or may reduce the probability of adopting land management alternatives. Non-structural engineering alternatives diminish the probability of adopting insurance programs as short-term property loss levels in erosion hazard areas are usually reduced.

- Adopting regulatory land management (non-acquisition) alternatives does little to diminish the probability of implementing most of the other alternatives. However, they do lessen the need for erosion control structures, relief, and rehabilitation. Thus, regulatory alternatives appear to present a great deal of flexibility in allowing the subsequent adoption of other alternatives that would decrease erosion loss potential.

INTERACTION AND COMBINATION OF ADJUSTMENTS TO EROSION

SOURCE: TAKEN FROM SORENSEN AND MITCHELL (1975)

DAMES & MOORE

FIGURE IV.D-1

- Adopting relief and rehabilitation programs decreases the probability of adopting most other alternatives designed to directly protect against or avoid future erosion losses. These programs remove the incentive to protect against, or to implement planning measures designed to reduce future erosion-related losses.

- The adoption of non-acquisition, land management alternatives increases the probability of adopting insurance programs. The short-term, direct property losses that may occur under a land management alternative would require insurance subsidies to ease the burden of the costs incurred by shorefront property owners. In the long run, the reliance on relief and rehabilitation programs would decrease as development intensity in erosion hazard areas would decline.

The consideration of combining alternative shore protection techniques into comprehensive packages to mitigate or avoid future erosion-related losses requires consideration of the impacts associated with their collective implementation. It is clear that the simultaneous implementation of groups of alternatives do present opportunities to increase shore protection benefits.

Given the consideration of shore protection alternatives in this chapter, and the policy review provided in Chapter III, shore protection alternatives for New Jersey are developed and evaluated in Chapter V. Based on those evaluations, the Plan presented in Volume 1, Chapter II is proposed for implementation.

CHAPTER V

SELECTION AND ANALYSIS OF SHORE PROTECTION ALTERNATIVES FOR NEW JERSEY

A. INTRODUCTION

1. General

This chapter presents a comparative evaluation of selected engineering and land management alternatives to cope with the shore erosion problem in New Jersey. Additionally, a "no action" alternative is discussed. The evaluation of alternatives addresses the following questions: What are the pros and cons of each approach? What is the actual cost of continuing to protect development adjacent to eroding shores? What are the benefits and who are the beneficiaries? What are the impacts on the socioeconomic system and on the natural ecosystem and resources?

In the selection of shore protection alternatives for New Jersey, the available techniques and concepts presented in Chapter IV were considered. Given the objectives of the Shore Protection Master Plan, operative coastal processes, shoreline conditions, the density of development along the shore, and State and Federal shore protection policies, two major approaches for mitigation of potential adverse effects of coastal erosion were considered worthy of further consideration for application in New Jersey. These include engineering alternatives and land management alternatives.

The engineering design plans developed and evaluated in Chapter VI for the 16 shoreline reaches are alternatives to the authorized Corps of Engineers multipurpose shore protection plans which have been developed over the last 20 years. Summary descriptions of engineering alternatives for all reaches are provided in Volume 1, Chapter II, Table II.B-1. A full discussion and schematic representation of reach alternatives is provided in Chapter VI, Section B. The authorized Corps of Engineers plans, which are currently inactive because of the inability of State and local government interests to commit to initial cost-sharing and maintenance responsibilities, are summarized in Chapter VI, Section C.

In the Master Plan analysis, five engineering alternatives, of varying design levels, are considered for each reach:

- Storm Erosion Protection
- Recreational Development
- Combination (Storm Erosion and Recreational Development)
- Limited Restoration
- Maintenance Program

For the purpose of this comparative evaluation of alternatives, it was necessary to select a limited number of cases to illustrate the potential socioeconomic benefits and impacts. Four reaches and the following engineering alternatives were selected for analysis:

- Peck Beach (Reach 10) — Recreational Development
- Absecon Island (Reach 9) — Recreational Development
- Long Branch to Shark River Inlet (Reach 3) — Limited Restoration
- Sandy Hook to Long Branch (Reach 2) — Maintenance Program

These examples collectively encompass most of the socioeconomic and land use characteristics found along the New Jersey shore.

The two land management alternatives considered are:

- o Coastal Land Use Regulation
- o Acquisition

These two land management alternatives are compared on a generic basis for all shoreline reaches.

For the comparison, the no action alternative is also considered.

The rationale for selecting the engineering and land management alternatives is set forth in the following section. Each alternative is evaluated with regard to costs, benefits, and beneficiaries, impacts on the natural ecosystem and resources, socioeconomic impacts, and feasibility and implementation. To adequately assess the effects of implementation, each alternative is considered as if it was the preferred solution. It is recognized that a combination approach is likely, even though the major choices are between continued engineering measures and land management measures. Acquisition, for example, may be appropriate as a supplement to an engineering approach or to a regulatory approach. The individual evaluation of the alternatives will provide an assessment of the effects and implications of possible alternative combinations.

2. Selection of Alternatives Evaluated

a. Engineering Alternatives

The selection of four reaches and engineering alternatives for detailed socioeconomic evaluation was based primarily on the priority analysis of the engineering alternatives which is developed and discussed in Volume 1, Section II.B.1.d. Table V.A-1 presents the priority list of top ranking reach alternatives based on benefit/cost ratios. Component present worth costs and benefits for the alternative engineering plans for oceanfront reaches are presented in Table V.A-2.

In addition to the priority analysis, the selection of reaches for evaluation was also based on consideration of representative socioeconomic characteristics. In Chapter II, Section D.5 of this volume, the reaches are analyzed with regard to community classification. The results indicate that the ocean shore reaches can be classified into two general types — urban reaches (e.g., Absecon Island and Long Branch to Shark River Inlet) and recreational reaches (e.g., Long Beach Island or Peck Beach). The top ranking alternative on the priority list, in terms of benefit/cost ratios, is Recreational Development for Peck Beach (Reach 10), followed by Recreational Development for Absecon Island (Reach 9). Peck Beach was chosen as the representative recreational reach and Absecon Island and Long Branch to Shark River Inlet (Reach 3) as the representative urban reaches. The most cost beneficial alternative for Reach 3 is the Limited Restoration Program. Based on the overall priority analysis, one reach (Reach 2 - Sandy Hook to Long Branch) was selected for evaluation of the Maintenance Program alternatives. In terms of socioeconomic impacts, the Maintenance Program alternative was evaluated as a distinct alternative adjustment to erosion.

TABLE V.A-1

RELATIVE PRIORITY RANKING BY BENEFIT/COST RATIO
HIGHEST RANKING ENGINEERING ALTERNATIVE FOR EACH REACH

Reach No.	Reach/Alternative	Relative Rank	Benefit/ Cost Ratio	Initial Cost (in million dollars)	Estimated Total Present Worth Cost (in million dollars)
10	Peck Beach Recreational Development	1	1.70	3.447	17.573
2	Sandy Hook to Long Branch Maintenance Program	2	1.51	3.709	4.482
9	Absecon Island Recreational Development or Combination	3	1.45	11.506	28.741
12	Seven Mile Beach Recreational Development	4	1.37	0.700	7.711
7	Long Beach Island Recreational Development	5	0.96	3.638	11.321
11	Ludlam Island Recreational Development	6	0.88	0.501	20.687
14	Cape May to Cape May Point Recreational Development	7	0.80	9.808	31.740
4	Shark River Inlet to Manasquan Inlet Recreational Development	8	0.70	3.574	13.164
5	Manasquan Inlet to Mantoloking Recreational Development	9	0.63	0.528	4.271
3	Long Branch to Shark River Inlet Limited Restoration	10	0.51	19.891	28.837
6	Mantoloking to Barnegat Recreational Development	11	0.38	0.708	7.870
8	Brigantine Island Recreational Development	12	0.17	0.702	4.649
13	Five Mile Beach Recreational Development	13	0.10	0.752	0.973

Notes:

1. Each of the nonmaintenance alternatives may include maintenance as a component, e.g., the total cost for the Peck Beach recreational development alternative includes $1.007 million of maintenance plus $16.566 million of additional costs above and beyond maintenance, for a total cost of $17.573 million. Details of cost estimates for each reach alternative are presented in Volume 2, Chapter VI.
2. In reaches where two, preferred, non-maintenance alternatives had identical benefit/cost ratios, the lower total present value cost among the two alternatives was entered in the table.

TABLE V.A-2

COST-BENEFIT ANALYSIS FOR OCEANFRONT REACHES (2-14) [a]

Reach No.	Reach Name	Erosion Control Alternatives [b]	Engineering Cost (in million dollars)	Public Service Cost (in million dollars)	Recreational Benefits (in million dollars)	Property Protection (in million dollars)	Benefit/ Cost Ratio	Relative Rank [c]
2	Sandy Hook to Long Branch	(1)	10.402	5.081	10.163	7.280	1.13	13
		(2)	23.689	9.709	19.418	7.209	0.80	18
		(3)	26.187	9.709	19.418	7.280	0.74	22
		(4)	8.578	5.081	10.163	7.209	1.27	9
		(5)	4.482	0	0	6.755	1.51	3
3	Long Branch to Shark River Inlet	(1)	41.272	10.384	20.769	4.383	0.49	30
		(2)	21.495	4.140	8.280	4.360	0.49	29
		(3)	40.232	10.477	20.954	4.383	0.50	27
		(4)	28.837	6.932	13.864	4.383	0.51	26
		(5)	11.883	0	0	1.579	0.13	43
4	Shark River Inlet to Manasquan Inlet	(1)	29.876	7.502	15.004	2.481	0.47	32
		(2)	13.164	5.234	10.468	2.479	0.70	23
		(3)	29.876	7.502	15.004	2.487	0.47	32
		(4)	29.876	7.502	15.004	2.487	0.47	32
		(5)	3.598	0	0	0.566	0.16	41
5	Manasquan Inlet to Mantoloking	(1)	12.401	0.374	0.749	2.161	0.23	39
		(2)	4.271	0.374	0.749	2.161	0.63	25
		(3)	12.401	0.374	0.749	2.161	0.23	39
		(4)	7.357	0.374	0.749	2.161	0.36	36
		(5)	0.602	0	0	0.050	0.08	47
6	Mantoloking to Barnegat Inlet	(1)	21.750	0.203	0.406	2.704	0.14	42
		(2)	7.870	0.203	0.406	2.697	0.38	35
		(3)	21.750	0.203	0.406	2.704	0.14	42
		(4)	12.725	0.203	0.406	2.697	0.24	37
		(5)	0.944	0	0	0.100	0.10	44
7	Long Beach Island	(1)	28.496	4.306	8.612	6.894	0.47	31
		(2)	11.321	3.905	7.810	6.894	0.96	15
		(3)	28.496	4.306	8.612	6.894	0.47	31
		(4)	14.153	4.047	8.094	6.894	0.82	17
		(5)	5.149	0	0	1.183	0.23	38
8	Brigantine Island	(1)	13.297	0.257	0.515	0.352	0.06	49
		(2)	4.849	0.257	0.515	0.352	0.17	40
		(3)	13.297	0.257	0.515	0.352	0.06	49
		(4)	12.308	0.257	0.515	0.352	0.07	48
		(5)	0.980	0	0	0.035	0.04	50
9	Absecon Island	(1)	25.279	50.456	100.911	2.328	1.36	8
		(2)	28.741	71.165	142.330	2.328	1.45	4
		(3)	28.741	71.165	142.330	2.328	1.45	4
		(4)	23.018	26.698	53.397	2.328	1.12	14
		(5)	3.487	0	0	0	0	54
10	Peck Beach	(1)	30.708	43.898	87.696	17.925	1.41	6
		(2)	17.573	42.431	84.861	17.193	1.70	1
		(3)	30.504	43.867	87.734	17.925	1.42	5
		(4)	21.617	43.184	86.367	17.193	1.60	2
		(5)	1.007	0	0	1.187	1.18	11
11	Ludlam Island	(1)	42.409	8.460	16.921	8.584	0.50	28
		(2)	20.687	8.460	16.921	8.584	0.88	16
		(3)	42.409	8.460	16.921	8.584	0.50	28
		(4)	28.511	8.460	16.921	8.584	0.69	24
		(5)	0.795	0	0	0.349	0.44	33
12	Seven Mile Beach	(1)	18.724	24.448	48.896	0.514	1.14	12
		(2)	7.711	16.097	32.193	0.402	1.37	7
		(3)	18.724	24.448	48.896	0.514	1.14	12
		(4)	12.963	21.974	43.949	0.402	1.27	10
		(5)	0.959	0	0	0.092	0.10	45
13	Five Mile Beach	(1)	4.150	0.052	0.103	0	0.02	52
		(2)	0.973	0.052	0.103	0	0.10	46
		(3)	4.150	0.052	0.103	0	0.02	52
		(4)	3.244	0.052	0.103	0	0.03	51
		(5)	0.911	0	0	0	0	53
14	Cape May Inlet to Cape May Point	(1)	35.837	22.196	44.393	0.754	0.78	21
		(2)	31.740	20.324	40.648	0.754	0.80	19
		(3)	35.837	22.196	44.393	0.754	0.78	21
		(4)	34.263	22.196	44.393	0.754	0.80	20
		(5)	1.497	0	0	0.571	0.38	34

Note: See text for cost-benefit methodology discussion.

(a) All estimated costs and benefits are expressed in present worth values.

(b) Alternative engineering plans are: (1) Storm Erosion Protection; (2) Recreational Development; (3) Combination of Storm Protection and Recreational Development; (4) Limited Restoration; and (5) Maintenance Program

(c) For alternatives with identical benefit/cost ratios, the one with the lower total cost was given priority over the others.

In addition to the analysis of selected alternatives, the probable secondary socioeconomic impacts for other reaches are briefly described. Emphasis is placed on how the impacts for other recreational reaches might vary from those of the Peck Beach example, and how impacts at other urban reaches might vary from those estimated for Absecon Island and Long Branch to Shark River Inlet.

b. Land Management Alternatives

(1) Coastal Regulation. Land use regulation has been implemented by several coastal states to preserve and protect environmental resources of the beach/dune system from development activities and to mitigate the losses associated with coastal erosion and flooding hazards. In general, dune and beach preservation laws within the framework of State coastal management plans are used for resource protection, while setbacks would be used to delineate a coastal regulatory zone for areas subject to shoreline erosion hazards. Erosion setback can apply to the dune/beach regulatory zone on barrier islands and to bluff areas where dunes are not present.

In this chapter, the model used to compare engineering and land management alternatives considers an erosion setback as the mode of delineation for regulation of erosion hazard areas. The selection of setback does not imply the substitution of existing and proposed legislation which is discussed in Chapter XI. It should be noted that coastal land use regulation programs likely to evolve and be implemented in New Jersey will be lesser programs than the erosion setback — erosion hazard area regulated zone evaluated in this chapter. Similarly, the anticipated impacts would be substantially less significant. The regulation alternative evaluated and the impacts identified in this chapter may be considered maximum likely to ever occur.

The erosion setback delineation approach is specifically related to erosion and its related hazards, though it does, in effect, protect the dune within the shore zone in most places. The setback approach also serves as a tool for mitigation of coastal flood hazards which tend to be associated with the ocean side of barrier islands. It can be applied to the entire oceanfront or bayfront shoreline, including areas where dunes presently do not exist (due to development practices) or where they do not occur naturally, such as along coastal bluffs. Using the erosion setback delineation as the basis for comparative evaluation thus represents a reasonable approach for comparison of the engineering alternatives. Depending on the degree of similarity to other land management tools, it can be used to predict their advantages and disadvantages.

Delaware, Florida, Georgia, Michigan, New York, and North Carolina have incorporated an erosion setback concept or have proposed such setbacks. In 1971, Florida enacted a Coastal Construction Setback Law to prevent beach encroachment that would endanger the existing beach and dune system and to help prevent existing and future structures from being unreasonably subject to harm. In 1978, the Florida setback law was amended and renamed the Coastal Construction Control Line. The construction of inhabitable structures or shore protection structures seaward of the control line requires a permit from the Florida Department of Natural Resources' Bureau of Beaches and Shores. The determination of the construction control line is based on long-term erosional trends, short-term storm related effects, historic (100-year) storm tide levels, predicted wave uprush, dune line, erosion trends, wind forces, and existing development. Construction permits may be granted for the regulated zone upon submission of adequate engineering data on the stability of the shoreline in

question. The data must clearly show justification for the permit or that the location in question is adjacent to or landward of a structured existing construction line which has not shown erosion effects. Uninhabitable structures, such as pipelines and piers, may be authorized if it can be shown that such projects would not cause erosion of the adjacent beach areas. As of July 1980, 400 permits for major inhabitable structures had been issued since the enactment of the 1971 setback law (Personal communication, D. Athos, Chief of the Florida Bureau of Beaches and Shores, July 1980). Under the original setback law, technical complexities, administrative weaknesses, and legal issues created variance problems. Many of the deficiencies have been corrected for under the amended coastal construction permit process.

Any erosion setback delineation must incorporate the short-term erosion component associated with the rapid erosion losses accompanying a major storm as well as the long-term erosion trend based on historic data. It has been pointed out by participants of the National Conference on Coastal Erosion (FIA, 1977) that the single storm event effects are already integrated into long-term erosion rates. Although this is true, the long-term rate represents a net change and incorporates the recovery aspects of storms as well as their recessional losses. With regard to the planning of a safe erosion setback distance, it is important to incorporate the maximum recession associated with a single major event since this penetration is capable of erosive destruction regardless of the nature of the subsequent shoreline recovery.

In this chapter, we consider both the long-term erosion rate and the short-term storm recession rate and use the larger of the two as the setback distance; that is, where the historic erosion rate indicates that for the period under consideration (50 years is selected for this analysis), erosion would be less than the erosion distance that is expected due to major storm erosion (100 feet for this analysis), the single short-term erosion distance would govern the erosion setback distance. The erosion setback distance is measured from the seaward toe of the frontal dune at the break in slope with the beach; or, where no dunes are present, from the landward edge of the beach or at the slope increase associated with a bluff. In seawalled areas such as Seabright, it is assumed that structural maintenance would be performed, and thus the setback behind the seawall is set at a nominal amount — 20 feet — to allow for wave overtopping. The migration of the shoreline would be incorporated in the setback scheme through the reassessment of the setback line approximately every 5 years, or when necessary. The erosion hazard setback evaluated here as a land use regulation scheme is illustrated on Figures V.A-1 and V.A-2 for Peck Beach (Reach 10) and Long Branch to Shark River Inlet (Reach 3) respectively. For comparison, the area that would have been regulated under the proposed Dune and Shorefront Protection Act (A-1825), which was withdrawn by the sponsor in 1980, has also been delineated in Figure V.A-1 and V.A-2.

A further discussion of the methodology used to develop the erosion setback distance and a review of other approaches to coastal erosion hazard area delineation are provided in Chapter X.

(2) Land Acquisition. In addition to coastal regulation using an erosion setback concept, land acquisition is also evaluated as a land management alternative. Acquisition, which reduces hazard losses and increases public access to beaches, has been a major emphasis of the evolving Federal and State policies, as outlined in Chapter III.

For the purposes of this comparative evaluation, we have chosen to evaluate post-storm acquisition. The New Jersey shoreline is heavily developed.

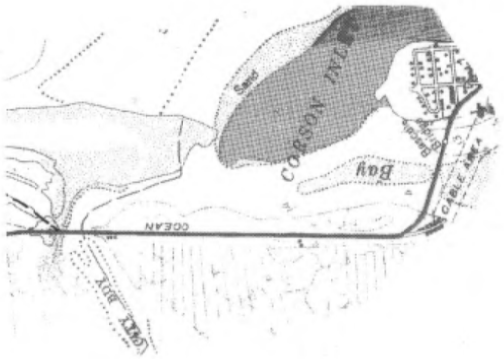


COMPARISON OF PROPOSED

REACH 10 - GREAT EGG HARBOR

0

SCAL

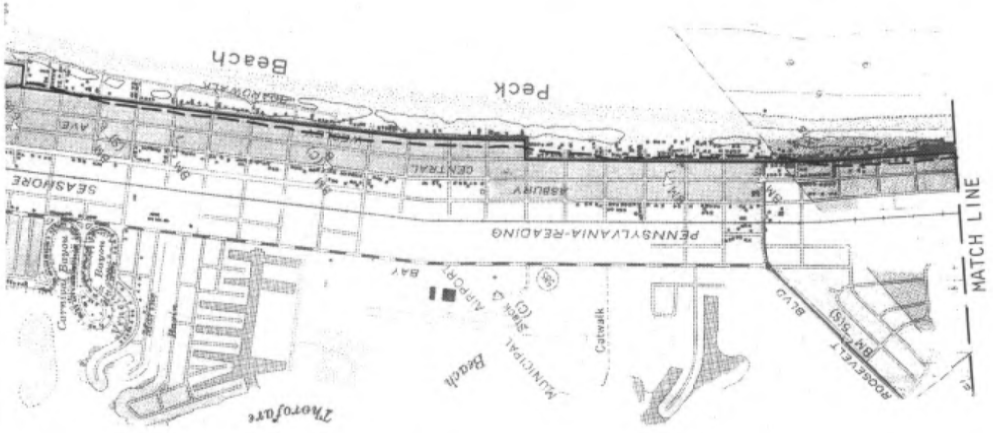


KEY:

EROSION SETBACK REGULATION LINE (THIS STUDY) ASSUMING NO ENGINEERING PLANS ARE IMPLEMENT

PROPOSED DUNE AND SHOREFRONT PROTECTION ACT REGULATION LINE (WITHDRAWN BY SPONSOR 1980)

NOTES:
1. REGULATED ZONES FOR EACH CASE ARE SEAWARD OF THE APPROPIATE REGULATION LINE.
2. THE PROPOSED EROSION SETBACK SHOULD INCLUDE THE ENTIRE WIDTH OF THE DUNE AREA ALONG THOSE SECTIONS OF THE SHORELINE WHERE DUNES EXIST.



COASTAL REGULATION ZONES

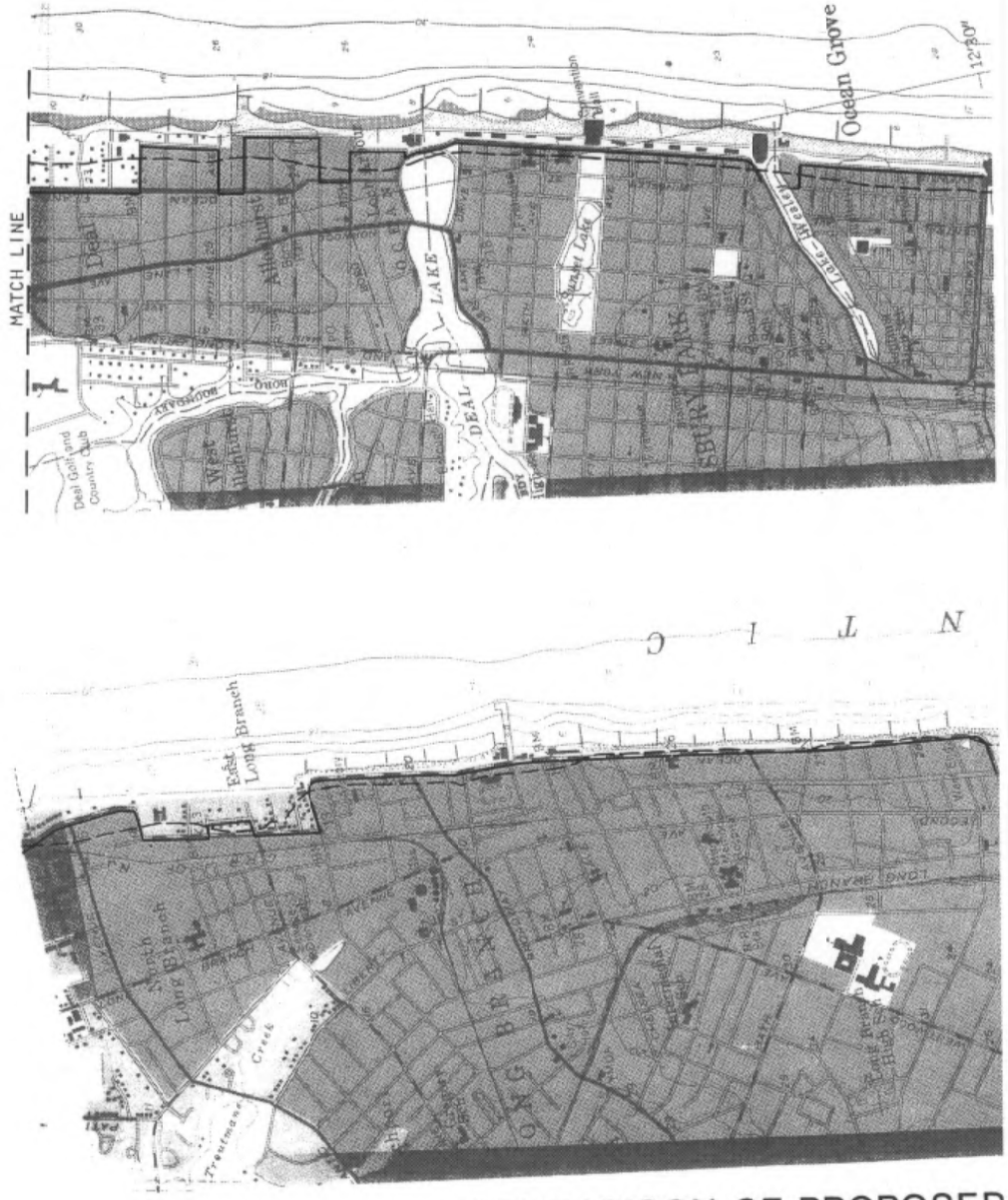
LET TO CORSON INLET (PECK BEACH)

½ 1

IN MILES

DAMES & MOORE

FIGURE V.A-1

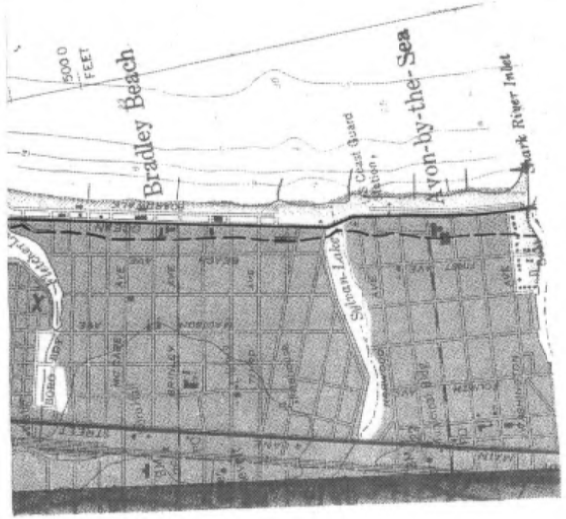


COMPARISON OF PROPOSED

REACH 3 - LONG BRANC

0

SCALE



N

KEY:

EROSION SETBACK REGULATION LINE (THIS STUDY) ASSUMING NO ENGINEERING PLANS ARE IMPLEMENT

PROPOSED DUNE AND SHOREFRONT PROTECTION ACT REGULATION LINE (WITHDRAWN BY SPONSOR 1980)

NOTES:
1. REGULATED ZONES FOR EACH CASE ARE SEAWARD OF THE APPROPIATE REGULATION LINE.
2. THE PROPOSED EROSION SETBACK SHOULD INCLUDE THE ENTIRE WIDTH OF THE DUNE AREA ALONG THOSE SECTIONS OF THE SHORELINE WHERE DUNES EXIST.

A T L A



COASTAL REGULATION ZONES

TO SHARK RIVER INLET

1

MILES

DAMES & MOORE

FIGURE V.A-2

Typically, the value of land with structures is in the range of $100,000 to $300,000 per acre. The lowest purchase price for an entire barrier island is about $302 million for Brigantine Island (Reach 8). The estimated acquisition costs for some of the other barrier island reaches are:

- $995 million for Long Beach Island (Reach 7)
- $1,720 million for Absecon Island (Reach 9)
- $867 million for Peck Beach (Reach 10)
- $378 million for Ludlam Island (Reach 11)
- $563 million for Seven Mile Beach (Reach 12)
- $738 million for Five Mile Island (Reach 13)

The alternative of barrier island acquisition was not evaluated in detail due to the high costs and the major social and political disruption that would occur. However, post-storm acquisition of the area which would be encumbered by the regulatory zone is considered. Overall, acquisition is not likely to be considered as a mutually exclusive option, but as a supplement to other approaches.

B. EVALUATION OF SELECTED ENGINEERING ALTERNATIVES

This section provides a discussion of the probable impacts and implementation feasibility of selected engineering alternatives. A generic discussion of the impacts of a range of engineering erosion control alternatives on shore natural ecosystems and resources is followed by an assessment of the quantifiable and nonquantifiable socioeconomic impacts of selected engineering alternatives in four example reaches. Also, the probable socioeconomic impacts for other reaches are briefly discussed with emphasis placed on how they might vary from these described for the four example reaches.

1. Impacts on the Natural Ecosystem and Resources

In general, the beach nourishment programs would tend to have the most significant impact on the natural environment, but even these are of minor concern due to their short-term duration and highly localized impact. Likewise, the impacts of dredging offshore sands for beach nourishment should not have a significant adverse impact as long as productive shellfish beds are avoided and fine-grained sediments (silts and clays) are not extracted.

Dredging, beach nourishment, structural maintenance, and the construction operations associated with each alternative will result in short-term localized impacts (e.g., turbidity, habitat disturbance, water and air quality degradation) on the environment. Table V.B-1 summarizes the variability and intensity of anticipated impacts.

a. Generic Ecosystem and Biological Resource Impacts

(1) Seawall Construction. Seawall construction typically involves stone or concrete placement. The ecosystem and biological resource impacts associated with this activity should be minimal along the New Jersey shore since seawalls would normally only be constructed in highly developed areas and where groin fields and other shore protection structures already exist. Anticipated construction activity would involve the use of heavy equipment including trucks and cranes, most of which could operate from the landward side of the wall, thus minimizing disturbance of the existing shorefront area. Noise and air quality degradation would occur during the period of construction equipment operation.

(2) Groin Construction and Maintenance. Where proposed, groins would be constructed and maintained using rock or timber. During construction, these materials would be trucked to the site and handled with heavy equipment. The major impacts of construction are burial of habitat and the various effects of heavy equipment operation – ground disturbance, noise, and air pollutant emissions. The burial of sandy substrate by rock during groin construction is an impact of minor significance due to the small area involved and the short duration of the impact. The sand community would be eliminated only beneath each new structure. Burial would be most significant in the lower beach zone where the inhabitants (species such as crabs, sand dollars, and some molluscs) are usually more abundant and diverse and less mobile than species inhabiting the middle and upper beach. This elimination should have little impact on food availability for higher predators which usually feed in the shore zone. Minimal impact is anticipated either updrift or downdrift of the construction as a result of the emplacement of the groin or the change in drift transport, since the organisms in this beach zone are highly mobile and would be able to cope with the subtle changes in sand deposition and erosion.

TABLE V.B-1

POTENTIAL IMPACTS ASSOCIATED WITH SHORE PROTECTION ALTERNATIVES FOR OCEANFRONT REACHES 2-14

Reach/Alternative	Burial	Turbidity	Adverse Effect on Finfish	Adverse Effect on Shellfish	Water Quality Degredation	Release of Toxic Contaminants	Dune Disturbance	Disturbance of Vegetation and Land Animals	Air Quality Degradation	Disturb Colonial Nesting Birds	Enhance Sport Fishing	Provide Habitat for Attaching Marine Community	Increase Beach Size Which Will Enhance Vegetation and Land Animals
Reach 2													
Storm Erosion Protection	+	+	L	L	M	M	—	—	+	—	—	—	—
Recreational Development	+	+	L	L	M	M	—	—	+	—	—	—	—
Combination Program	+	+	L	L	M	M	—	—	+	—	—	—	—
Limited Restoration	+	+	L	L	M	M	—	—	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	—	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 3													
Storm Erosion Protection	+	+	M	L	L	L	—	—	+	—	+	+	—
Recreational Development	+	+	L	L	L	L	—	—	+	—	—	—	—
Combination Program	+	+	L	L	L	L	—	—	+	—	—	—	—
Limited Restoration	+	+	M	L	L	L	—	—	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	—	+	—	+	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 4													
Storm Erosion Protection	+	+	M	L	L	L	—	—	+	—	—	—	—
Recreational Development	+	+	L	L	L	L	—	—	+	—	—	—	—
Combination Program	+	+	M	L	L	L	—	—	+	—	—	—	—
Limited Restoration	+	+	L	L	L	L	—	—	+	—	—	—	—
Maintenance	—	—	—	—	—	—	—	—	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	—	—	—	—	—	—	—
Reach 5													
Storm Erosion Protection	+	+	L	L	M	M	P	P	+	—	—	—	—
Recreational Development	+	+	L	L	M	M	P	P	+	—	—	—	—
Combination Program	+	+	L	L	M	M	P	P	+	—	—	—	—
Limited Restoration	+	+	L	L	M	M	P	P	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 6													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	—	—	—	—
Recreational Development	+	+	L	L	L	L	P	P	+	—	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	—	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 7													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	—	—	—	—
Recreational Development	+	+	L	L	L	L	P	P	+	—	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	—	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 8													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	P	—	—	+
Recreational Development	+	+	L	L	L	L	P	P	+	P	—	—	+
Combination Program	+	+	L	L	L	L	P	P	+	P	—	—	+
Limited Restoration	+	+	L	L	L	L	P	P	+	P	—	—	+
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	P	—	—	—

KEY:

+ Applicable
— Not applicable or of any significance
M Moderate - Each dependent upon siting of offshore structures and fill sources.
L Low - Each dependent upon siting of offshore structures and fill sources.
P Potential - Possible dependent upon points of access to beach.

TABLE V.B-1 (Continued)

Reach/Alternative	Burial	Turbidity	Adverse Effect on Finfish	Adverse Effect on Shellfish	Water Quality Degradation	Release of Toxic Contaminants	Dune Disturbance	Disturbance of Vegetation and Land Animals	Air Quality Degradation	Disturb Colonial Nesting Birds	Enhance Sport Fishing	Provide Habitat for Attaching Marine Community	Increase Beach Size Which Will Enhance Vegetation and Land Animals
Reach 9													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	—	—	—	—
Recreational Development	+	+	L	L	L	L	P	P	+	—	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	—	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 10													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	—	+	+	+
Recreational Development	+	+	L	L	L	L	P	P	+	—	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	—	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	—	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	—	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	—	—	—	—
Reach 11													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	P	+	+	+
Recreational Development	+	+	L	L	L	L	P	P	+	P	+	+	+
Combination Program	+	+	L	L	L	L	P	P	+	P	+	+	+
Limited Restoration	+	+	L	L	L	L	P	P	+	P	+	+	+
Maintenance	—	—	—	—	—	—	P	P	+	P	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	P	—	—	—
Reach 12													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	P	—	—	—
Recreational Development	+	+	L	L	L	L	P	P	+	P	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	P	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	P	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	P	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	P	—	—	—
Reach 13													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	P	—	—	—
Recreational Development	+	+	L	L	L	L	P	P	+	P	—	—	—
Combination Program	+	+	L	L	L	L	P	P	+	P	—	—	—
Limited Restoration	+	+	L	L	L	L	P	P	+	P	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	P	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	P	—	—	—
Reach 14													
Storm Erosion Protection	+	+	L	L	L	L	P	P	+	P	+	+	—
Recreational Development	+	+	L	L	L	L	P	P	+	P	+	+	—
Combination Program	+	+	L	L	L	L	P	P	+	P	+	+	—
Limited Restoration	+	+	L	L	L	L	P	P	+	P	—	—	—
Maintenance	—	—	—	—	—	—	P	P	+	P	—	—	—
Land Mgt. Alternatives	—	—	—	—	—	—	P	P	—	P	—	—	—

KEY:

+ Applicable
— Not applicable or of any significance
M Moderate - Each dependent upon siting of offshore structures and fill sources.
L Low - Each dependent upon siting of offshore structures and fill sources.
P Potential - Possible dependent upon points of access to beach.

Disturbance of dune areas would frighten birds and small mammals and could destroy the vegetation which helps maintain the dunes. To mitigate impacts from construction operations on dune and beach areas, care should be taken when moving equipment onto the beach. Equipment and personnel should use existing access areas and avoid disturbance of dunes and vegetational areas.

Animals usually react to a new noise by avoiding it, however, they often learn to ignore new sounds and adjust to the change in their environment. Some animals may be unable to cope with a continual noise source or may be physiologically affected (Memphis State University, 1971). The susceptibility of individual species is not fully understood and can be expected to vary according to several factors including lifestage, season, ecological niche, population density, social activities, and physical parameters such as noise frequency. Noise generated by bulldozers, trucks, etc., would range from 70 to 90 dBA (50 feet from the source) and should cause little or no increase in noise levels off the beach area because of high background noise levels (surf) and normal attenuation of noise over distance (USACOE, Philadelphia District, November 1976b). The impulse noise generated by pile-driving equipment during construction of groins or bulkheads would range from 90 to 101 dBA (50 feet from the source) and would tend to affect a somewhat larger area (USEPA, 1977).

Of particular concern would be the potential for noise impact on colonial nesting birds (e.g., black skimmer, herons, egrets, etc.), which are known to be appreciably more sensitive to noise than mammals. To mitigate the disturbance of nesting areas on barrier beaches, construction should take place during fall and winter where practical.

Minimal changes in air quality are expected as a result of the short-term use of construction equipment. The emission of air pollutants would temporarily degrade air quality in the vicinity downwind of the construction equipment. The impact is similar to that associated with any large internal combustion engine and will disappear on completion of equipment operation.

A positive impact of groin construction would be the creation of hard substrate habitat where rock and timber are placed below the mean high water line. The organisms that would inhabit these structures are described in Appendix B, Section 1.b. The attaching species add to the diversity of organisms in the lower beach and shallow nearshore zones and provide a food source for fish and invertebrates which may take up residence around the groins. This fish attraction offers the potential for improved recreational fishing.

(3) Beach Nourishment. Beach nourishment is described in Chapter IV, Section B.3.d. The periodic placement of large quantities of sand on the beach would bury the organisms of the upper, middle, and lower beach zones. Since many of these species are active burrowers, some organisms may be able to escape the impact of burial. They are typically accustomed to change and frequently incorporate this into their life cycle. The less mobile species, including haustoriid amphipod crustaceans and polychaete worms, would probably succumb to burial.

The surf clam has a large foot and slender shell which allow rapid burrowing. Kranz (1972) studied the response of 30 species of clams to burial. Species such as the surf clam, which live at shallow depths below the bottom and extend a short siphon, were able to escape from beneath 10 to 50 centimeters of their native sediment. Therefore, the mortality of surf clams due to burial should not be significant where beach fill materials are similar to the sediments in place. Also, surf

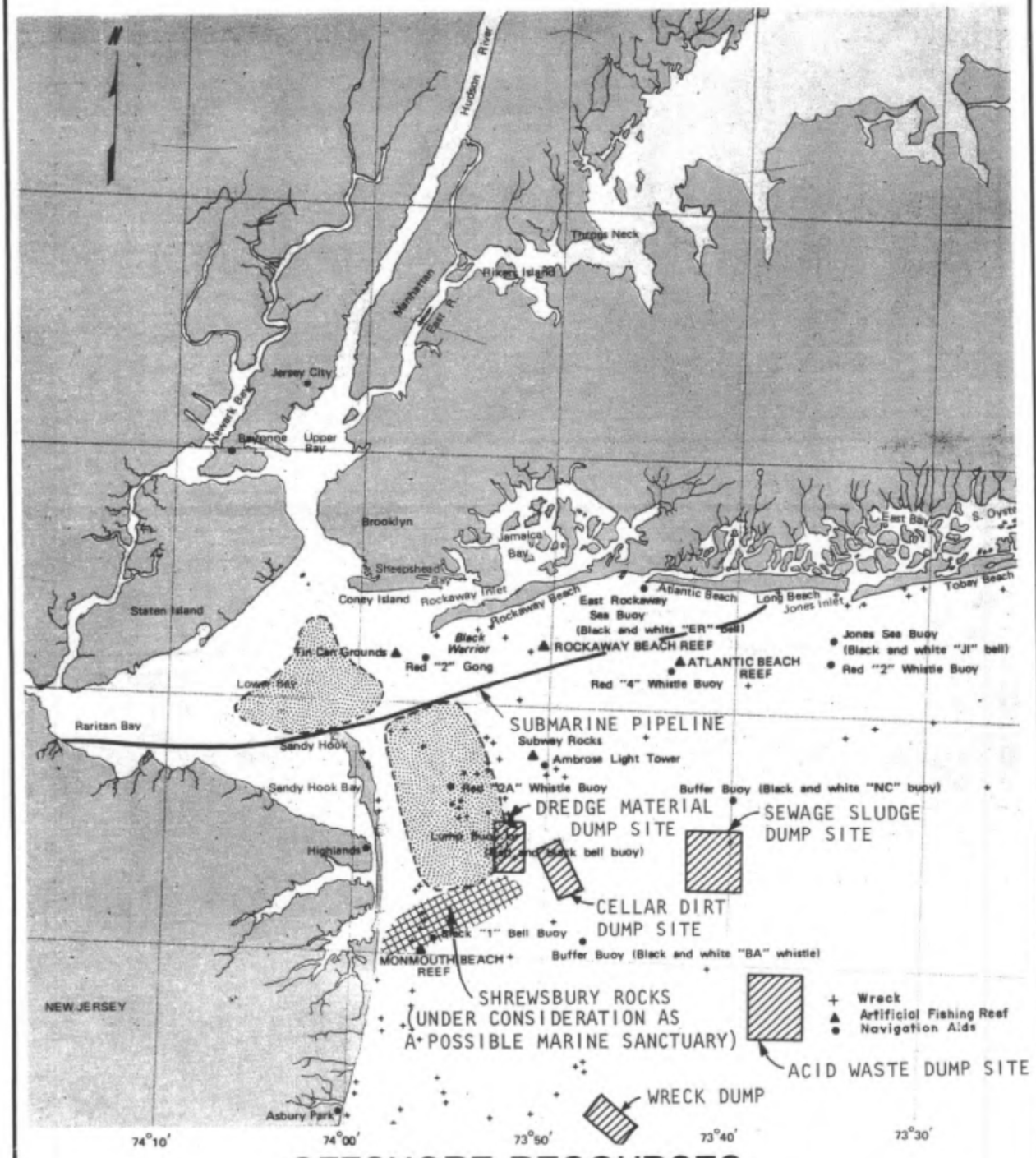
clam beds should not be significantly affected because of the relatively small area which would be filled. Additionally, suspended particulates resulting from fill placement should not adversely affect surf clam populations. The sand to be placed on the beach should generally have the same or similar grain size distribution as that of the existing beach and should be formed with a similar slope. Recolonization of the new beach would be effectively enhanced by the migration of adult and juvenile species from adjacent unaffected beach areas and the movement of larval stages of some organisms by naturally occurring physical transport. With the placement of nourishment sands on the beach, particles (especially the finer sediments) will be washed out and will form a turbid plume downdrift of the beach filling activity. This plume should not have a major impact on distant downdrift communities since the species inhabiting the surf and nearshore zone are adapted to variable levels of suspended sediments generated from storm conditions.

Care should be taken concerning the selection of sites for extracting material for beach fill. For the proposed Master Plan alternatives, it is assumed that the sand sources will be offshore since these areas have the most suitable grain size. Sediments from the bay would tend to be unacceptable due to the difference in grain sizes and the potential for contamination from estuarine sediments. Where possible, offshore shellfish beds, shipwrecks, and artificial fishing reefs should be avoided.

Another consideration of the sand dredging and discharge operations is the potential for water quality degradation by contaminants such as heavy metals, organohalogens, and petroleum hydrocarbons in fine sediments. Contaminants from numerous sources discharged into rivers, estuaries, and coastal areas eventually make their way to the ocean. The nearshore region receives that material which does not settle before it leaves the rivers and bays. These contaminants are, however, normally associated with finer sediments such as silt, clay, and organic detritus. Numerous investigators have reported on the impacts to organisms exposed to increased levels of these contaminants; the impacts include death or impairment of bodily functions, such as locomotion, respiration, feeding, and reproduction. However, the material taken from offshore sources, as recommended above, would be relatively coarse grained, and the contaminants are typically associated with fine sediments. To mitigate any potential impacts associated with placement of contaminated sediments on the beach, the sediments from questionable source areas could be tested prior to dredging. Areas with potentially harmful concentrations should be avoided.

In addition to effects on the aquatic system, other impacts may be associated with the placement of beach fill. The movement of equipment and personnel onto the beach should be limited to access points that will not adversely affect existing dunes and dune vegetation. Any disturbance of these areas tends to be harmful to the stability of the vegetation and sand and to the animals found in this ecosystem. Noise and air quality degradation would occur from the operation of offshore dredges, work boats, trucks, bulldozers, etc. Impacts associated with construction equipment are also discussed in Section B.1.a.(2) above. In particular, colonial nesting birds may be affected by noise, equipment disturbances, and personnel. This could be partially mitigated if the operations were concentrated in the fall and winter months. Offshore equipment operations should have a minimal effect on nesting birds.

Areas identified as potential sand sources for beach nourishment are shown on Figures V.B-1 to V.B-3. As previously mentioned, dredging of the seabed may have a short-term negative impact on the environment by disturbing habitat and inducing turbid water conditions downstream of the dredging location. This impact, though



OFFSHORE RESOURCES
RARITAN BAY AND ATLANTIC COAST
FROM SANDY HOOK TO ASBURY PARK

5 0 5 10

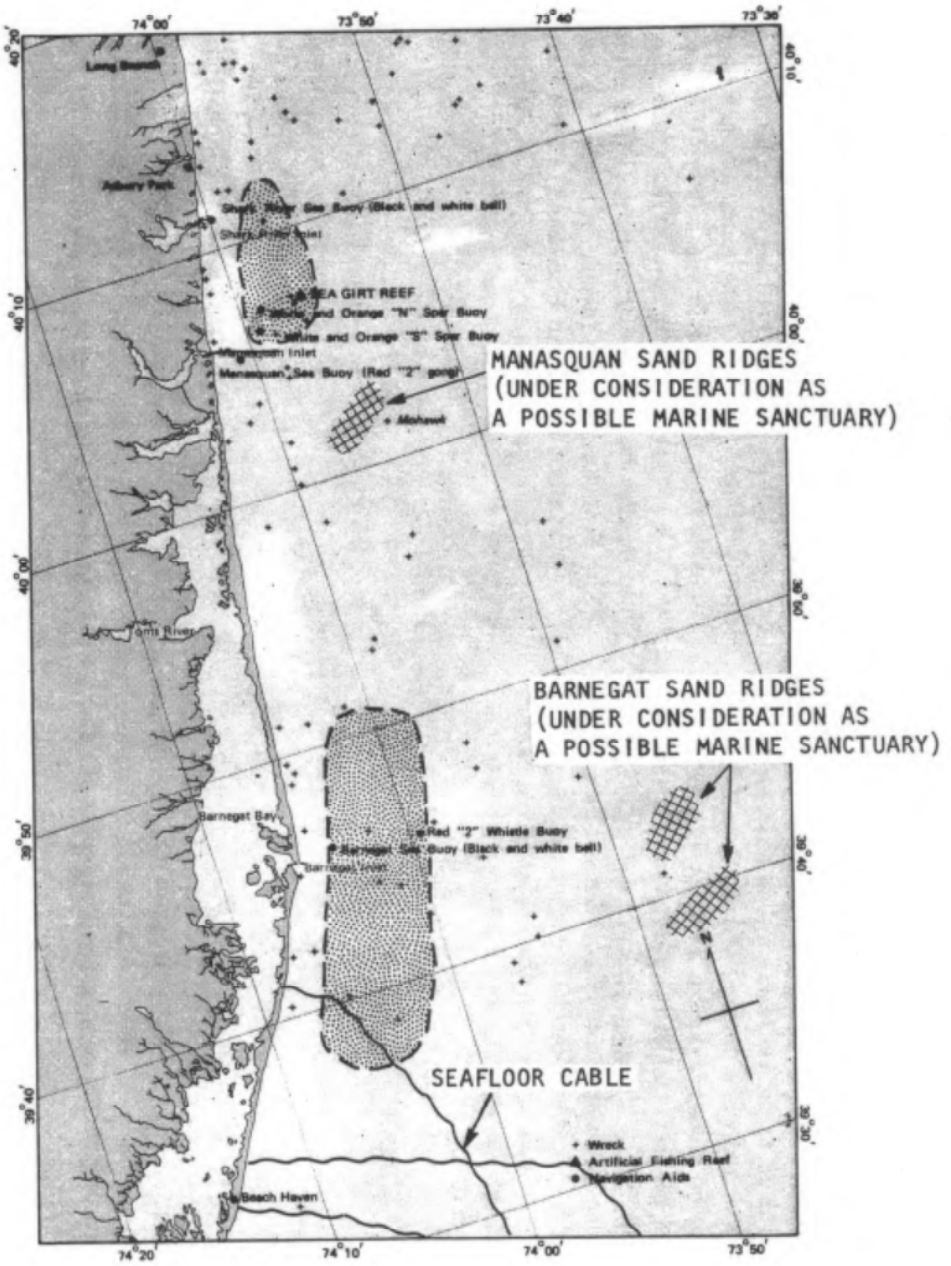
NAUTICAL MILES

KEY:

REPORTED MAJOR SAND RESOURCE AREAS

DAMES & MOORE

FIGURE V.B-1



OFFSHORE RESOURCES FROM ASBURY PARK TO BEACH HAVEN

5 0 5 10

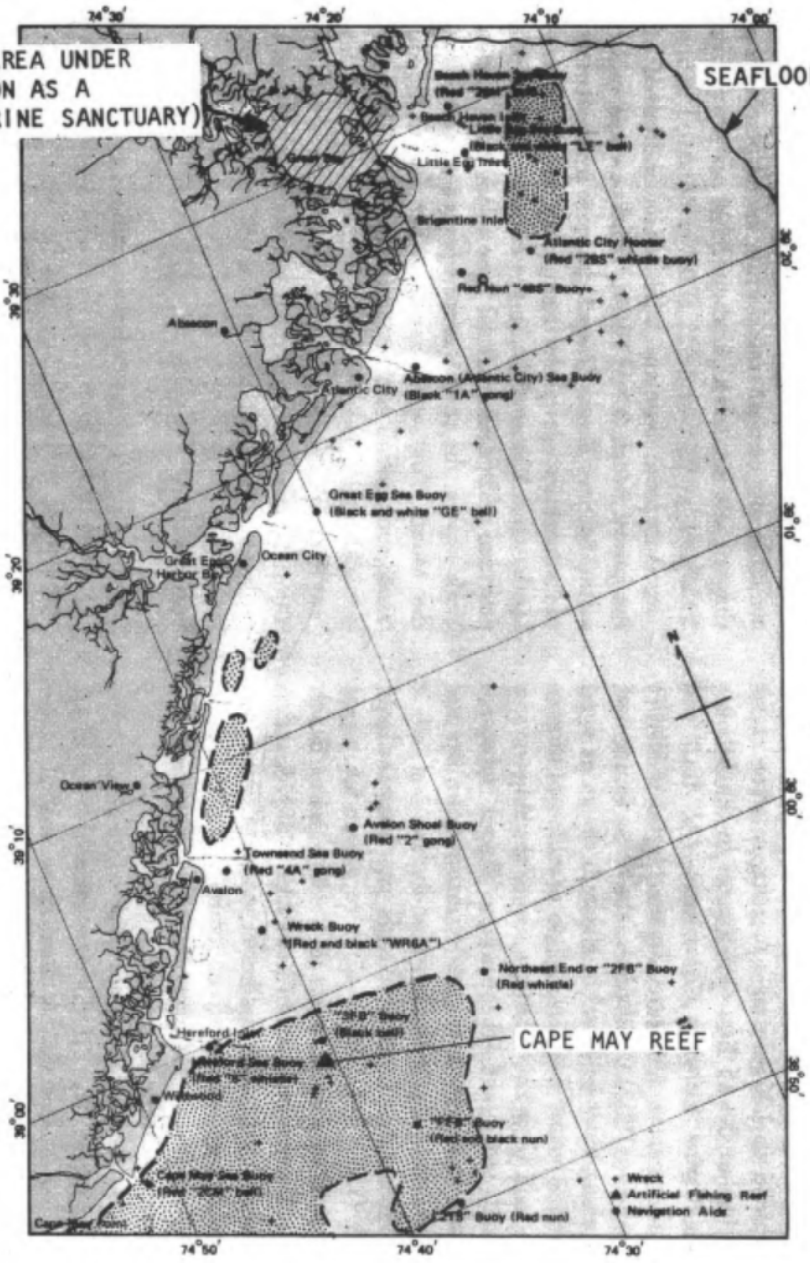
NAUTICAL MILES

KEY:

REPORTED MAJOR SAND RESOURCE AREAS

DAMES & MOORE

FIGURE V.B-2



OFFSHORE RESOURCES FROM BEACH HAVEN TO CAPE MAY POINT

5 0 5 10

NAUTICAL MILES

KEY:

REPORTED MAJOR SAND RESOURCE AREAS

DAMES & MOORE

FIGURE V.B-3

minor, is most significant to the infaunal benthic community. After the disturbance has subsided, benthic organisms would begin to recolonize the disturbed area. Since the seabed is characterized by sandy sediments, the established benthic community composition would consist of organisms which inhabit sandy areas. Recolonization would be expected within 2 weeks of cessation of sand mining, though it may take a year or more for a similar benthic community to be reestablished (Conner et al., 1979).

The major cause for concern would be the disturbance of surf clam beds. Due to their economic importance, the dredging of areas where surf clam densities are of commercial or potential commercial value should be avoided. Haskins and Merrill (1972) reported on coastal densities of the surf clam. From their data, it appears that, in the sand source areas east of Cape May (Reach 14) and off Ludlam Island (Reach 8), commercial densities of surf clams are very common. A major portion of the New Jersey surf clam landings comes from these areas. Similarly, the offshore sand source east of Barnegat Inlet is also within an area mapped by Haskins and Merrill (1972) as having significant densities of surf clam. The other sand source areas on Figures V.B-1 to V.B-3 do not appear to lie within areas of commercially significant surf clam densities. Prior to use of any of the sand source areas, the extent of surf clam beds should be mapped to identify zones within each source area which may be more favorable for sand mining.

(4) Structural Maintenance. Proposed structural maintenance involves making repairs to seawalls, bulkheads, and groins on an as-needed basis. The impacts associated with this type of construction activity have already been addressed in Section B.1.a.(2) above. The impacts associated with maintenance programs would tend to be less significant, however, since the repair program would be less intensive and of shorter duration than the construction of new shore erosion control structures.

b. Potential Impacts on Cultural and Historic Resources

No adverse impacts on historic places are anticipated as a result of the implementation of alternative engineering reach plans. However, indirect secondary impacts are possible. For example, where recreational or storm beaches are constructed along a specific shore reach, it is conceivable that historic places open to the public could experience an increased visitation rate resulting from the larger influx of summer visitors to the new, wider, and more aesthetically pleasing beaches. This would be considered a favorable impact, but would involve higher facility operation and maintenance expenditures.

It is anticipated that none of the structural or nonstructural engineering alternatives will threaten known prehistoric sites close to the ocean or bay shorelines. If offshore sand sources are exploited for beach nourishment, it is conceivable that unknown prehistoric sites or artifacts might be disturbed or destroyed. A positive impact of offshore sand dredging for beach nourishment would be the possibility of discovering submerged cultural resources.

To preserve the historic value and unique habitats provided by the shipwrecks and artificial reefs in the waters off New Jersey, it will be necessary, where possible, to avoid all such sites when looking for suitable offshore sand sources for beach nourishment. The locations of known shipwrecks and reefs in relation to major offshore borrow sources identified by the Army Corps of Engineers are shown in Figures V.B-1 to V.B-3. Shipwreck remains in the beach or surf zone along the coast could be partially or completely covered if beach fill alternatives are implemented.

Placement of fill would tend to protect the remains from further destruction by wave action. It is not anticipated that groins or other proposed structures would disturb shipwrecks in the beach, nearshore, or surf zones.

Similarly, it is not anticipated that the unique geologic areas or proposed marine sanctuaries (discussed Chapter II, Section E.2.b.) would be adversely affected by proposed engineering plans. However, if offshore sand ridge areas or inlets receive sanctuary status, sand mining activities in those areas could be severely restricted. The location of major offshore sand source areas relative to sand ridge areas is illustrated in Figure V.B-2. Offshore waste disposal sites shown on Figure V.B-1 are already off limits (environmentally) for sand mining.

2. Socioeconomic Impacts

This section assesses the secondary socioeconomic impacts that may result from implementation of four selected engineering alternatives — with particular emphasis on the Recreational Development alternative for Peck Beach (Reach 10), the Recreational Development alternative for Absecon Island (Reach 9), and the Limited Restoration alternative for Long Branch to Shark River Inlet (Reach 3). Peck Beach is a recreational reach, and Absecon Island and Long Branch to Shark River Inlet are urban reaches. The Maintenance alternative for Sandy Hook to Long Branch (Reach 2) is also assessed. This discussion does not address the direct costs and benefits used as inputs to the priority analysis. These are summarized in Table V.A-2.

Probable socioeconomic impacts in the selected sample reaches should be characteristic of impacts in the other reaches when community classification —urban or recreational — is taken into account (see classification scheme in Chapter II, Section D.5). The impacts are presented in two categories — quantifiable and nonquantifiable. The quantifiable impacts, such as income and taxes, are presented for Reaches 3, 9, and 10. Accompanying methodologies and assumptions are included. Quantifiable impacts are presented for both the nonmaintenance (storm erosion protection, recreational development, combination of storm erosion protection and recreational development, and limited restoration) and maintenance engineering alternatives. In Section 2.b. below, the quantifiable impacts are listed for the other reaches not individually analyzed. Section 2.c. presents the nonquantifiable secondary socioeconomic impacts, such as dislocation and public access, and the significant controlling factors.

a. Quantifiable Economic Impacts

(1) Nonmaintenance Alternatives for Specific Reaches

(a) Spending Impacts. Perhaps the most significant secondary economic impact is the expenditures of beach visitors in the purchase of local goods and services. The initial impact is the direct expenditures or the actual outlays made by the beach users. These include the beach admission fee (defined as the opportunity cost of $2 per person in the priority analysis) and the purchases of food, entertainment, and other miscellaneous goods and services from local establishments. For the purpose of this analysis, direct expenditures are estimated to be $7.50 per beach user per day, based on an estimate of $5.50 for visitor spending in Atlantic City, as compiled by Economic Research Associates (1977), plus the opportunity cost of $2 per day per beach user. The components of the $7.50 total typically include the payment of a $2 beach fee, $3 in food purchases, and $2.50 for other expenses (entertainment, rentals, etc.). The $7.50 does not include expenditures for boardwalk recreational and

amusement facilities or evening entertainment; it is only designed to approximate the daily expenses directly incurred as a result of using the beach. By using only these direct, beach-related expenditures, it is felt this per capita daily spending estimate is applicable in both communities with and without boardwalks. It is recognized that in areas with boardwalks and amusement piers, the total daily expenditures of visitors would probably be higher than $7.50 for beach and non-beach recreational goods and services.

Beach fees vary between shore communities, and certain communities do not charge for beach use. For the purpose of this analysis, a State average of $2 per user per day is used. This amount is considered representative of the daily fee that the average shore visitor is willing to pay for use of a beach. Undoubtedly, beach fees will fluctuate and some communities that do not presently charge fees may do so in the future to help meet facilities maintenance costs or pay for shore erosion control or land management programs.

Table V.B-2 shows the beach user spending impacts as a result of implementation of the selected engineering alternatives. The additional beach users accommodated are the net increase above the total users that would be accommodated under the no action alternative over the next 50 years. The initial spending impact (direct income) produces two additional spending rounds. The second round effect is indirect income – the purchase of local goods and services by the businesses that were recipients of the initial direct expenditure. The third round is induced income – the local spending of workers employed in the tourism and recreational establishments.

These spending impacts were estimated using a traditional export-base multiplier employing the use of location quotients. The specific application to tourism was modeled after the methodology employed by the U.S. Travel Data Center (November 1975). County level multipliers indicate the total increase in income (direct, indirect, and induced) that will accrue to the State economy. It must be remembered that a significant share of local expenditures will not remain in the local economy.

The amount of the direct expenditure that would actually remain in the community to become local income is dependent on the percentage of a tourist expenditure that is sent out of the local area to purchase goods and services. For example, if 40 percent of all tourist expenditures for food in Ocean City was, in turn, used by businesses to purchase foodstuffs from another location, the import propensity for this sector would be 0.4. The higher the propensities to import, the lower the amount of income that remains in the local economy to be respent.

At the state level, the consideration is whether the expenditure remains within or flows out of New Jersey. The fact that Ocean City restaurants purchase their supplies from Cumberland County is not significant since the spending impacts remain in New Jersey. For this reason, the estimates of induced and indirect income presented in Table V.B-2 are statewide estimates. Local income for most areas would be expected to be from $.40 to $.80 of every $1.00 tourist expenditure (U.S. Department of Commerce, Travel Service, 1978).

Using the appropriate coastal county income multipliers, Table V.B-2 presents the various beach user expenditure impacts for the Peck Beach, Absecon Island, and Long Branch to Shark River Inlet reaches. The direct expenditure is the present value of future expenditures of all the additional beach users accommodated (see Chapter VII, Section B.3 for tabulation). The total income is the present value of

TABLE V.B-2

BEACH USER SPENDING BENEFITS DUE TO THE IMPLEMENTATION OF SELECTED ENGINEERING ALTERNATIVES
(in millions of dollars)[a]

Reach	Direct Expenditures	Retail[c] Portion of Direct Expenditures	Estimated[d] Sales and Use Taxes	Total[e] Income
9 - Absecon Island	$533.7	$433.8	$20.49	$1451.7
10 - Peck Beach	$318.2	$248.3	$12.22	$747.8
3 - Long Branch to Shark River	$52.0	$43.2	$2.0	$143.0

(a) Figures are given in discounted present worth values for 50 years at 9 percent.

(b) All direct expenditures are confined to the retail and service sectors using $7.50 as direct, per capita, daily beach user expenditures (no inflation assumed).

(c) Based on retail portion of county total receipts: 81.3 percent for Absecon Island (Atlantic County), 78.0 percent for Peck Beach (Cape May County) and 83 percent for Long Branch to Shark River Inlet (Monmouth Co.), (U.S. Department of Commerce, Bureau of Census, 1980).

(d) Based on average annual sales and use tax of 3.84 percent (1973-1978) of retail portion of direct expenditures.

(e) Based on county income multipliers of 2.72 for Absecon Island (Atlantic County), 2.35 for Peck Beach (Cape May County), and 2.75 for Long Branch to Shark River Inlet (Monmouth Co.), (U.S. Department of Commerce, Bureau of Economic Analysis, 1977).

all future direct, indirect, and induced income effects that would accrue to the New Jersey economy. The estimated sales and use taxes are the present value of the tax revenues that would be generated by the direct expenditures. The sales and use taxes would accrue to the State government.

The sales and use taxes were estimated using the relationship between total estimated retail sales in New Jersey and total sales and use tax receipts. This relationship produced a correlation coefficient of 0.991 for the period from 1973 to 1978. Over this period, annual sales and use taxes averaged 3.84 percent of annual estimated retail sales. The direct expenditures were divided between the retail and service sectors based on the ratio of total retail sales to total service receipts, as contained in the 1977 Census of Retail and Service Trades for New Jersey (U.S. Bureau of the Census, 1980). The resulting retail portion of the direct expenditures was multiplied by 0.0384 to obtain estimated sales and use tax revenues.

(b) Property Taxes. Property tax revenue is the second quantifiable secondary economic benefit that would be retained by the municipalities within a reach. Local governments will receive revenues from shorefront real property that would have been lost without the protection provided by the engineering measure. Table V.B-3 lists property tax impacts from nonmaintenance engineering alternatives. Dollar values are present value dollars, allowing for the fact that actual erosion losses of real property would not begin to occur until some time in the future.

TABLE V.B-3

PROPERTY TAX IMPACTS FROM IMPLEMENTATION OF SELECTED NONMAINTENANCE ENGINEERING ALTERNATIVES
(in millions of dollars)

Reach	1979 Effective Property Tax Rate (per $100 market value)	Year Losses Would Begin	Estimated Value of Property Taxes Retained (in present worth dollars)
9 - Absecon Island	$1.79	2021	$0.3
10 - Peck Beach	$2.60	2005	$3.8
3 - Long Branch to Shark River Inlet	$2.84	2003	$1.7

The tax revenues retained were assumed to begin accruing at the same time that erosion was projected to begin affecting developable lands within the three reaches. These revenues were then converted to present value dollars. The year property losses would begin to occur under the no action alternative were estimated from historical erosion rates. It is recognized that future erosion rates may differ from the observed averages. Thus, it is likely that property losses could begin to occur either before or after the above dates under a no action alternative.

The value of the property tax revenues retained for Absecon Island is lower than the respective values in the other two reaches for two reasons — (1) Absecon Island's erosion-related losses of real property are projected to begin occurring later in the planning period; and (2) receipt of property tax revenues would be delayed until the end of the planning period. Finally, given the existing erosion rates and beach widths,

more real property would be affected by erosion during the 50-year planning period in the Long Branch to Shark River and Peck Beach reaches.

(2) Maintenance Alternative. As already noted, because the Maintenance alternative will not result in any incremental recreational benefits, no expenditure benefits can be calculated for this option. However, the Maintenance alternative will result in the retention of property tax revenues that would otherwise be lost. These benefits, shown in Table V.B-4, were calculated for the selected Maintenance alternative. The methodology employed was the same as used for the nonmaintenance alternatives.

TABLE V.B-4

PROPERTY TAX IMPACTS FROM THE SELECTED ENGINEERING MAINTENANCE ALTERNATIVE
(in millions of dollars)

Reach	1979 Effective Property Tax Rate (per $100 market value)	Year Losses Would Begin	Estimated Value of Property Taxes Retained (in present worth dollars)
2 - Sandy Hook to Long Branch	$2.80	1990	$3.8

b. Quantifiable Impacts — Remaining Reaches

Table V.B-5 shows the spending and tax revenue impacts for the remaining reaches not analyzed above. The same methodology described earlier was employed. Note the significant variations in the spending impacts; these result from differences in the design capacity of the most cost beneficial engineering alternative within each reach. For example, the spending impact generated by the engineering alternative is small along Mantoloking to Barnegat Inlet (Reach 6) and along Five Mile Beach (Reach 13) — where little additional beach capacity is added. Conversely, existing beach capacity would be substantially increased at Seven Mile Beach (Reach 12) and Cape May Inlet to Cape May Point (Reach 14), and the attendant expenditure benefits would also be higher.

Depending on the values of the income multipliers for different areas, the same amount of direct spending would have a different cumulative impact (direct, indirect, and induced) on regional income. In essence, there are economics of scale in terms of a specific area's ability to maximize its income (and employment). For example, due to the differences in size and diversity of the county economics, the multiplier for spending in Atlantic County is higher than in Cape May County, implying greater total economic benefits to be gained by concentrating expenditure in Atlantic City.

However, the Cape May economy is more dependent on tourism and beach user expenditures than is the economy of Atlantic City. The diversion of expenditures from Cape May County could have significant indirect impacts, such as increases in unemployment, increases in business failures, and corresponding increases in government-related expenses (unemployment compensation, welfare, etc.). Thus, maximizing economic spending benefits in one reach could cause secondary economic and nonquantifiable social costs in other reaches that were not provided engineering measures.

TABLE V.B-5

BEACH USER SPENDING BENEFITS DUE TO IMPLEMENTATION OF SELECTED NONMAINTENANCE ENGINEERING ALTERNATIVES FOR REMAINING REACHES
(in millions of dollars)[a]

Reach Number	Reach Name	Present Value of Direct Expenditures[b]	County Income Multiplier[c]	Present Value of Total Income Generated	Estimated Sales and Use Taxes[d]
2	Sandy Hook to Long Branch	38.1	2.5	94.1	3.0
4	Shark River Inlet to Manasquan	39.3	2.5	97.0	3.1
5	Manasquan Inlet to Mantoloking	2.8	2.5	6.9	0.2
6	Mantoloking to Barnegat	1.5	2.7	4.1	0.1
7	Long Beach Island	29.3	2.7	80.0	2.7
8	Brigantine Island	1.9	2.7	5.3	0.2
11	Ludlam Island	63.5	2.4	149.1	4.5
12	Seven Mile Beach	120.7	2.4	283.7	8.5
13	Five Mile Beach	0.4	2.4	0.9	0.03
14	Cape May Inlet to Cape May Point	152.4	2.4	358.2	10.7

(a) Dollar figures are discounted present worth values over 50 years at 9 percent.

(b) All direct expenditures are confined to the retail and service sectors using $7.50 as the direct, per capita, daily beach user expenditure (no inflation assumed).

(c) U.S. Department of Commerce, Bureau of Economic Analysis, 1977.

(d) Based on retail portion of county total receipts; 78.0 percent — Cape May County, 81.3 percent for Atlantic County, 86.6 percent for Ocean County, and 83.0 percent for Monmouth County (U.S. Department of Commerce, Bureau of Census, 1980); and based on average annual sales and use tax of 3.84 percent (1973-1978) of retail portion of direct expenditures.

Significant net seasonal employment increases will be generated in the Seven Mile Beach, Cape May Inlet to Cape May Point, and Long Beach Island reaches. In all three, the projected multiplier spending impacts are substantial, and even with the large propensity to import services which is inherent in a barrier island location, sufficient local income will be generated to provide significant seasonal employment increases for local and nonlocal residents.

A significant increase in peak day beach users to Long Beach Island will likely strain the island's transportation and parking facilities. It has only one link to the mainland, Route 72, which would become increasingly congested on peak demand days unless mass transit approaches were adopted. Similar impacts are likely for the Cape May Inlet to Cape May Point reach. Although not a barrier island, transportation access to this reach is limited by access across the Cape May Canal.

c. Generic Nonquantifiable Impacts

(1) Development and Land Use. The installation of any one of the engineering alternatives in a given reach may influence local investment decisions. The protection provided could lead to an enhancement in property values because of the lower probability of short-term erosional loss. An owner or a potential buyer of shorefront property would value the property more highly after completion of an engineering program because of the resultant increase in the expected life of the property and its structure.

It is not clear that engineering measures, in and of themselves, significantly affect coastal land values and development. After the 1962 storm, even the most heavily damaged barrier islands were rapidly redeveloped. The implication is that, in spite of the hazards associated with development in coastal areas, the demand for shorefront locations will continue to remain high because of their unique aesthetic and locational amenities. As discussed in Chapter III, present Federal policy on subsidized insurance and disaster relief also encourages shorefront development in hazardous areas. Erosion protection could prevent price declines for shorefront lands which face imminent erosion damage. However, the societal demands for intense use of shorefront locations will be the prevailing factor in their development.

The implementation of engineering alternatives would have similar effects on land use patterns and development pressures in all reaches. In the northernmost ocean reaches (Reaches 2, 3, and 4), engineering alternatives would likely provide short-term maintenance or enhancement of property values in areas faced with imminent erosion losses. Immediate berm expansions could enhance the recreational attractiveness of beaches. In areas where the beach has all but disappeared, new wider beaches could provide the incentive for new development of recreational establishments along the coast. In the remaining barrier island reaches, impacts would include the maintenance of existing property value and the reinforcement of existing waterfront land use patterns.

Moderation of the erosion hazard would reinforce the already high demand for shorefront property, increasing the tendency toward very dense commercial and recreational development of shorefront areas. The present land use patterns found in the Absecon Island, Peck Beach, and Long Branch to Shark River Inlet reaches would persist. These patterns include specialized recreational infrastructure (boardwalks, amusement piers) and high density development (hotels, motels, Atlantic City casinos) located immediately behind the beach. The central business districts are located behind this initial strip of development.

(2) Local Employment. The expenditures of the additional beach users would have significant impacts on local seasonal employment. Local establishments serving the needs of beach users would have to hire additional employees to meet the increase in seasonal demands. The magnitude of the employment increase will depend partially on the propensity to import of the businesses which receive the initial direct income expenditures. For example, an establishment that obtains the bulk of its supplies from local firms would cause additional local people to be hired to help meet its demands. This direct and indirect increase in local jobs would be the most significant employment impact.

Due to the seasonal nature of the demands of additional beach users, the bulk of this hiring would be for the summer months only. The likely hirees would consist of students and others looking for part-time employment, such as the elderly seeking to supplement retirement pensions. This hiring would be concentrated in the service and retail sectors, particularly eating and drinking establishments and amusement facilities. Secondary hiring impacts would accompany the multiplier spending impacts; additional workers would be hired by firms in other parts of the State to assist in supplying goods and services to coastal resort establishments.

(3) Other Social Impacts. Table V.B-6 lists other social impacts that could be expected as a result of the implementation of the selected engineering alternatives for Absecon Island, Long Branch to Shark River Inlet (urban reaches), and Peck Beach (a recreational reach).

It is expected that generic social impacts will be similar for all reaches, with the magnitude of the impacts dependent on a number of reach-specific factors. Some of these include the projected recreational demand, severity of the current erosion problem, existing land use patterns, future growth trends, and physical constraints (total land area and developable land). For example, the increase in additional beach users in an urban reach would most likely result in a proportionally smaller increase in demand for public services than the same increase in a recreational reach. The additional beach user would be less likely to strain the existing service capacities in the urban reach than in the smaller recreational reach.

The nonquantifiable social impacts in the other barrier island recreational reaches would be similar to those projected for Peck Beach. In particular, Seven Mile Beach and Ludlam Island would be likely to have similar impacts since they are projected to accommodate similar levels of additional beach users. On Five Mile Beach (Reach 13), the existing beach is so wide and the projected erosion losses over the next 50 years are so small that the implementation of an erosion control alternative would not generate any property protection benefits or accompanying decreases in short- and long-term human suffering. The number of additional beach users accommodated would also be insignificant.

In the reaches with severe erosion problems, the property protection benefits and accompanying short-term decreases in human suffering would be greater. Reaches 2, 3, 4, 8, 9, 10, 11, 12, and 14 would receive the most significant benefits; erosion control measures would begin to generate immediate benefits by protecting homes and businesses facing imminent erosion loss.

TABLE V.B-6

OTHER SOCIAL IMPACTS DUE TO IMPLEMENTATION OF ENGINEERING ALTERNATIVES

Impact Sector	Impact
Local Community	
Community Cohesion	Minor increase in seasonal disruption of community interaction patterns.
Dislocation	Prevention of loss of residential and commercial structures, roads, and utilities.
Human Suffering	Decrease in short-term (forced) relocation from homes or businesses as a result of protection from erosion.
	Long-term maintenance or increase in probable human suffering from an extreme storm event due to continued development in shorefront areas.
Aesthetics	Additional beach area enhancing aesthetic quality.
Regional/State	
Public Access	No significant change for Absecon Island or Peck Island since the entire reachs are accessible to the public.
	Increase in access in those sections of the Long Branch to Shark River Inlet reach which are currently private since engineering measures would be implemented only in areas which provide public access or benefits, possibly funded through State aid agreements prior to program implementation.
	Increased beach fees to fund engineering programs may have a negative effect on public access.

Over the short-term, human suffering in terms of forced relocation or evacuation of homes or businesses would be diminished. This, in turn, would mean lower levels of accompanying personal and social stress. The evacuation of homes or the abandoning of a stable business establishment may sever local friendships and community ties that have developed over the years. The added engineering shore protection is only designed to certain storm levels and, due to the potential for major storms, cannot guarantee that significant losses and related human suffering will not occur.

The Seven Mile Beach and Cape May Inlet to Cape May Point reaches may have seasonal disruptions of community social interaction patterns similar to those projected for Peck Beach. Each of these reaches would accommodate large numbers of additional beach users, and these seasonal inflows would increase the number of visitors such that the local residents' social linkages (friendships, gathering places, etc.) might be suppressed. In some remaining reaches such as Brigantine Island, this problem would be much less significant since the number of projected additional beach users is much smaller.

Public benefits would result from the increased level of protection to public facilities (roads and utilities). Similarly, in the short run, State and local expenditures for storm disaster relief and erosion losses would be diminished. In general, public access will be encouraged through State aid agreements prior to the implementation of engineering alternatives.

The construction of shore protection structures, dredging, and beach nourishment can be undertaken without significant threat or impact to coastal utilities, submarine cables, pipelines, and outfalls. It is important, though, that such existing facilities be identified and located prior to initiating such activities. Identification of facilities is usually tied to the State and Corps of Engineers coastal construction or dredging permit processes. In most cases, the long-term storm erosion threat to such facilities directly on the shoreline would tend to be reduced where engineering alternatives were implemented. A positive impact would also be realized by the control of erosion at coastal waste disposal sites, such as dredged spoil disposal areas. Depending on the character and quality of disposal site materials, erosion control might preclude water and sediment quality degradation and associated ecosystem impacts that would otherwise occur. At present, no reported solid or liquid waste disposal impoundment sites are being threatened by erosion along the shores of any of the 16 reaches.

d. Summary of Socioeconomic Impacts

The implementation of an engineering alternative generates immediate and long-term economic benefits. The existing recreational beach is maintained and enhanced, and its future viability as an economic and aesthetic resource is preserved. Additional beach users are accommodated, thus increasing local direct recreational expenditures; local income and employment (primarily seasonal) increase, as do statewide income and tax revenues.

In addition, the engineering alternative protects shorefront real property from erosional loss. This protection, in turn, mitigates short-term levels of human suffering and the adverse social impacts that accompany the destruction of shorefront homes and establishments. The protection afforded by the engineering alternative retains local property tax revenues that would otherwise have been lost over time due

to continuing erosion. However, the occurrence of a greater than 50-year storm event would result in the loss of the engineering improvement, as well as damage to public and private shorefront properties.

The implementation of an engineering alternative enhances the short- and long-term value of shorefront property. Decreasing the probability of erosion loss will maintain investment demand for these parcels, thus reinforcing or intensifying coastal land use patterns. Overall, the implementation of an engineering alternative has only a minor positive effect on the demand for shorefront properties. The continuing high demand for these properties is primarily a function of their locational attributes and the natural scarcity of coastal sites.

If coupled with State aid agreements requiring public access, the implementation of an engineering alternative could increase public accessibility to the shore. Without such a requirement, public access would diminish with the continuation or intensification of present land use patterns and access restrictions.

The presence of additional beach users within a community results in increased demand for State and local public services (parking, transportation infrastructure, beach services, etc.). A sizable increase in seasonal visitors could disrupt community economic and social interaction patterns. Off-season community gathering places (local parks, churches, restaurants) would be temporarily used by the newly accommodated visitors.

Finally, the implementation of an engineering alternative retains and may enhance the aesthetic quality of the beach.

It is recognized that Absecon Island (Atlantic City) is an anomaly due to the tremendous growth generated in this reach by the introduction of casino gambling. The magnitude of future growth and economic development within this reach is likely to be very high as compared to other sections of the coast. Thus, conclusions and impacts relative to Atlantic City cannot be extended to apply to other barrier island reaches.

3. Feasibility/Implementation

As discussed in Chapter IV, a wide variety of engineering techniques have been implemented at various levels of government and by individual private property owners in an attempt to control shoreline erosion. Many of these attempts have been successful while others have resulted in the acceleration of erosional processes. The proposed alternatives, which are summarized above in Section A of this chapter and detailed in Chapter VI, are designed to deal comprehensively with an entire "reach" as opposed to the more traditional piecemeal, stop-gap approach to erosion control.

The Master Plan cost benefit analysis, which is detailed in Chapter VII, demonstrates that certain reach engineering plans are economically justifiable. The feasibility of implementing engineering alternatives is, therefore, primarily dependent on the availability of funds. A detailed discussion of funding options for engineering plans is provided in Volume 1, Section II.B.3. As discussed in that section, due to the high cost of engineering solutions, consideration of cost effectiveness, and emergency funding relief for potential losses of erosion control projects resulting from major storms, the feasibility of implementing and maintaining the proposed engineering plans would be significantly improved if Federal participation and cost-sharing is involved.

However, such participation would probably decrease the likelihood of timely implementation when compared with the option of State-local participation only.

A number of implementation problems which exist with Federal participation also apply to cost-sharing between the State and local municipalities on shore protection programs. Factors which could contribute to problems in delays in implementing proposed engineering programs include:

- o Reluctance of State and local interests to agree on cost-sharing rules.
- o Inability of State or local interests to provide the necessary funds.
- o Lack of cooperation between municipalities within a reach.

As State-local aid agreements develop for implementation of a particular reach plan, one or more municipalities may not be willing to provide the necessary public access or other program requirements. This could result in implementation delays or forfiture of State (and Federal) cost-sharing.

C. EVALUATION OF LAND MANAGEMENT ALTERNATIVES

This section describes the impacts and implementation feasibility of selected land management alternatives, specifically coastal regulation and acquisition. The rationale for selection of these alternatives was provided in Section A.1 of this chapter. As discussed in Section A.1, for the purpose of this impact analysis, it is assumed that none of the five engineering shore protection alternatives will be implemented under the land management schemes. It is recognized that a combination approach is likely, however.

1. Impacts on the Natural Ecosystem and Resources

a. Generic Ecosystem and Biological Resource Impacts

Coastal regulation would restrict new development in the erosion hazard zone as well as redevelopment after storm erosion destruction. Such an alternative is environmentally favorable since it would allow for reestablishment of the natural beach and dune zone habitats.

Past development trends in coastal New Jersey have destroyed much of the natural primary dune areas and their ecological components. Regulation or acquisition of dune areas along the beach would permit dune building and eventual revegetation and colonization by dune community plants and animals. These organisms are discussed in Chapter II, Section E.1.f. The dunes would not only provide increased erosion protection, but also the reestablishment of a dune community. Once natural areas are established under State control, it is assumed that they will be properly managed with respect to pedestrian and vehicular traffic; for example, care should be taken that beach access lanes, such as dune walkover structures, be used to avoid physical disturbance of the dune community.

b. Cultural and Historic Resource Impacts

Where a land management alternative is selected in place of an engineering alternative, it is expected that erosion would continue. Shoreline migration could have various unfavorable effects on existing cultural and historic resources.

Although Chapter II, Section E.2.b, lists historic places that are somewhat removed from the present shoreline in some cases, it is important to consider the trend of uncontrolled erosion on the integrity of a particular location. Where erosion is severe and shore erosion control measures are not implemented, it is conceivable that the continued erosion of the ocean shore could threaten or destroy historic sites now located several blocks from the oceanfront. Certain sites now located on or adjacent to beaches will probably be threatened or lost in the short-term if some level of remedial erosion control is not implemented to protect them. This process can be illustrated by examining the history of the Barnegat Lighthouse at the northern tip of Long Beach Island (Reach 7). The lighthouse was originally constructed in 1834, but had to be rebuilt at a new location in 1858 because of severe beach erosion damage. When erosion again threatened the lighthouse at its new location in the early 1900's, shore protection structures were built to protect it from further damage.

Similarly, where a prehistoric archaeological site is within a zone threatened by uncontrolled erosion, it would eventually be lost or submerged. A positive aspect of erosion is that new sites or artifacts would likely be exposed as the erosion and shoreline migration continues.

2. Socioeconomic Impacts

This section presents the secondary socioeconomic impacts associated with the implementation of land management alternatives under the Master Plan. Two approaches are analyzed — the establishment of a regulated coastal zone based on an erosion setback delineation, and the acquisition of shorefront property (either pre-storm or post-storm). These two approaches could obviously complement one another. However, for purposes of this analysis, it is assumed that each approach will be implemented without the other. Further, it is assumed that seawalled areas will be maintained and that there will be a nominal setback behind them. The impacts of both coastal regulation and acquisition are assessed for the Peck Beach, Absecon Island, and Long Branch to Shark River Inlet reaches.

The purpose of this impact assessment is twofold — (1) to focus on the probable socioeconomic impacts on the three reaches which collectively encompass most of the socioeconomic and land use characteristics found along the New Jersey shore, and (2) to estimate the type and magnitude of secondary impacts in similiarly classified reaches.

The following Sections 2.a. and 2.b. describe the probable quantifiable and nonquantifiable secondary socioeconomic impacts associated with the regulation and acquisition alternatives. The discussion of the generic nonquantifiable impacts indicates the probable range of impacts and focuses on the significant variables that can affect their magnitude.

a. Coastal Regulation

The analysis of socioeconomic impacts for the regulation alternative is related to the controls which would result from the establishment of the regulated zone. As discussed in Section A of this chapter, the regulatory zone evaluated here is based on an erosion setback delineation. Additional development within this zone would be prohibited, except as allowed by the issuances of variances or permits. Existing structures would have to retain their existing bulk and land coverage configurations. The conversion of land uses within the area from residential to commercial would be prohibited. Finally, as land parcels become vacant through deterioration of their structures or significant storm damage, they would have to remain vacant.

The width of the regulated zone would be readjusted approximately every 5 years to incorporate the erosion that may or may not have occurred during the intervening time. This concept is a dynamic one, reflecting the nature of the beach erosion process and the continuing need to regulate development within the erosion hazard zone.

The socioeconomic impacts described below are based on the assumption that maintenance of existing erosion structures and all other engineering programs (beach nourishment etc.) would be halted. Since the beach is allowed to migrate naturally, the recreational resources and related spending impacts associated with beach area capacity would be maintained. Losses of beach and the related economic spending benefits would occur in areas where natural migration is impeded due to the presence of seawalls or bulkheads.

Eventually, the migration of the beach/dune area will begin to encroach upon public and private property and facilities located immediately inland of the present beach. This may lead to short-term losses of property. However, longer term erosion losses would be minimized by limiting future development in the defined

erosion hazard zone. The immediate establishment of the erosion setback area would have impacts on local land use patterns arising from possible diversion of development from the regulated area. The presence of the regulated zone would have localized effects on shorefront land prices in accordance with existing land uses within the area and present and future development pressures.

(1) Quantifiable Impacts — Specific Reaches

(a) Spending Impacts. As previously discussed in Section B.2.a. of this chapter, spending impacts are related to the expenditures anticipated due to the total beach users provided for in the regulatory scheme. If the natural system is allowed to migrate, the beach/dune system will maintain its natural configuration over time. In areas where seawalls are present, erosion of the submarine portions of the profile will eventually undermine the base of the structures and cause their collapse. Our calculations indicate that the seawalls would not be undermined over large areas in the 50-year planning period. Local damage due to undermining is anticipated, however. It is assumed that bulkheads would be lost once exposed to direct wave attack (no beach). For estimation of the total recreational area that would be available under the regulation alternative, the actual beach area would equal the present beach area totalled over the 50-year period, less the area that would not be available during periods when the beach is eroded and the seawalls and bulkheads are undermined (see Chapter VII, Section B.2). This lost beach area for the appropriate sectors of the Absecon Island, Peck Beach, and Long Branch to Shark River reaches was estimated based on projections of eroding beach profiles using the present erosion rates.

The percent reductions in beach user capacity below the equilibrium beach profile capacity that would exist if no bulkheads or seawalls were present are listed below. These figures are for the entire 50-year planning period.

- Reach 9, Absecon Island — 8 percent
- Reach 10, Peck Beach — 32 percent
- Reach 3, Long Branch to Shark River Inlet — 13 percent.

The spending impacts, total income generated, and sales tax related to the anticipated direct expenditures were calculated as outlined above in Section B.2 and are presented in Table V.C-1 for the 50-year period. In general, these impacts are less than for the selected engineering alternatives due to the smaller beach areas that would occur under the two schemes. The engineering alternative beach is designed to meet projected demand, while no comparable increase would occur in the natural migrating beach. In addition, losses will occur due to the presence of seawalls or bulkheads. This points out the long-term negative impacts of the implementation of such shore-parallel structures. Over the long-term, after these structures are undermined, the equilibrium beach will eventually return and regain these losses.

The total beach user spending impacts for the land management and no action alternatives are the same. This is because erosion will continue, no new beach will be added, thus the total number of beach users that would be accommodated over 50 years are the same under each alternative. Thus, the figures shown in Table V.C-1 are referred to as total spending impacts, not benefits.

(b) Opportunity Cost of Development. Under the regulation alternative, future development within the erosion hazard area would be prohibited. The land uses in the affected area would be "frozen" for the most part, with a long-term decline in development intensity as existing structures become obsolete or damaged and the resulting vacant land is not redeveloped.

TABLE V.C-1

BEACH USER SPENDING IMPACTS FROM LAND USE REGULATION
(in millions of dollars)[a]

Reach	Direct[b] Expenditures	Retail[c] Portion of Direct Expenditures	Estimated[d] Sales and Use Taxes	Total[e] Income
Absecon Island	$ 899.7	$ 731.5	$28.1	$2,447.3
Peck Beach	$ 493.4	$ 384.8	$14.8	$1,159.5
Long Branch	$ 732.3	$ 607.8	$23.3	$2,013.8

(a) Figures are given in discounted present worth values for 50 years at 9 percent.

(b) All direct expenditures are confined to the retail and service sectors using $7.50 as direct, per capita, daily beach user expenditures (no inflation assumed).

(c) Based on retail portion of county total receipts: 81.3 percent for Absecon Island (Atlantic County), 78 percent for Peck Beach (Cape May County) and 83 percent for Long Branch to Shark River Inlet (Monmouth County), (U.S. Department of Commerce, Bureau of Census, 1980).

(d) Based on average annual sales and use tax of 3.84 percent (1973-1976) of Retail Portion of Direct Expenditures

(e) Based on County Income Multipliers of 2.72 for Absecon Island (Atlantic County), 2.35 for Peck Beach (Cape May County), and 2.75 for Long Branch to Shark River Inlet (Monmouth County), (U.S. Department of Commerce, Bureau of Economic Analysis, 1977).

The possible cost of this type of action would be the loss of development and tax revenues. As is immediately apparent, there would be concurrent public and private opportunity costs. Opportunity cost is best described as the cost to the community (public and private sectors) of being unable to use the land in the productive manner in which it could otherwise have been used (James, 1972).

Without the imposition of the regulation alternative, the owner of land within the developed portion of the regulated zone would have several development options:

- Redevelopment of holdings to their best and highest uses (assuming that they are not presently being used in such a capacity, and that local zoning regulations and the Coastal Area Facility Review Act (CAFRA) would permit such a conversion).
- Major expansion or alteration of the existing structure.
- Demolition of obsolete structures and redevelopment of the parcel.
- Retention of the property for future sale in its present use.
- Retention for speculative purposes for sale and conversion to a best and highest use that will occur in the future.

With the regulation, only the fourth option would remain. The owner could also continue to derive utility from the land in its present use (as a summer house, for example).

This opportunity cost can be defined as the difference between the discounted present value of all future land rents the owner would realize without the regulated zone and the discounted present value of all future land rents he would receive with a regulated zone. Regardless of whether the effect is positive or negative, its size will vary from area to area depending on existing land values, development opportunities as they are capitalized into prevailing prices (present and anticipated best and highest uses), availability of nearby developable land, and local site-specific characteristics (aesthetics, access, environmental quality, etc.). An owner of shorefront property will try to maximize both the economic and social benefits he derives from possession of the land. The imposition of a regulated zone could decrease expected economic returns by limiting future resale or development options. For example, the owner of property within the zone could no longer sell the lot for commercial redevelopment at a substantial profit. Further, in the long run, an owner's expected economic return from a shorefront property could be expected to decline as the probability of erosion-related loss increases.

The opportunity cost to property owners located within the regulated zone will vary from reach to reach. All three of the preferred reaches analyzed in this section have significant waterfront recreational development in the form of boardwalks, amusement activities, and commercial development. The Absecon reach contains casino development, while Ocean City has a substantial boardwalk. In the Long Branch to Shark River Inlet reach, boardwalks in Long Branch, Asbury Park, Bradley Beach, and Avon-by-the-Sea are interspersed with less densely developed communities such as Deal, Allenhurst, and Loch Arbour.

In those areas with significant development pressures, most notably Atlantic City, the imposition of a regulated zone could result in significant opportunity costs where the zone extends landward of the first cultural feature. On the other hand, in areas of Monmouth County with small, affluent residential communities, the opportunity costs would be smaller and could conceivably generate a benefit because the local nonresidential demand for that land would be significantly less and the imposition of the regulated zone would ensure the continuing homogeneity of land uses within the zone. The residential owner would have the assurance that the property next door could not be converted to a recreational or commercial use and thus adversely affect the value of his property.

Differential affects will occur within a given locale. The owner of a presently vacant parcel would suffer the greatest loss since he would be prohibited from any future development. Thus, his opportunity cost would be very high since the net present value difference between the two future streams of land rents would be large. Conversely, the residential owner in the same area whose land is presently developed at its best and highest use, and who can count on a continuing strong demand for shorefront houses, could conceivably incur no opportunity cost in the short run. The imposition of a regulated zone could create an artificial scarcity in the supply of shorefront houses by freezing development. The combination of continuing high demand for shorefront lands and the creation of a fixed supply of shorefront homes would lead to an increase in their value in the short run.

The range of possible impacts on the value of land located within a regulated zone make a precise determination of opportunity cost difficult. As already noted, in the short-term, land values could be enhanced or reduced depending on local development pressures and current land uses within the zone. To accurately calculate an opportunity cost, a reasonable estimate of the change in value over time of the affected land after the imposition of the regulation alternative is required. From 1973 to 1979, land prices in the Absecon Island, Peck Beach, and Long Branch reaches have appreciated at approximately 4, 7, and 7 percent per year, respectively (in real terms corrected for inflation). Given the casino-related growth pressures in the Absecon Island reach, any future estimate of the annual appreciation in land prices would be highly speculative.

For illustrative purposes, opportunity costs for vacant land within the regulated zone were calculated since the incidence of opportunity costs would fall most heavily on owners of vacant land. The opportunity costs are based on the assumption that the vacant properties could be economically developed.

However, when viewed from the community or reach level, the overall net opportunity costs could be much lower than those borne by the landowners in the regulated area. Where the development diverted from the regulated zone could be suitably located elsewhere within the same community or reach, the opportunity costs would be close to zero. In the short run, some property tax revenues would be foregone by the local community until the diverted development becomes relocated. Over the long run, the same intensity of development may have occurred within the reach, but its spatial pattern would be altered. The municipality, over the long term, could have retained nearly the same level of property tax revenues.

In this scenario, a transfer of demand has occurred such that the opportunity costs of shorefront property owners are offset by the increase in value of the land in the area receiving the new development pressure. Landowners faced with new demand for their properties will find the land worth more than they had expected,

and they could sell their holdings for higher profits, thus capturing this increase in demand.

Assuming no change in community zoning, the ability of opportunity costs occurring in one area to be recaptured in another part of the same community or reach is largely dependent on the amount and type of vacant or developable land remaining. Most of New Jersey's barrier islands have relatively small land areas and a scarcity of vacant land. This implies that the development diverted from the regulated area would have to compete with existing users in other areas; this competition would be most probable if the diverted development is a higher value commercial or recreational/entertainment land use (e.g., high value commercial use vs. lower value residential use).

In an area like Absecon Island, the opportunity costs of the landowners within the regulated area would be significant. However, given the economic ability of the diverted commercial and recreational development to bid away sites from users in other parts of the reach, the development would be more likely to remain within the reach. Thus, at the reach level, the net opportunity costs would be much lower than where costs accruing only to the shorefront property owners are considered.

The Long Branch to Shark River Inlet reach is located on the northern headlands sections of the coast. Development diverted from a regulated zone here would not be as spatially confined to a small land area as it would on a barrier island. Thus, there is a higher probability that diverted development in these reaches could relocate out of a municipality or reach to other suitable locations up and down the coast. It is possible that there could be higher net opportunity costs for headland reaches. However, in both barrier island and headland reaches, the longer term effect of the coastal regulation alternative would be to concentrate shorefront recreational development behind the regulated area.

For the three reaches analyzed, Table V.C-2 presents estimates of the vacant developable and opportunity costs for the regulated zone; 1977 aerial photos were used in preparing these estimates. The estimate of present value opportunity cost over the 50-year period was based on the methodology recommended by James (1972).

TABLE V.C-2

OPPORTUNITY COSTS OF DEVELOPMENT DUE TO IMPLEMENTATION OF LAND USE REGULATION

	Reach	Vacant Developable Land Within Regulated Zone (acres)	% of Total Acreage Contained Within Regulated Zone	Present Value Opportunity Cost Over 50-Year Period (millions of dollars)
9	Absecon Island	9.5	4.3	$4.0
10	Peck Beach	4.2	1.2	$8.5
3	Long Beach to Shark River Inlet	6.0	2.0	$2.4

(c) Remaining Reaches. Secondary socioeconomic impacts on the other barrier island recreational reaches would be similar to those described above for Reaches 3, 9, and 10. However, because of certain reach-specific characteristics the magnitude of these impacts will vary. Differences in the amount of developable land within the initial regulated area would impose different initial impacts on opportunity costs and the amount of development diverted from the regulated area.

In both the Seven Mile and Five Mile Beach reaches, the short-term erosion losses of private property and public infrastructure would be significantly smaller than for Peck Beach. Seven Mile Beach does not have a boardwalk or the accompanying recreational and entertainment facilities; the amount of developable shorefront that would be contained in an initial regulated zone is dependent on the erosion rate and the width of the existing dune area. Thus, the net opportunity costs for this reach would be lower since fewer landowners would be affected. This, in turn, would result in less diversion of development. In the Five Mile Beach reach, the proportion of developable land likely to be included in a regulated zone would be smaller than in the Seven Mile Beach reach, and thus result in proportionately smaller initial opportunity costs and less diversion of development.

In both of the above reaches, the local private sectors would have more opportunity to adjust their investment decisions to the presence of the regulated zone. However, such an adjustment could result in a rapid, intense buildup of development in shorefront areas before the land becomes included in the regulated zone. Shorefront property owners currently outside of the zone may accelerate their plans for development while they have the chance. Thus, in the short run, development in unregulated shorefront areas could increase.

The imposition of a regulated zone in the northern reaches, in other than seawalled areas, would have distinctly different short-term impacts. In these areas (Reaches 2, 4 and 5), a higher relative proportion of developed land would likely be included in the initial regulated zone. Thus, a larger initial area may be foreclosed to future development, generating significant opportunity costs in some areas within the regulated zone. Many of these beach communities are quite small in land area even though they are not situated on barrier islands. For example, the three municipalities in Reach 4 (Belmar, Spring Lake, and Sea Girt) are each less than 1.3 square miles in area. The imposition of a regulated zone in these communities could include a substantial amount of their real property tax base.

In the long-term, the erosion losses and storm event losses which would be prevented by regulation would be significant. This long-term benefit would have to be measured against the higher short-term erosion losses that would occur. Reaches 3 (Long Branch to Shark River Inlet) and 4 (Shark River Inlet to Manasquan Inlet) have very significant concentrations of highly developed recreational and entertainment infrastructure (eight municipalities have boardwalks). The size of this short-term erosion loss would be significant even when compared with the long-term erosion losses expected to be prevented.

(2) Nonquantifiable Impacts

(a) Land Use Changes. The imposition of the coastal regulation alternative within a reach would probably result in the diversion of some land uses into other sections of the various municipalities. The commercial and recreational establishments that formerly sought prime, oceanfront parcels (motels, restaurants, etc.) would

be forced to consider sites farther inland. The transfer of development pressures from oceanfront parcels to the only slightly less desirable inland sites could be significant. There is a potential for increased adverse environmental impact with the transfer of water-dependent uses to backbay sites. In the southern barrier island reaches with substantial amounts of recreational and tourism development on the ocean (boardwalk, amusement pier, etc.), some activities are so dependent on waterfront locations that their relocation may not be feasible.

The degree of diversion of development and the accompanying increase in the price of parcels located inland would be a function of local factors, including the amount of remaining vacant developable land, current development pressures, and local zoning and State (CAFRA) land use regulations. In barrier island reaches with limited land areas and little remaining developable (and environmentally suitable) land, the confinement of this demand to smaller areas could be significant.

The question is whether a complete transfer of development pressure would occur such that a decline in oceanfront land prices would not be totally offset by increases in land values elsewhere. This depends on the intensity and type of present shore development pressure. In areas with a predominantly residential shorefront, it is likely that the decline in shorefront prices or transfer of development pressures would be minimal. As has been noted by Baker and others (1975):

> In some hazard zones, as with seashores, the potential loss in economic rent may be so high as to create an inseparable obstacle to effective land use management of any sort. Some activities benefit so immensely from being located in a hazardous area their location elsewhere may be economically precluded.

(b) Uncertainty Impacts. One additional impact of the imposition of a regulated zone would be the uncertainty that such an ordinance may create in the local private sector. For example, a property located immediately behind the inland extension of an existing regulatory zone may be added to the regulated area when the boundary is periodically readjusted. The probability of this inclusion is related to modifications in the long-term erosion rate due to the changes which have occurred and the actual changes in the beach/dune boundary from which the zone is measured.

In most cases, the regulated zone boundary would be determined by the long-term 50-year erosion based on long-term historic data. The inclusion of updated erosion data for a particular area for each successive 5-year designation is not expected to significantly modify the new 50-year setback delineation. In a few areas, the controlling parameter is the short-term storm erosion recession distance of 100 feet, used in areas where the long-term erosion rate is less than 2 feet per year. As discussed in Chapter X, though there is considerable uncertainty regarding the use of the short-term recession distance, present evidence indicates that it represents a reasonably conservative erosion setback distance that could be applied and workable for a number of years. However, there is a possibility that modification in the 100-foot setback would occur – either due to the inclusion of new data on shoreline recession associated with storms or the initiation of more definitive methods to relate storm parameters to recession distance. This may result in a slight modification of the regulated zone for the period when these modifications are being implemented. The resulting uncertainty over whether such a property will be regulated could have an impact on the investment decision of a prospective buyer.

As already noted, owners or buyers are attempting to maximize the net present value of future streams of income that a property may generate. The introduction of uncertainty decreases the ability of investors to make accurate assessments of future returns. Consequently, they may be less willing to gamble the expenditure of significant amounts of capital now in return for highly variable future economic returns. For example, a potential buyer of a presently unregulated property may be less willing to purchase such a parcel knowing that his development options may be closed or limited at a later date.

The magnitude of the possible dampening of investment generated by the uncertainty inherent in a dynamic regulatory zone method would vary from reach to reach. In reaches such as Absecon Island, and to a lesser extent Peck Beach, with strong current and projected development demand for shorefront locations, the impacts may be more significant. In the Long Branch to Shark River Inlet reach, these effects would be concentrated in the municipalities with boardwalks and other concentrations of shorefront recreational facilities; the uncertainty impacts would be less significant in the residential communities of this reach, such as Deal and Loch Arbour.

On the other hand, it is conceivable that the presence of a regulated zone could generate positive external economic impacts on the price of land immediately adjacent to the setback by increasing the demand for these parcels. Investors could attempt to develop parcels immediately adjacent to an existing regulatory zone — knowing that the likelihood of inclusion during the next adjustment period assures them a favorable position. For example, a land owner who constructs a commercial establishment (a restaurant) which is subsequently included in the regulated zone knows that no other restaurants (potential competitors) will be allowed into the zone in the future. This is an example of artificially induced scarcity.

(c) Property Tax Impacts. The limitation or prohibition of future development in a regulated zone will have a direct opportunity cost to the local municipality in terms of lost property tax revenues. The municipality will lose the property tax revenues it would have otherwise received if future development and redevelopment within the zone not been regulated.

This potential revenue loss must be weighed against two potential offsetting factors. First, given the high demand for shorefront development, the development that would have originally located in the regulated zone would likely be directed to other areas (inland of the hazard zone) within the community such that the net property tax loss could be much smaller. Second, the municipality is going to lose some property tax revenues due to the future erosion-related losses of property currently located in the regulated area. It is possible that the diversion of development from the regulated zone could result in the retention of property tax revenues. This diverted development would likely relocate in areas where it would not be exposed to probable erosion loss within 50 years. Thus, the municipality would have the benefit of receiving property tax revenues from this development over a longer period of time than if it had originally located within the erosion setback area. Thus, the net tax revenue difference over 50 years could be small .

(d) Public Access. The natural beach profile that would eventually result from the adoption of the regulation alternative would be a dynamic feature. This beach would migrate over time, and if erosion continues as expected, the migration would be inland (westward) along much of the New Jersey Atlantic coast. Even if the migrating beach was to retain the same capacity it has at present, the amount of recreational

services offered in a given reach could decline. Recreational services encompass the sum of beach resources and accompanying recreational and entertainment facilities that border a beach. For Peck Beach, for example, the recreational services include the beach plus the additional facilities on the boardwalk. If over 50 years, the beach migrates inland to the point where the boardwalk is no longer accessible (is situated in the wet sand area or offshore), the boardwalk would lose much of its value as a supporting recreational facility. In essence, the level of recreational services obtainable from the beach would decline since beach visitors would no longer be able to use the recreational and entertainment facilities that were formerly available.

To maintain the existing level of recreational services in the future, accompanying infrastructure (streets, utilities, etc.) and recreational facilities (boardwalks, amusement piers, etc.) would have to be relocated or replaced. Shore communities could face the future decision of having to construct a new boardwalk to provide the same level of recreational services they are currently offering to their beach users and tourists.

Each of the three reaches analyzed in detail has a substantial boardwalk and accompanying recreational, resort, and amusement facilities. In all three, the long-term inland migration of the beach would isolate these facilities, diminishing their accessibility. Ocean City was cognizant of this problem and correspondingly relocated (farther inland) a section (approximately 800 feet) of their boardwalk that required replacement (Personal communication, S. L. Gabriel, Ocean City Planner, 1980).

Relocation would not be feasible in Atlantic City where structures on property adjacent to the boardwalk are required to abut the boardwalk. The intent of this policy is to retain the boardwalk as the focus of new development. It would not be economically feasible to relocate boardwalks where sizable development of amusement, commercial, and recreational facilities has occurred on or immediately adjacent to the boardwalk. This would include Atlantic City, as well as the four boardwalks contained in the Long Branch to Shark River Inlet reach. It would be easier to relocate boardwalks such as those in Ocean City and Wildwood, which serve more as promenades and are abutted by fewer large recreational and amusement facilities.

The encroachment of the beach farther inland may encounter privately owned land and thus diminish public access to the beach. If the supporting recreational amenities (boardwalks, etc.) and infrastructures (streets and utilities) are not available immediately behind the beach in its new location, public access would be much lower than at present. Beach users may have fewer routes through the private shorefront properties. Adoption of the coastal regulation alternative cannot be considered without planning for future public access.

(e) Other Social Impacts. In addition to the economic and social impacts discussed above, the implementation of the land use regulation alternative would have impacts on the social sectors of both the local community and the region or State, as summarized in Table V.C-3. Of greatest significance are the dislocation and human suffering impacts that would be incurred over the short-term by occupants of the regulated zone. Over the long run, erosion-related losses would be reduced due to restriction on future development in the regulated zone. As discussed above, without other programs of acquisition and development of recreational facilities in response to the new shoreline positions, the regulation alternative may not necessarily provide increased public access to the beach.

TABLE V.C-3

SOCIAL IMPACTS DUE TO IMPLEMENTATION OF LAND USE REGULATION

Impact Sector	Impact
Local Community	
Community Cohesion	No net long-term effect on community interaction patterns.
Dislocation	Loss of residential and commercial structures and roads located within the regulated zone.
	Impact on utilities outside the regulated zone.
	For Absecon Island, increase in the likelihood of residential dislocations in areas receiving diverted growth.
Human Suffering	Increased suffering in the short-term due to erosion losses in the regulated zone.
	Considerable long-term decrease in probable human suffering from an extreme storm event due to the decline in development intensity in erosion hazard area.
Aesthetics	Long-term increase in visual access to the shore as shorefront development density declines.
Regional/State	
Public Access	Possible decrease in accessibility as migrating beach encroaches on private property located inland.

Unlike private property losses, utility damage would not be only a localized problem. This is particularly true in the extreme case where erosion damages affect major water, sewer, or power lines or roads, whereby an entire community, including areas away from the shoreline, can be impacted. Due to the level of development and severity of current erosion along the coast of New Jersey, continuing erosion is a threat to utilities along some portion of almost every reach. Certain reaches are more vulnerable to major utility losses, however. Although specific treatment of the utilities in all the communities in each reach is not practical herein, the reaches can be grouped into two categories with regard to vulnerability to major utility damages during storm erosion events – (1) vulnerable low-lying barrier reaches such as Absecon Island (Reach 9), Peak Beach (Reach 10), and Reaches 2, 6, 7, 8, 9, 11, 12, and 13; and (2) less vulnerable headland, bayshore, and river reaches such as Long Branch to Shark River Inlet (Reach 3) and Reaches 1, 2, 4, 15, and 16.

Should erosion threaten solid or liquid waste-handling or disposal sites where hazardous or contaminated materials are involved, their release to estuarine or ocean waters could have deleterious effects on the quality of local water and sediments. There are at least two major dredged material disposal areas located along reach shorelines – the federally controlled Artificial Island and the Pedricktown Disposal Area on the Delaware River shore (Reach 15). There are numerous other smaller State and Federal disposal sites along shores of backbays, inlets, and tributary waterways. Depending on the quality of the material involved, where fine-grained dredged materials become subjected to erosion, waters and sediments in the vicinity of a disposal site may experience temporary quality degradation. These impacts, in turn, could affect local ecologically significant resource areas. At present, no waste sites are reported to be threatened by shoreline erosion.

b. Acquisition Alternative

The acquisition alternative comprises several possible activities by the local or State government, including pre-storm purchase of all properties within the erosion hazard area, post-storm acquisition of damaged areas, and selected acquisition. In the most extreme case, the government would purchase all the property and structures currently located in an erosion hazard area. The goal of a pre-storm acquisition program would be to eliminate current development in the erosion hazard area through fee-simple purchase, such that future erosion losses of private property and structures would be avoided. Under this approach all present dwellings would be razed, the residents and businesses relocated, and the acquired land area left vacant to revert to a natural state.

The obvious drawbacks of this strategy are the prohibitive costs involved and the social effects accompanying the relocation of the residents and businesses currently in the area. For example, the costs to purchase the real property located in the short- and long-term erosion zone (50-year erosion distance and storm erosion loss) for the Absecon Island, Peck Beach, and Long Branch to Shark River Inlet reaches are estimated at $119.6 million, $393.3 million, and $85.6 million, respectively. This is obviously not an economically feasible alternative in these highly developed reaches.

The undeveloped and unprotected areas along the shoreline which may be considered feasible candidates for pre-storm acquisition are limited. One site is the 350-acre Stone Harbor Point site on the southern tip of Seven Mile Beach, which is currently owned by the Borough of Stone Harbor. The Borough has plans to preserve the area in its natural state. If the State was to acquire the site from Stone Harbor, purchase costs could range as high as $60 million.

The other major acquisition strategy is a post-storm acquisition program. Under this approach the government (Federal, State, or local) would acquire sites of damaged structures after a major storm event. The likely economic benefit is that the purchase of these properties would be considerably cheaper after the storm. Under this option, the government would remove the damaged structures from the purchased lands and allow the area to revert to its natural state. Redevelopment within the area would be prohibited so as to avoid the probability of future property and personal losses and shore protection expenditures in an area known to be exposed to erosion and storm hazards.

Under this alternative, a government would develop contingency plans for the purchase of structures known to be currently located in areas that have historically suffered severe storm damages. This would allow the government to more easily purchase structures after a major storm event and would preclude redevelopment. Also, it would eliminate the probability of future erosion losses in these areas.

Obviously, the costs of such a program cannot be estimated prior to the actual storm event. The amount of property affected, probable post-storm purchase prices, and salvage values of damaged structures are a function of the storm intensity, the actual area affected, and the type and intensity of development within the impacted area. The accompanying Table V.C-4 shows estimated purchase costs for 500-acre parcels at various locations along the shore. The costs for land where the structures are destroyed by a major storm would be about half their pre-storm value. Land values in post-storm situations may be depressed, although there is no clear evidence that this was the case along the New Jersey coast following the 1962 storm. Assuming the occurrence of a major storm that completely destroys all structures on a 500-acre parcel, the probable post-storm acquisition costs in various coastal locations could range as high as those noted below in Table V.C-4 under the column for land values.

TABLE V.C-4

ESTIMATED PURCHASE COSTS OF 500-ACRE BARRIER PARCELS
(in millions of dollars)

Parcel	Land	Land and Structures
Barnegat Light and Harvey Cedars Boroughs	$ 69.0	$ 120.0
Sea Bright Borough	22.7	74.7
Beach Haven Borough	68.8	130.3
Brigantine City	37.3	80.4
Longport Borough	51.2	112.8
Ocean City	111.5	235.7
Sea Isle City	62.4	131.7
Avalon Borough	45.1	88.1
Stone Harbor Borough (350 acres)	64.2	64.2

Source: 1979 land and total real property values were obtained from the Abstracts of Ratables and Exemptions for the respective counties as contained in the New Jersey Division of Taxation's Annual Report for Fiscal Year 1979.

It is clearly evident that even under the conditions noted above, probable post-storm acquisition costs would still be significant. The cost of cleanup and demolition of partially damaged structures may also have to be included in post-storm acquisition programs.

Governments can gain full or partial ownership of land through other than a fee-simple purchase. Often the most expedient, and possibly cheaper, method is through the purchase of easements. As Ducsik (1974) has explained about easements:

> Under this approach, title to the land remains in private lands but is subject to constraints associated with the easement, which can be either positive or negative depending upon the type of rights acquired. A positive easement secures for the buyer the right to actually use the land in question for specific purposes, whereas a negative easement limits the uses to which the land can be put.

The value of an easement is essentially the cost of the future development options the seller is foregoing by agreeing to keep his land in less than its best and highest use. For example, an owner of land in Ocean City which could be developed commercially would have to be paid the difference between the present value of the future ecomomic returns he could have received by developing the property commercially and the present value of the economic returns he can expect by keeping the land in a recreational use. This is essentially the concept of opportunity costs as discussed previously.

Easements may be cheaper than fee-simple purchases. However, in areas with high development pressures, the cost of an easement may be so high or so close to the actual acquisition price as to make fee-simple purchase more viable. The government does not have complete control over the land under an easement approach and still has to incur some related annual maintenance and administrative costs. For these reasons, a one-time purchase cost has to be compared not only with the cost of acquiring the easement, but also the total cost incurred in administering an easement.

The acquisition strategy assessed below is the post-storm acquisition program. It was selected because of the prohibitive costs of implementing a large-scale pre-storm acquisition program along most of New Jersey's Atlantic coast, and particularly in the Absecon Island, Peck Beach, and Long Branch to Shark River Inlet reaches. Additionally, the obvious dislocation impacts of a large-scale pre-storm acquisition program along these highly developed shoreline area makes the implementation of such a method highly unlikely.

(1) Property Protection Impacts. The implementation of a post-storm acquisition strategy has widely varying impacts, depending primarily on the occurrence of the extreme storm event. A storm that occurs in 1981 could have significantly lower damage impacts than a storm that occurs in 2029. This would depend on the development that would have been allowed to occur along the shorefront area prior to the storm's occurrence in 2029.

A storm that occurs in 1981 would enable the purchase of the affected lands and structures at prices below the pre-storm 1981 market values. After the purchase of this land, it would be cleared of structures and no redevelopment would be permitted. Therefore, future erosion losses in the storm-affected area would be eliminated by the removal of development from the zone. The erosion losses prevented would be those which would have affected additional development that would have located in the storm-affected area. The development currently located in the storm hazard area would be lost to either a major storm event or to long-term erosion at some time during the 50-year planning period.

If the 100-year storm came at the end of our 50-year planning period, the actual property losses would be significantly higher. First, during the preceeding 49 years, annual erosion losses of property located in the erosion hazard area would have occurred. Second, the growth and development of the shorefront would have continued (immediately inland of the actual eroding area) such that the storm-related losses would be higher. The higher property losses under this scenario would be attributable to the incremental growth that had been permitted to occur.

The costs of acquiring the storm-damaged land 50 years from now would undoubtedly be much higher due to the continuing demand for shorefront land. Further, if development patterns change and the land is more intensely developed in the future, the post-storm prices could be significantly higher than at present. For example, it is likely that 50 years from now Atlantic City's shorefront area will be more intensely developed than at present. This increase in developed value ($/acre) in real terms, when combined with the continuing demand for shorefront sites, could result in the present value of storm-damaged land in 2029 being higher than the value of storm-damaged land now. In this instance, the government would end up paying more for the land, as well as incurring the intervening increased level of erosion losses due to increased development. However, it must be noted that considerable intervening economic benefits will have been generated from this area prior to the occurrence of the major storm event.

The timing of a storm within a planning period changes the composition of the relevant benefits and costs that would accompany a post-storm acquisition program. With an early storm, the potential net savings of purchasing storm-damaged properties plus the property protection benefit of preventing future erosion losses would be offset by potential opportunity costs of foregone development. Under a late storm, the benefit of the additional development that occurred up to the storm's occurrence would be offset by higher property acquisition costs and additional amounts of storm-related property damage.

The other obvious liability of a post-storm acquisition strategy is waiting for the storm to occur. In essence, erosion protection would not be implemented until after some storm damages have occurred.

(2) Opportunity Costs. The opportunity costs associated with the implementation of the post-storm acquisition alternative would be minimal. In particular, the present owners of shorefront properties would not incur opportunity costs. The government would be required to pay the owners of storm-damaged properties the fair market value for their parcels. This price would be based on the value of the future economic returns the owner would have received had he retained ownership of his property. Excluding the probability of the future imposition of a regulatory program limiting development of shorefront parcels, the purchase price would be higher in areas of high growth potential, such as Absecon Island.

(3) Property Tax Impacts. If the major storm event occurred in 1981, and the land was purchased (passed into public ownership), all tax revenues formerly coming from the land would be foregone. This loss of tax revenues would be larger under the post-storm acquisition option than under the regulation alternative. Under the land use regulation alternative, the local municipality continues to receive property tax revenues from the existing development. However, under a post-storm acquisition, no tax revenues would be received from this land once it passed into public ownership. This loss of revenues could be offset by increased recreational income or by the institution of beach fees or recreational taxes. Therefore, beginning in 1981, if the post-storm acquisition strategy encompassed the same developed land area that would have been included in a regulated zone, the property tax revenues foregone through post-storm acquisition could be significantly greater. The net long-term losses in revenue would be lower if the displaced development relocated within the same reach.

If the extreme storm event occurred late in the planning period, the property tax revenues lost would be lower than those lost under a 1981 storm. The amount of revenues the municipality would have received up to the time of the storm event would be at least as high as those they would have received under the imposition of the regulation alternative. If significant development had occurred in the shorefront area (regulated zone) during the time up to the occurrence of the storm, the revenues received would be higher.

The magnitude of the property tax revenues that could be foregone under a 1981 major storm event occurrence are considerable. For example, if a major storm impacted the same area as would be affected by 50 years of erosion plus 100 feet (short-term storm erosion) and if this land was acquired and remained undeveloped, the present value of foregone property tax revenues would amount to an estimated $41.1 million for Peck Beach, $16 million for Absecon Island, and $22.6 million for the Long Branch to Shark River Inlet reach.

However, once the land is acquired, it can be anticipated that the usage demand will shift to inland areas. To the extent that this shift occurs, much of the foregone revenues will be replaced by increased taxes from more intense development away from the shoreline.

The initial purchase of a coastal hazard strip does not take into account the long-term migration of the shoreline. Over the ensuing time period, erosion would continue and new properties presently located behind the hazard area would become subject to probable erosion-related losses. Thus, these properties would be required to implement some type of erosion hazard mitigation at a future date (i.e., future purchases, the implementation of a regulatory alternative, or the implementation of engineering techniques).

(4) Spending Impacts. The spending impact resulting from recreational benefits that would occur under the post- (or pre-) storm acquisition strategies will be the same as under the land use regulation alternative, except that the seawalls are assumed to be maintained. For both coastal land regulation and acquisition, it was assumed that all current engineering programs were stopped and maintenance of all existing structures was halted. The natural dynamic forces would begin to reassert themselves, and reestablishment of the natural profiles of the beach would begin. Therefore, it is assumed over the long run (beyond 50 years) that the beach would have a capacity (the same level of recreational services) similar to that of the existing beach, taking into account the additional losses of beach in areas where there are seawalls and bulkheads.

(5) Other Social Impacts. Initial adverse social impacts on community cohesion, existing social interaction patterns, and human suffering would be generated by the occurrence of the major storm. The magnitude of these initial impacts would be at least equal to those that would occur under the regulatory alternative. For example, if a storm occurred late in the planning period, the additional development that may have occurred in the potentially affected areas could result in a higher level of initial adverse social impacts and accompanying human suffering; thus, the implementation of a post-storm acquisition program could increase the level of human suffering directly caused by the major storm event.

The purchase of storm-damaged properties under a post-acquisition program could result in persons choosing to relocate (from storm-damaged homes and businesses) who might otherwise have remained in the storm-affected areas. The removal of these persons from the storm-affected areas decreases the future long-term levels of adverse social impacts and human suffering due to erosion-related losses and major storm events. The mitigation of human suffering would not begin to occur until after the occurrence of the extreme storm. At this point, the mitigation would be the prevention of future erosion losses that would have occurred had the area continued to develop or been allowed to redevelop. The quick and more intense redevelopment of the New Jersey shore areas destroyed by the 1962 storm has ensured that future erosion losses are likely to be significantly higher than they would have been if post-storm redevelopment in the affected areas had been regulated or prohibited.

The earlier the extreme storm occurs, the larger the succeeding period during which future erosion losses can be mitigated by prohibiting or lessening development. Conversely, the later the extreme storm occurs, the longer the intervening period during which continuing development patterns along the shore will be maintained or intensify, and the larger the corresponding property losses due to

continuing erosion. A major advantage of the acquisition approach is that it would provide increased public beach access.

c. Summary of Socioeconomic Impacts

The imposition of coastal regulation results in fewer total beach users being accommodated over a specified period than the implementation of an engineering alternative. The viability of the recreational beach as an economic asset and its resulting capacity, under a land use regulation alternative, is totally a function of the dynamic natural forces that govern coastal erosion processes. This lower capacity results in lifetime recreational spending impacts, both direct and indirect, that are lower than under the engineering alternatives.

The regulatory land management alternative does not provide immediate or long-term protection against erosion for shorefront properties. However, it does diminish future shorefront development intensity levels within the erosion hazard area by freezing existing development and prohibiting future development. This results in lower levels of human suffering and adverse social impacts as a result of erosion losses and major storms than would occur under the engineering or no action alternatives.

The establishment of a land use regulation induces changes in local land use patterns by diverting future development from the shorefront to other areas. This diverted development would likely relocate within the same reach except in instances where the remaining developable land area is very small and already highly developed, in which case the increased demand (and resulting higher prices) could result in the dislocation of lower value land uses (residential). Owners of property (particularly vacant parcels) within a regulated zone would incur opportunity costs in terms of their foregone future development opportunities. In the short run, it is conceivable that a regulated zone could enhance the value of affected parcels.

The impact on public access due to use of the land use regulation alternative would be insignificant since land ownership patterns (public vs. private) within a given reach would not change over the short-term. Additionally, the preservation of the beach as an aesthetic resource would be enhanced in the short-term as development intensity in coastal hazard areas begins to diminish. Over the long-term, as the natural processes begin to reassert themselves and as the intensity of development immediately adjacent to the dune line declines, the beach should regain its natural equilibrium profile, with a resulting enhancement of aesthetic and recreational quality.

The acquisition of erosion hazard areas — via outright purchase by a government or post-storm purchase of storm-damaged properties — will result in a decrease in development intensity in those areas. In both instances, future redevelopment will be prohibited. Except in a few areas along New Jersey's highly developed coast, the pre-storm purchase of land would be economically infeasible.

Future human suffering and real property damage could be lessened under a post-storm acquisition strategy. However, the magnitude of this effect is dependent on the occurrence of the storm within a given planning period and the incremental development that occurs in erosion hazard areas prior to the storm's occurrence. An early occurrence and rapid post-storm purchase would generate significant future savings in erosion losses and public post-disaster assistance funds. The opposite would be true for a late occurrence, particularly if the preceding economic growth rate had been high.

The government's acquisition of shorefront property removes land from the private sector, thus decreasing the local tax base. In addition, future development opportunities in acquired areas, which would have generated local and State economic benefits, are foregone. The location of this diverted and dislocated development in other areas of a reach or municipality would minimize the net opportunity costs foregone.

In summary, the acquisition alternative enhances public access, particularly through the strategic purchase of parcels designed to maintain or increase access. The aesthetic quality of the beach resource would be as favorably affected under an acquistion strategy as under the coastal regulation alternative.

3. Feasibility/Implementation

a. Coastal Regulation

In the presentation of a model ordinance for coastal setback for a community in Florida, Maloney and O'Donnell (1978) discuss some of the problems in the implementation of regulations using coastal setback lines. The following steps are required after legislative enactment of a setback regulation —scientific surveys, public notice, and public hearings. The hearing must include adequate consideration and presentation of all issues and views. In some cases, the inadequate resolution of adverse views at hearings has resulted in denial of regulations based on procedural grounds.

The basis for challenge due to a change of conditions is a recognized aspect of coastal regulation based on such dynamic systems. In general, the reassessment of regulated zones every 5 years would tend to accommodate major concerns. Additionally, provision for review of the setback designation of a particular area (based on an owner's scientific evidence) should also be incorporated into the regulation. Some of the problems associated with the methodology used to delineate the erosion setback line are discussed in Chapter X.

With regard to problems associated with variances to a coastal setback ordinance, Maloney and O'Donnell (1978) point out the importance of listing permit conditions in a clear and precise manner to obviate the challenge on the grounds of inadequate criteria for granting or denying a variance. The validity of the regulations is undermined when excessive numbers of variances are granted in a given area. Restrictions against an individual can become unenforceable when several owners in an area have received variances or permits. While the location of the regulated zones has been considered quasi-legislative, courts have considered decisions on individual variances as quasi-judicial or administrative in nature and thus subject to closer judical review.

The issue of "taking" is also an important consideration in coastal regulation. In recent years the courts have tended to sustain setback lines in the coastal zone as a legitimate regulatory measure not requiring public compensation. Justification for this has been related to the following considerations:

- Regulation may have minimal adverse impact on the use of a particular property.
- Although a regulation may prohibit construction or excavation of a particular property segment, it generally allows other compatible uses of that segment and does not affect other uses of the remaining areas beyond the regulated zone.

- Benefits that are realized by the owner include direct property value enhancement through proper siting and indirect property value enhancement because of similar restrictions on adjacent properties.

- Setbacks serve a legitimate public purpose by promoting the public safety, health, and aesthetic appeal of a community.

When the question of "taking" has been explored, the courts upholding setback lines in recent cases have adopted the approach of "remaining benefical use" in contrast to "dimunition in value" which has been used to justify public compensation. This is especially true when applied to flood zoning and hazard areas where there is a potential for public harm. If natural conditions prove sufficiently hazardous or inhospitable to obviate any profitable use of a property without undue risk of threat to public welfare, the basis for sustaining coastal regulations without compensation is supported. In review of recent judicial decisions, Maloney and O'Donnell (1978) conclude that construction and excavation in areas subject to flooding, erosion, and ecological degradation do not represent reasonable beneficial uses of such land, and the denial of such uses of land should not be regarded as a compensable "taking."

The New Jersey courts have addressed the "taking" issue with regard to the consideration of the hazardous and inhospitable nature of the area in the case of Spiegle vs. Borough of Beach Haven (46 N.J. 479 (1966) and 116 N.J. Superior Court 148 (1971)). Plaintiff Spiegle owned four beachfront lots in Beach Haven Borough. Two of the lots were undeveloped, one contained a single home, and one contained a small apartment house. Following the March 1962 storm, the Borough passed an ordinance delineating a building line, seaward of which no construction of a habitable structure could take place. The area between the bulkhead line (defined as the rear of the backshore) and the building line was designated as a dune area, and certain activities destructive to dunes were prohibited in the area. The building line was delineated by a consultant on the basis of where dunes occur in a normal beach profile. The dune area passed through all four of the plaintiff's lots.

Spiegle challenged the ordinance on the basis that it so restricted the beneficial use of his property as to constitute a taking of the property. Considering both the potential public harm and the probable private losses that would result from any construction seaward of the building line, the Court concluded that the "regulation prescribed only such conduct as good husbandry would indicate that plaintiffs should themselves impose on the use of their own lands." Thus, the Court upheld the validity of the ordinance, but held that Spiegle could bring a claim based on an actual showing of economic injury considering the hazards of the site.

In the 1971 proceeding, Spiegle introduced evidence showing that a residence on a lot immediately adjacent and identical in topography to one of his undeveloped lots survived the 1962 storm with only minor damage. He first demonstrated that, technically, his planned dwelling could be constructed seaward of the setback line in such a way as to withstand predicted storm forces. He further showed that it would be economically feasible for him to undertake such a project. He thereby established to the satisfaction of the Court that the proposed use of his land would be to his benefit.

The Court accepted this as proof of a beneficial use being denied the plaintiff and awarded compensation for that lot. For the remaining parcels, however, the Court accepted the findings of the Borough's expert that development would not be safe or economically feasible, especially with regard to installation and maintenance

of utilities. The potential for rupture of sewer, water, or gas lines could present a threat to health or public welfare. Since review of the evidence for the other lots indicated that they were suitable only for beach use and that they could be used for that purpose by the abutting property, the Court held that the enforcement of the dune ordinance would not constitute a "taking" and no compensation was awarded.

The potential for numerous challenges based on the "taking" issue could be mitigated by incorporating into the setback regulation the following exceptions (from the North Carolina regulation of ocean hazard areas) to the use standards:

- The construction or placement of a structure to be used for residential, institutional, or commercial purposes may be permitted on the frontal dune if it can be demonstrated that the size or location of an existing lot would otherwise preclude any practical use to be made of the subject lot.

- A minimum amount of removal or relocation of frontal dune sand or dune vegetation may be permitted if it can be demonstrated that the size or location of an existing lot would not otherwise allow any practical use to be made of the subject lot or if the development requiring that removal or relocation is shown to be in the best public interest.

Depending on the extent of the potential variances, application of these exceptions could result in the undermining of the regulation and its protective benefits. This must be weighed against the potential for continued legal challenges to the regulation based on the "taking" issue.

As discussed by Sorensen and Mitchell (1975), sufficient research has not been conducted into the effectiveness of various management tools in assessing why a particular land management approach is successful in one area and not in others. For instance, the nature of public response to certain approaches is not thoroughly understood. However, some research has been conducted on the degree of public support for land management of coastal hazard areas (setback zone) over a period of time following a major storm (Baker, 1976). It had been anticipated that public attitudes toward legislation restricting the use of hazardous areas would be favorable immediately following a disaster, but that the people in the affected area would be less favorable to such controls with the passage of time.

Baker's research was conducted after Hurricane Eloise's passage through the Florida panhandle in the fall of 1975. Initial attitudes were recorded at Panama City and Ft. Walton Beach, Florida, immediately following the hurricane, 6 months later, and 1 year later. A degree of support for land regulation was evident 2 weeks after the storm, as might be expected. Six months later, public support was stronger than in the initial survey. The proportion of respondents favoring the regulation using a setback line increased slightly (3.3 percent). The trend continued 6 months later when the favorable attitudes toward setback grew to a point where almost 95 percent of the respondents either favored or strongly favored this approach. An additional surprise of the study was the fact that state-level regulation was preferred over local regulation. This study would tend to negate the generally held opinion that such land management regulations are generally unfavorable.

A practical advantage in any state-level efforts at coastal regulation would be to have a parallel and supportive Federal program, such as that outlined in Chapter III, Section C.2.a., regarding high-level protection options for the National Flood Insurance Program (NFIP). These modifications call for the development of erosion

setbacks to ensure that new construction is not physically undermined during the terms of federally subsidized insured mortages. In the modified program, the Federal Disaster Assistance Administration (FDAA) would deny federally subsidized flood insurance for new construction in coastal high hazard areas or seaward of the erosion setback line. In addition, the proposal to provide relocation assistance for businesses and residents who voluntarily elect to relocate to safer areas would be greatly supportive of a State land use regulation program. Without these changes, the effectiveness of a State program would be hampered by the conflicts in existing Federal programs. Acquisition problems similar to those discussed in Section C.2.b. of this chapter would be encountered. The time frame necessary to establish such program modifications is probably many years away. Thus, a land regulation-erosion setback program initiated in the near future could not have the support of related Federal programs. The State regulation would tend to contain the expansion of new development in the hazard zone and reduce the impacts of future damaging events. The near-future limitations associated with the next major storm would not be extensive due to the existing highly developed nature of the New Jersey shore. Over the long-term, coastal land use regulation would be an effective tool for hazard mitigation since it would diminish development in the hazard areas.

The application of support from the proposed Federal program changes centers around post-storm activities. As discussed above in the section on socioeconomic impacts of land use regulation (Section C.2.a(1)), the maximum potential economic impact associated with opportunity lost as a result of foregone development is associated with the post-storm situation because an increased acreage of developable land would be available as a result of the storm destruction of existing development. The individual social and financial impacts associated with dislocation could be lessened by the availability of incentives such as the proposed Federal program for relocation assistance for those who volunteer to move to safer areas. Such programs would be most beneficial if initiated in sufficient time prior to the major storm event.

If the storm occurs prior to these program changes, the State coastal land use regulation would not be totally effective in reducing potential damages and losses associated with future storm events and erosion losses over time. This would also appear to be the case if only the moderate level protection options are adopted since they do not provide the supporting components for restriction of development.

b. Acquisition

Some of the difficulties associated with the post-storm implementation of an acquisition program for coastal high hazard areas are highlighted in the experiences of the New England states following the severe northeaster known as the Blizzard of 1978 (NERBC, 1980). Existing programs such as the Federal Land and Water Conservation Fund and state programs for nature conservancy were not used. This lack of implementation is related to the fact that the priorities for these programs are set in advance and difficulty arises when they have to be redefined too quickly. In addition, local matching funds are required which cannot always be met. An additional deterrent is the negative impact of the removal of properties from the tax rolls, as discussed above.

Section 1362 of the National Flood Insurance Act (NFIA) of 1968 provides for the Federal purchase of high-hazard properties heavily damaged by flooding. At the time of the 1978 Blizzard, Section 1362 had not received funding from Congress. Funding is now available for the first time for this program. For fiscal year 1980, $5.4 million was appropriated nationwide for the acquisition of damaged properties from willing sellers. However, there is no incentive for the owners of damaged property to sell. The NERBC study of post-storm recovery activities indicates that, due to a

number of factors, Federal and state rebuilding requirements for floodproofing were only partially effective. Once a structure is "substantially improved," it then requires floodproofing and moves from the subsidized insurance rates to actuarial rates, which are supposedly designed to reflect the true risk associated with the particular area. NERBC found that structures which should have been classified "substantially improved" were not. There is a greater incentive to sell for those structures which would be classified "substantially improved" since owners would subsequently be paying for the true risk of coastal habitation. Some of the problems with the effectiveness of the program are that:

- o The regulations are based on the amount of repair rather than on the amount of damage.
- o Personal property and household effects are not included.
- o Inspectors were not given adequate training and guidelines and were subjected to political pressures.

These deficiencies have been recognized, and the options addressed by the Heritage Conservation and Recreation Service Environmental Impact Statement (HRCS EIS) for Flood Insurance and Disaster Mitigation and Recovery would provide the framework for their resolution.

Regarding the problems associated with establishing a specific percentage of damage criteria which would determine whether reconstruction would be allowed in regulated zones, the New Jersey State Supreme Court has ruled that "the section of zoning ordinance in question is invalid." The applicable State statute (NJSA 40:55-48) provides for restoration or repair in the event of partial destruction of nonconforming structures (structures which existed in the zone prior to regulation but which would not be allowed if newly constructed). The courts have indicated that what constitutes "partial destruction" must depend on the facts in each case and ruled that a percentage delineation by ordinance is not authorized (H. Behlen & Bros. vs. Mayor etc. of Kearney, 31 N.J. Super. 30, 39 (App. Div. 1954). This case is cited in Spiegle vs. Borough of Beach Haven, in which the court invalidated that portion of the dune ordinance which set a 50 percent damage limit for reconstruction within the dune setback line. Without changes in State legislation, problems similar to those encountered in New England regarding post-storm implementation of various programs are inevitable.

Proposed programs include the requirement for the preparation of a State contingency redevelopment plan which would encourage reconstruction away from coastal high hazard areas by applying State standards. It would also link the State's disaster plan to Federal regulations. Until these new regulations and program elements are in place, acquisition programs for a developed coastal state such as New Jersey will not be very effective. A worthy suggestion from the NERBC study for increasing incentives for selling properties in the hazard areas was that persons who sell their homes and property would be allowed to live out their lives in the home prior to Federal or state disposition.

Section 315(2) of the Coastal Zone Management Act (CZMA) provides a vehicle for funding assistance to the State on a 50 percent matching basis to be used in the purchasing of access to beaches and other coastal areas. The moderate level HCRS protection options for acquisition policy (see Chapter III, Section C.2.a) recommend that the Office of Coastal Zone Management (OCZM) analyze the merits of implementing Section 315(2) and carefully evaluate the possible use of techniques

such as less-than-fee-simple acquisition. To date Congress has not appropriated any monies for Section 315(2) acquisitions.

For the first time, for fiscal year 1980, Congress appropriated monies for purchase of storm damage properties under Section 1362 of the National Flood Insurance Act (NFIA). Although FEMA's use of NFIA-Section 1362 funds does not require local cost sharing, the distribution of scattered parcels which tends to result from use of this approach alone results in management and administrative difficulties. Thus, other programs which would involve local cost sharing — such as State Green Acres local matching grants and the Federal Land and Water Conservation Fund monies — may be needed to provide manageable areas. Tax assistance to local communities from State or Federal programs would go a long way toward increasing the feasibility of NFIA-Section 1362 or CZMA Section 315(2) acquisition.

At any rate, some time will pass before all the program revisions needed to make acquisition an effective tool are in place and adequately funded. Maximum benefits would occur from such an acquisition program, either on its own or in combination with other adjustments, only if these programs are adequately funded and in place prior to the next major storm.

D. EVALUATION OF THE NO ACTION ALTERNATIVE

Under the no action alternative, the State or local governments would not take any steps to mitigate or protect against the effects of the natural beach erosion process. This alternative includes the elimination of all engineering programs that involve beach filling and construction of jetties, groins, or other structures designed to prevent further erosion, trap littoral sand, or protect shorefront real property from probable erosion effects. It also assumes that existing engineered structures would not be further maintained and that there will be no periodic renourishment of beaches.

In addition, it is assumed that the State and local governments would not adopt regulatory schemes whose explicit goals include the decreasing of shorefront development so as to reduce future erosion losses, or the prohibition of new or additional development on beach and dune areas so that natural shorefront erosion processes may be reestablished. However, the no action alternative does assume that the CAFRA, Wetlands, and Waterfront Development permit programs would continue. These programs are not explicitly intended to protect or mitigate adverse erosion effects. However, the long-term adverse effects of continuing erosion would be somewhat mitigated depending on the degree to which these programs limit future development in the coastal zone.

The natural forces controlling the dynamic shore erosion process would cause the continuing inland migration of the beach and dune area along most of New Jersey's heavily developed ocean shore. This would result in continuing future losses of shorefront real property and accompanying human suffering.

Simultaneously, the demand for shorefront properties, if left unregulated, would continue to remain high because of the scarcity of these sites and their unique, aesthetic, environmental, and recreational assets. The continuing increase in demand for leisure activities, particularly those oriented around beach or shorefront locations, would cause a corresponding increase in demand for these properties. This would translate into continuing and probably higher levels of development along New Jersey's coast. Under the no action alternative, the continuing high demand for shorefront properties would remain concentrated in the areas that are most likely to be adversely affected by continuing erosion.

The following section assesses the significant impacts of adopting the no action alternative along New Jersey's ocean shore. A number of the probable impacts have already been discussed in the previous assessments of the engineering and land management alternatives. The impacts of the no action alternative are compared with those expected for the other alternatives.

1. Impacts of the Natural Ecosystem and Resources

Since the no action alternative does not involve engineering or land management actions, it is likely that the remaining unprotected natural beach and dune habitat areas would be lost or depleted due to the continued encroachment of development and the migration of the shoreline.

Where new tidal inlets are formed through the natural process of barrier island breaching, and the inlets are not subsequently filled in, backbay areas could be affected. Formation of new inlets could increase the salinity and alter the flow characteristics of backbays. Changes in flow characteristics in backbay and related tidal tributary areas could alter the character of tidal flooding, possibly adversely

impacting development adjacent to those areas. Salinity changes could affect the biological community (such as species migration) and commercial shellfish beds. Along an undeveloped barrier island coast, the formation or filling of inlets and the subsequent habitat alteration in backbay areas is an ongoing natural process.

As with the land management alternatives, cultural and historic resources could be threatened or lost where uncontrolled erosion encroaches on developed areas. Similarly, it is conceivable that where there is erosion of waste disposal sites, such as sanitary landfills, or dredge material spoil areas, the quality of local estuarine or ocean sediments and water could be adversely affected — especially where contaminated or hazardous substances are involved. At present, no such sites are reported to be threatened by shoreline erosion.

2. Socioeconomic Impacts

a. Spending Impacts

The adopton of a no action alternative would retain existing recreational spending levels, as would occur under either of the land management alternatives. Thus, the direct and indirect spending impacts for the various reaches under the no action alternative would approximate those shown in Table V.C-1.

A consequence of adopting the no action alternative would be to maintain and probably increase the intensity of existing recreational and commercial development in the shorefront zone located immediately behind the beach and dune area. As previously noted, a number of recreational activities (boardwalks, amusement piers, etc.) are economically dependent on shorefront locations. Atlantic City's policy of maintaining the boardwalk as the focal point of continuing development is a recognition of the economic importance of shorefront locations to recreational development.

b. Property Protection.

There would be no property protection benefits generated under the no action alternative. The property and structures lying within the short- and long-term erosional areas noted earlier would probably be lost over the next 50 years if erosion continues at historical rates. In addition, the eventual losses of real property would be significantly higher under this alternative than under the coastal regulation alternative due to the development (primarily infilling) that can be expected to continue to occur in shorefront areas. Conversion of shorefront residential land uses to higher order commercial and recreational uses would also mean higher erosion losses in the future.

The adoption of the no action alternative effectively condemns existing shorefront properties located in erosion hazard areas to eventual loss due to erosional processes. Alternatively, major costs will be incurred in the future to replace or to relocate public facilities and infrastructure presently in erosion hazard areas. Accompanying public disaster assistance outlays would increase, particularly after short-term erosion losses following major storms.

Under the no action alternative, shorefront development in erosion hazard areas would not receive protection from engineering structures, nor would it be regulated. Recreational development would continue to be attracted to those shorefront locations which are capable of generating maximum economic benefits. However, these are also the same areas that are most likely to experience erosion-related losses.

The denial of engineering protection or the absence of any regulation of shorefront developent perpetuates the cycle of periodic destruction and reconstruction of shorefront infrastructure in these areas. Shorefront development would seek to maximize economic returns and benefits in the face of continuing erosion and the probable occurrence of a major storm event. Periodically, shorefront infrastructure and establishments would be lost, requiring the use of public or private resources to construct new or relocate old facilities. The new or relocated facilities would attempt to locate so as to maximize economic returns prior to the next occurrence of a major storm event or erosion loss.

c. Opportunity Costs and Land Use Change

Since this alternative would not regulate land use and development in shorefront or erosion hazard areas, no opportunity costs would be incurred and no development opportunities would be foregone (except possibly through the CAFRA, Wetlands, or Waterfront Development permit programs). The shorefront sites would be developed to their best and highest uses as determined by market forces and as constrained by existing local and State regulatory programs (zoning etc.).

As already noted, a major impact of the no action alternative would be to maintain or increase existing land use patterns and development intensities in shorefront areas, at least until the next major destruction storm. Continuing demand for these sites could generate economic pressure for converting shorefront residential uses to higher order recreational or commercial uses.

No diversion of development pressure away from prime shorefront locations would occur under the no action alternative. The main focus of recreational development demand would remain on shorefront properties. Therefore, there would be less conversion of lower order land uses to higher order commercial and recreational land uses in other areas of a community, barrier island, or reach.

d. Costs

The adoption of the no action alternative would result in no direct annual program expenditures being incurred by State or local governments. Similarly, it would require no public investment in engineering structures or periodic outlays to maintain them. Finally, no monies for acquiring shorefront properties would be expended.

However, the absence of direct annual program outlays would be offset by an increase in future, indirect governmental expenses. If shorefront development intensified, an increase in the annual public service costs of State and local governments would be required (utilities, parking, police, fire, etc.). Simultaneously, it would increase the future level of post-disaster assistance relief expenditures incurred by Federal, State, and local governments.

The additional public service costs incurred by local governments under the no action alternative would be less than those incurred under the engineering alternatives, which provide beach capacity for a substantial net increase in the number of beach users accommodated over the 50-year planning period. These additional users would require a corresponding increase in local public services. Under both the no action and engineering alternatives, development behind the beach and dune area would be unregulated, thus generating the same intensity of development and resulting demand for public services over time.

e. Social Impacts

The major social impact of the no action alternative would be to increase the probable future level of human suffering and adverse social effects that accompany catastrophic storm events and long-term erosion-related losses of shorefront real property. The adverse social effects include the forced evacuation from or dislocation of homes and businesses and the severing of established social interaction patterns due to the relocation of residents.

The social impacts would be higher under the no action alternative because existing levels of development would be maintained or would increase in those areas exposed to probable long-term or storm-related erosion losses. In addition, future losses would be higher because, after the occurrence of a major storm event, redevelopment would be permitted in those areas directly affected by the storm. This is part of the development-property loss-redevelopment cycle noted earlier. In contrast, the post-storm acquisition strategy would result in the same level of human suffering and accompanying adverse social impacts as the no action alternative up to the time of the first storm; thereafter, social impacts under the post-storm acquisition alternative would be lower since redevelopment of the affected area would be prohibited.

f. Public Access

The continuation or increase in development intensity in shorefront areas, in the absence of State regulation, would probably decrease public access. Private sector recreational development in shorefront areas would limit shore access to those persons patronizing the shorefront establishments or those wealthy enough to purchase shorefront sites. The maintenance or increase in demand for shorefront properties translates simply into high prices for shorefront sites and higher prices for recreational services.

E. SUMMARY

This section summarizes the significant benefits and costs and the influencing factors associated with adopting the Master Plan shore protection alternatives. The characteristics of these benefits and costs as they relate to size, jurisdiction (municipal, reach, state, etc.), and sector (public and private) are described.

In Chapter IV, a range of possible approaches for mitigation of the potential adverse effects of continuing coastal erosion were reviewed. In this chapter, four alternatives were selected for further analysis of potential impacts and implementation feasibility:

- o Engineering
- o Land Management - Land Use Regulation
- o Land Management - Post-Storm Acquisition
- o No Action

In Chapter VI the engineering plans are developed on a "reach" basis. A reach is defined as a length of shoreline in which similar coastal processes are acting. The engineering alternatives are designed to deal comprehensively with the entire reach, as opposed to the more traditional, piecemeal approaches to shore erosion protection.

Excluding no action, the alternatives represent two varying approaches to prevention of erosion-related losses of shorefront real property. The engineering alternative attempts to mitigate adverse erosion impacts by controlling or lessening the natural forces behind erosional processes. Land management alternatives seek to minimize or avoid losses by limiting or eliminating future development in erosion hazard areas. These two opposite approaches result in different direct and indirect benefits and costs. The direct costs, benefits, and impacts of the engineering alternatives are generally more readily quantifiable than those associated with the land management alternatives, which require considerable speculation about future trends (e.g., development and land use, population), and impacts (e.g., property losses avoided).

This section offers a summary of the tradeoffs involved when considering implementation of each of the shore protection alternatives. The tradeoffs are the significant benefits and costs that would be incurred with the adoption of one technique, as compared to the no action alternative.

The socioeconomic and environmental impacts that would accompany the implementation of selected, nonmaintenance engineering alternatives were assessed for three reaches — Absecon Island (Reach 9), Peck Beach (Reach 10), and Long Branch to Shark River Inlet (Reach 3). The same impacts were also assessed for implementation of the regulatory and post-storm acquisition alternatives in Reaches 9, 10, and 3. Finally, socioeconomic impacts were assessed for implementation of the maintenance alternative in Reach 2 (Sandy Hook to Long Branch).

1. Direct Benefits and Costs

The direct benefits and costs associated with the implementation of the engineering and the two land management alternatives in the Absecon Island, Peck Beach and Long Branch to Shark River Inlet reaches are presented below. These are the same short-term direct benefits and costs that were used in the priority analysis.

These are the additional benefits and costs that would be incurred above and beyond those that would occur under the no action alternative. "Short-term" refers to those direct benefits and costs occurring within the 50-year planning period. The composition of these benefits and costs for the three alternatives (excluding no action) are shown in Table V.E-1.

TABLE V.E-1

COMPOSITION OF SHORT-TERM DIRECT BENEFITS AND COSTS

Alternative	Direct Benefit	Direct Cost
Engineering	Recreational Property protection	Engineering Public service
Regulation	Recreation	Annual administration Property loss
Acquisition	Recreation	Purchase Property loss

a. Recreational Benefits

The engineering alternatives provide additional beach capacity, which in turn accommodates additional users; thus, the engineering alternatives would generate a substantial net increase in direct recreational benefits as compared with the no action alternative. Regulation or acquisition may provide a slightly higher level of recreational benefits than under the no action alternative, depending on the interaction of the migrating beach and dune area with the developed shorefront areas lying behind it. The net increase would be minimal. For purposes of this analysis it is assumed, that at best, the no action alternative would result in the same total beach capacity as would occur under the two land management alternatives. Thus, no net, direct recreational benefits occur the land management alternatives.

When compared with the land management alternatives, direct recreational benefits under the engineering alternatives increase by the following percentages:

22.3 percent for Absecon Island (Reach 9)
64.5 percent for Peck Beach (Reach 10)
10.7 percent for Long Branch to Shark River Inlet (Reach 3).

The difference in these estimated increases is a result of reach-specific differences in the design of the engineering alternatives. In general, proportional increases in recreational benefits tend to be higher in reaches with any or all of the following factors – high projected recreational demand, high erosion rates, and narrow beaches. Peck Beach is a notable example.

b. Property Protection

The direct, short-term protection impacts of the four alternatives on existing real property, public facilities, and infrastructure in the short-and long-term erosion zone are noted below:

- o Engineering — Property protection provided.
- o Regulation — Property protection not provided, losses occur.
- o Post-storm acquisition — Property protection not provided, losses occur.
- o No Action - Property protection not provided, losses occur.

The real property presently located in the short- and long-term erosion hazard area would be lost to erosion under the adoption of either the land management or no action alternatives over the next fifty years. Therefore, in comparing the land management alternatives to the no action alternative, no net property loss costs are incurred. In essence, the property loss would occur anyhow, and cannot be taken as a cost of implementing the land management alternative.

The occurrence of a storm exceeding the design standard of the engineering alternatives would reduce the property protection benefits and the recreational beach resource. The future probability of erosion losses of shorefront properties would increase as compared with the lower probability of loss before the storm. Depending on the timing of such a storm (early or late in the implementation period), the direct benefits of the engineering alternative could be immediately lost.

The property protection impacts would affect both public and private owners of shorefront property. Along New Jersey's ocean shore, approximately 75 percent of the dry sand and upland area is publicly owned. Immediately inland of this area, most of the land is privately owned. The loss of structures under the land management and no action alternatives would result in the dislocation of persons from their homes or businesses. This would have adverse impacts on community cohesion by severing established social interaction patterns. This adverse impact is reduced where seasonal housing comprises a high proportion of the affected structures.

c. Implementation Costs

The total costs of implementing the engineering alternatives consist of the initial capital cost, the annual maintenance cost and the intermittent but regularly recurring capital cost. The present value engineering costs for Reaches 9, 10, and 3 are shown in Table V.E-2.

TABLE V.E-2

PROGRAM COST COMPARISON
(present value in millions of dollars, 50 years at 9%)

Reach	Engineering Alternative	Regulation Alternative
9 - Absecon Island	$ 28.7	$ 2.2
10 - Peck Beach	$ 17.6	$ 0.5
3 - Long Branch to Shark River	$ 28.8	$ 4.3

The occurrence of a major storm exceeding the design standard of the engineering alternative may result in the complete loss of the engineering project. Therefore, it would have to be replaced to retain the projected level of direct recreational and property protection benefits. If the original engineering improvement

had been funded by the Army Corps of Engineers, they could choose to restore the beach to its pre-storm dimensions and pay the full cost; thus, no state or local monies would be required. The maximum additional capital cost increment would be incurred if a storm exceeding the design standard of the engineering alternative occurs immediately after the implementation of the project.

The land management alternative would require annual administrative costs to operate the regulatory framework, as well as initial planning costs and occasional legal fees. However, the magnitude of these costs over the 50-year planning period would be much smaller than comparable engineering costs. Based on a review of local municipal budgets for large shore municipalities, total annual costs to administer the regulatory alternative were estimated at $50,000 per municipality within the reach. This would be split 50/50 between the State and local municipal government. Thus, each municipality within a reach would incur annual costs of $25,000 to administer the regulatory alternative within their own jurisdiction, and the State would incur a similar cost. This is probably an overestimate of the of the actual cost that would be incurred under the regulation alternative. The total present value costs for the regulatory alternatives over a 50-year period are listed in Table V.E-2. It is clear that, even under a conservative assumption, total direct costs of implementing the regulation alternative are much smaller than those for the engineering alternative.

The direct costs of the post-storm acquisition alternative would vary depending on the magnitude of the storm, and the amount and type of shorefront properties impacted. As noted previously, a storm occurring late in the planning period would have higher acquisition costs associated with it due to continuing shorefront development and appreciation in shorefront property values. Conversely, a storm occurring early in the planning period would have lower associated acquisition costs.

The implementation of engineering alternatives in reaches with high recreational beach demands and highly developed shorefront recreational amusement and boardwalk facilities can be cost effective in the short-term. The communities containing these facilities (e.g. Atlantic City, Ocean City, etc.) have highly developed resort and recreational economic sectors that generate significant local, regional and state income, employment and tax revenue benefits. The implementation of engineering alternatives in these reaches would clearly be a cost beneficial way of helping to ensure the continuing economic viability of their resort and tourism sectors. Similarly, these alternatives provide significant property protection and recreational benefits, in spite of their high initial capital costs and long-term financial commitment. For example, in Peck Beach an approximate 50 percent increase in direct costs would yield a 77 percent increase in direct benefits. As indicated in Table V.A-2 in this chapter, engineering alternatives would be cost beneficial in the following reaches: Peck Beach, Sandy Hook to Long Branch, Absecon Island, Seven Mile Beach, and Long Beach Island. In addition, the property tax revenues presently coming from properties located with the short and long-term erosion hazard area would be retained under the engineering alternative. These revenues were presented previously in Table V.B-3.

The land management alternatives would result in no net increase in direct recreational benefits as compared with the no action alternative. Thus, the Land Management alternatives would retain the existing levels of direct beach expenditures that occur within each of the three reaches. The retention of these direct expenditures, plus the accompanying multiplier expenditure impacts, at minimal cost

over the next fifty years is a significant advantage of the regulatory alternative. Particularly in reaches where the provision of additional beach capacity is not cost beneficial. For example, within the Long Branch to Shark River Inlet reach, the engineering alternative would not be a cost beneficial way of providing additional direct benefits as the benefit/cost ratio is less than one (see Table V.A-2).

The regulatory alternative has an advantage in that the program costs are much lower than the comparable engineering alternative. Further, they are not subject to significant increases due to extreme storm-event occurrences. The regulation alternative would control further development in regulatory zone, thus mitigating future erosion and major storm event property losses. Development density in the regulated area would begin to decline due to erosion, attrition of structures and major storm events. However, the level of future property losses due to erosion or major storms that is avoided, is a benefit that will not become apparent in the short-term.

The regulation alternative results in a decrease in property tax revenues coming from the regulatory zone. The prohibition of additional development within the zone plus the attrition of structures over time decrease the value of tax ratables within the regulated area. This decline could be offset by development that locates elsewhere within the reach, but out of the regulatory zone.

The short-term cost effectiveness of an engineering alternative can be quickly eliminated by the occurrence of a major storm exceeding the design standards of the alternative. Due to the probabilistic occurrence of a major storm, there is no guarantee that the benefits that may accompany the implementation of an engineering alternative will be accrued. The likelihood exists for incurring significant additional costs if such a storm occurs.

The direct benefits and costs for the post-storm acquisition of hazard areas is also dependent on the occurrence of the major storm. Property protection benefits would not begin to be accrued until after the storm. In addition, the highly developed character of New Jersey's ocean shore makes the large scale implementation of such a program too expensive.

Finally, it is clear that focusing only on short-term, direct, primarily quantifiable, benefits and costs of the various alternatives does not given an accurate accounting of each alternative's total benefits and costs. Significant benefits and costs of the land use management alternatives may become apparent only in the long-term. Finally, there are a number of highly significant impacts that are not quantifiable: these are discussed below.

2. Other Impacts

A number of other significant impacts associated with the implementation of the different shore protection alternatives are not manifested as direct, short-term effects — particularly those for the land management and no action alternatives. In addition, there are indirect benefits and costs associated with the alternatives that can change their relative benefit/cost desirability.

a. Engineering Impacts

The positive impacts of implementing reach engineering plans include:

- Increases in multiplier spending effects of direct recreational expenditures in the short-term (e.g., increases in income and employment are greatest at the community and reach levels; increases in State sales tax revenues).

- Property protection benefits would be provided for additional development that locates in erosion hazard areas.

- Reduction of property damage generated by a storm exceeding the design standard of the alternative.

- Short-term decreases in erosion-related property losses result in lower levels of public relief and disaster assistance expenditures.

- There would be no imposition of opportunity costs or investment uncertainty on shorefront property owners.

- Wider, more aesthetically pleasing beaches under the recreational alternative, (i.e., increases in the quality of recreational beach services are provided by accommodating projected increases in demand).

- Reduced likelihood of adverse downdrift effects usually associated with piecemeal engineering measures.

- Short-term decrease in the level of human suffering that accompanies erosion-related losses of shorefront real property.

- Increase in public access if the implementation of the engineering alternative requires public access as a condition for receiving State funds.

The negative impacts include:

- Maintenance of or increases in development density in coastal areas subject to erosion-related and major storm impacts.

- Long-term increases in level of public relief and disaster assistance expenditures accompanying continuing erosion, future major storm events, and continuing sea level rise.

- Potential for short-term, local impacts on the beach, dune, and nearshore ecosystems.

- Potential for temporary adverse environmental impacts on shellfisheries during the offshore dredging required for beach nourishment activities.

- A substantial portion of public shore protection expenditures are for property protection which benefits private shorefront properties.

- Long-term increases in the probable level of human suffering and adverse social impacts (e.g., property loss and relocation) accompanying the occurrence of a major storm.

Table V.E-3 shows the increases in direct recreational expenditures, sales tax revenues and total income that would be produced under the implementation of the selected engineering alternative in each of the three reaches. It must be remembered

that the increases in tax revenues and total income are generated as a result of the additional beach users accommodated under the engineering alternative. By not providing additional beach area, these net benefits would not be realized.

TABLE V.E-3

BEACH USER SPENDING BENEFITS DUE TO THE IMPLEMENTATION OF SELECTED ENGINEERING ALTERNATIVES

(in millions of present worth dollars)

Reach	Direct Expenditures	Retail Portion of Direct Expenditures	Estimated Sales and Use Taxes	Total Income
9 - Absecon Island	$533.7	$433.8	$20.5	$1451.7
10 - Peck Beach	$318.2	$248.3	$12.2	$747.8
3 - Long Branch to Shark River	$52.0	$43.2	$2.0	$143.0

The implementation of engineering alternatives are clearly cost beneficial in the short-term in selected areas. In these specific reaches, engineering alternatives do provide significant direct, short-term recreational and property protection benefits. However, engineering does not offer a long-term, permanent solution to the problem of continued development in erosion hazard areas. Therefore, engineering and land management alternatives should be implemented simultaneously. This would permit the short-term protection of existing shorefront infrastructure and property in certain reaches, while concurrently regulating future development that would be subject to erosion-related and major storm event losses.

The implementation of an engineering alternative without also implementation a land management program could lead to increases in future levels of property loss. For example, it is estimated that there is approximately $95 million worth of structures, recreational facilities, and public infrastructure currently located within the short- and long-term erosion hazard area on Long Beach Island. A maintenance or increase in the intensity of development within the erosion hazard area that would accompany the implementation of an engineering alternative would maintain or increase the amount of real property located within the erosion hazard area. The occurrence of a severe storm exceeding the design standard of an engineering alternative would result in higher levels of property damage due to the continuing presence of development located within the hazard zone.

b. Land Management Impacts

The indirect impacts of the two land management alternatives are difficult to quantify, but it is these impacts that are the most significant in shaping related policy decisions. The realistic consideration of these potential impacts is particularly urgent along a heavily developed ocean shore, such as New Jersey, where the potential benefits and costs of land management alternatives are controversial.

The positive impacts of implementing land management alternatives include:

- o Short- and long-term declines in development density in coastal areas subject to erosion-related and major storm impacts.
- o Short- and long-term erosion loss mitigation as a result of the decline in development density in, and diversion of future development from, the erosion hazard area.
- o Natural evolution of ecosystem and protection aspects of the dune/beach system.
- o Increases in the amount of natural areas as the dune/beach system evolves.
- o Long-term decreases in future levels of human suffering and adverse social impacts accompanying erosion, major storms, and continuing sea level rise.
- o Long-term decreases in future levels of public relief and disaster assistance expenditures accompanying erosion-related losses, major storms, and continuing sea level rise.

The negative impacts include:

- o Diversion of shorefront development away from the regulated area into other areas of a reach offsets opportunity costs incurred by owners of property located in the regulatory zone.
- o Short-term increases in insurance claims paid to, and relocation expenses incurred by, shorefront property owners presently located in the erosion hazard area.
- o Property taxes from shorefront development diverted away from the regulated area into other areas of a reach offsets decline in property tax revenues coming from the regulated area (i.e., prohibition of new development and attrition of structures decreases the amount of ratables in the regulated area).
- o Short-term increase in adverse social impacts accompanying erosion-related losses of shorefront property currently located within the regulatory zone.

The major property protection benefits and accompanying impacts under the regulatory alternative become higher in the long-term. The implementation of this alternative does provide a long-term, permanent response to the problem of intense shorefront development in erosion hazard areas. However, it is recognized that such a program should be supplemented with engineering alternatives (when shown to be economically justifiable) in those reaches with severe erosion problems and substantial amounts of shorefront recreational development. This would ease the transitional effects associated with changing shore protection strategies from erosion protection to regulation.

The costs associated with the occurrence of a severe storm can be highly significant. For example, if a major storm destroyed only the structures currently located in the short- and long-term erosion hazard zone on Peck Beach, the damages could approach $100 million. A significant loss of or diminution in value of land would

raise this cost. The 1962 storm that struck the New Jersey coast caused an estimated $300 million (1980 $) worth of damages. The avoidance of a potential loss of this magnitude would be a significant benefit, especially when considering the secondary costs that will accompany such a storm. These would include post-disaster assistance, relocation expenses, and the costs of relocating or replacing shorefront infrastructure. Thus, the lack of short-term, direct benefits under the land management alternative have to be contrasted with long-term, indirect benefits that would be accrued.

Finally, it must be remembered that the implementation of the regulatory alternative would result in significant levels of direct recreational beach expenditures, and accompanying multiplier spending impacts being maintained. The existing beach resource does presently, and will continue under the regulatory alternative, to accomodate large numbers of beach users. The spending impacts that would be maintained under the regulatory alternative were noted in Table V.C-1, and are presented below:

TABLE V.E-4

BEACH USER SPENDING IMPACTS FROM IMPLEMENTATION OF LAND USE REGULATION
(in millions of present worth dollars)

Reach	Direct Expenditures	Retail Portion of Direct Expenditures	Estimated Sales and Use Taxes	Total Income
Absecon Island	$ 899.7	$ 731.5	$28.1	$2,447.3
Peck Beach	$ 493.4	$ 384.8	$14.8	$1,159.5
Long Branch to Shark River Inlet	$ 732.3	$ 607.8	$23.3	$2,013.8

c. Post-Storm Acquisition Impacts.

The positive and negative impacts of the post-storm acquisition strategy are similar to those of the regulatory alternative. The impacts noted below include only those unique to post-storm acquisition.

The positive impacts include:

- o No imposition of opportunity costs on shorefront property owners since they would receive the fair market value for their properties.
- o Long-term decreases in development density in shorefront areas after the occurrence of a major storm and subsequent acquisition.
- o Long-term erosion loss mitigation after acquisition due to prohibition of new development in acquired areas.
- o Increases in public access to beaches.

The negative impacts include:

- o Potential for higher, future levels of public relief and disaster assistance expenditures accompanying a major storm event if development is not regulated within the affected area prior to the storm's occurrence.
- o Potential for higher, future levels of human suffering and adverse social impacts accompanying a major storm event if development is not regulated within the affected area prior to the storm's occurrence.
- o High initial purchase costs plus the need to continually purchase additional parcels of shorefront land to maintain protective benefits.

The initial impacts of the post-storm acquisition strategy depend largely on the timing of the major storm. After the occurrence of the storm, the type of impacts generated would be similar to those occurring under the regulatory alternative. However, the post-storm acquisition strategy would have significantly higher costs. This alternative could also be considered as a supplement to the regulatory and engineering alternatives.

d. No Action Alternative Impacts.

The impacts of the no action alternative are generated by allowing the forces driving both the erosional processes and the development demand for shorefront areas to continue uncontrolled. In essence, no protective steps are taken to lessen the direct effects of erosion, and no planning is undertaken to mitigate future erosion-related losses.

The positive impacts associated with implementing the no action alternative are:

- o No annual, direct engineering or program costs.
- o No limitation of the rights of shorefront property owners (i.e., they retain the freedom to exercise all development options within the limits of local planning and zoning laws).
- o No imposition of opportunity costs or investment uncertainty on current private shorefront property owners.
- o No accrual of property protection benefits to private shorefront property owners at public expense.
- o Fewer short-term, property tax revenues foregone from shorefront areas than under the land management alternatives, but more revenues foregone in the short-term than under the engineering alternative.

The negative impacts include:

- o Short- and long-term increases in development density in coastal areas subject to erosion-related and major storm impacts.
- o No direct short-term, property protection benefits; increases in short-term property protection losses due to the additional development that locates in shorefront areas.
- o Short- and long-term increases in future levels of public relief and disaster assistance expenditures accompanying continued erosion, major storms, and sea level rise.

- o Short- and long-term increases in future levels of human suffering and adverse social impacts accompanying the above property losses.
- o Continuing decreases in the amount of natural areas as the dune/beach system is squeezed between the advancing shoreline and continuing intense shorefront development.
- o Decreases in public access to beaches due to continuing shorefront development.
- o Maintenance of or probable decrease in the available beach resource as compared to the regulation alternative, with corresponding effects on the level of recreational services and direct recreational spending, local income, local employment, and sales tax benefits.
- o Relocation of public utilities, infrastructure and public facilities currently located in the regulatory zone.
- o Potential for impacts on the beach, dune, and nearshore ecosystems due to maintenance or increase in shorefront development intensity.

3. Implementation of Alternatives

Overall, implementation is dependent on the availability of funds for the high cost erosion control alternatives and for land acquisition. In that regard, the State and local governments are faced with the problem of how to provide protective public beaches and access without bankrupting their treasuries or alienating beachfront property owners. High costs, considerations of cost effectiveness, and emergency funding relief for potential losses of erosion control projects resulting from major storms dictate the importance of the U.S. Army Corps of Engineers' participation in the Master Plan. However, such participation would probably decrease the likelihood of timely implementation when compared with State-local participation only.

Implementation of the land use regulation and post-storm acquisition land management alternatives would be dependent to some degree on all of the following: available funds; timing; implementation and funding of existing and proposed Federal program regarding barrier islands acquisition programs (FDAA, CZMA, and others), Federal insurance, and disaster relief programs; and parallel changes in State programs.

CHAPTER VI

ALTERNATIVE REACH ENGINEERING CONCEPTS AND COSTS

A. INTRODUCTION

This chapter contains a discussion of the engineering alternatives evaluated for each of the 16 shoreline reaches. Five alternative engineering plans are presented for each of the oceanfront reaches (2-14) along with their cost estimates. All estimated costs are stated in present worth terms with a planning period of 50 years and a rate of return of 9 percent.

Reach maps providing schematic representations of each oceanfront reach engineering alternative are provided in Section B of this chapter along with summary tables of cost component and total present worth cost estimates. Consideration of inlet, backbay, tributary waterway shore areas are provided in Sections B.16 and B.17 respectively.

The rationale and assumption for design of the alternative reach engineering designs presented in Section B of this chapter are discussed in Volume 1, Section II.B.1.a and are repeated in the following sections. A summary of the alternative reach plans presented here is also provided in Volume 1, Section II.B.1.c.

1. Rationale and Assumptions for Design

For the reach engineering designs presented in this document, a uniform set of design criteria and assumptions has been applied. The design methodology for engineering protection of the New Jersey shoreline is based on four fundamental assumptions:

- The overall coastal processes of the State should not be altered.
- The "reach" concept should be employed in the application of engineering plans, where appropriate.
- Although the Master Plan engineering alternatives include consideration of storm erosion protection, flood control or protection measures are not addressed explicitly. The controlling measures and long-term effects of flooding and erosion are substantially different.
- Plans should be in accordance with the State's policies for shore protection as set forth in the New Jersey Coastal Management Program (NJDEP/ NOAA, August 1980).

Thus, the erosion control solutions are created such that the overall coastal processes of the State are not significantly altered, since it is assumed that such an alteration would be detrimental.

The New Jersey Coastal Management Program emphasizes nonstructural solutions for shoreline protection. Structural solutions are only acceptable when nonstructural alternatives are incompatible with protection demands. Another important aspect of the State program requires that public and private resort-recreation developments adjacent to the shoreline provide for reasonable public access. Access takes the forms of visual and direct or indirect physical access; indirect physical access includes provision of parking, transportation, and support facilities. All shore-

lines protected with State or Federal funds must be accessible to all shorefront visitors on equal terms.

Although stated shore protection policies are primarily in favor of non-structural engineering techniques, such as beach nourishment, the construction of new shore protection structures, such as jetties, groins, seawalls, and bulkheads, is conditionally acceptable if they meet the following specifications:

- The structure is essential to protect water-dependent facilities or heavily used public recreation beach areas from tidal waters or erosion, or to protect existing structures and infrastructure in developed shorefront areas from erosion.
- The structure is designed to eliminate or mitigate adverse impacts on the local shoreline sand supply.
- The structure will not create adverse shoreline sand movement conditions downdrift, including erosion or shoaling.
- The structure will cause minimum adverse impact to living marine resources.
- The structure is consistent with the State Shore Protection Master Plan conceptual engineering plans.
- If the proposed project requires filling of a water area it must also be consistent with the General Water Area Policy for filling as specified in The New Jersey Coastal Management Program (NJDEP/NOAA, August 1980.

Development of an effective and successful engineering solution for each shoreline reach is dependent on sufficient accurate data that can be used with appropriate civil engineering methodology and coastal process descriptions. Data are required for:

- Wave climate
- Storm surge characteristics
- Beach profile history
- Beach sediment characteristics
- Available sand sources and characteristics of those sands
- Integrity and performance of existing structures
- Historic erosion rates
- Littoral transport rates
- Inlet stability and dynamics
- Storm event erosion rates
- Available construction materials
- Recreational beach demand projections
- Beach access
- Dune location.

Additionally, information is required on availability of hydraulic dredging equipment, construction and material costs, concurrent planning efforts for shore stabilization and inlet modification by various agencies, and potential and practical limitations on the growth of recreational demand. Situations do occur, however, in which adequate data are not available, or are not uniform, in which case, it is necessary to extrapolate or infer data from other existing sources so that the data base is consistent for comparative analyses of reaches.

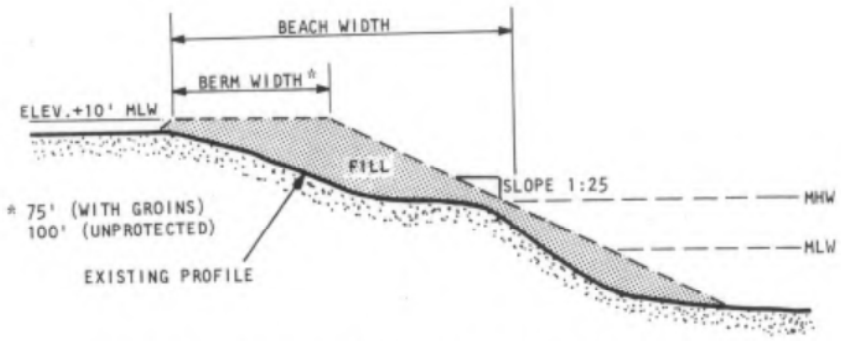
Because data on coastal processes are not precisely defined, previous investigators have developed and presented varying concepts of the actual processes. The estimates of littoral drift are generally based on measurements of fill behind "terminal structures," dredging requirements of inlets, and estimations of erosion rates or volumes. The interpretations of coastal processes for each reach were reviewed, and the most reasonable interpretation in relation to those of other reaches was used in the development of the erosion control solutions for this study.

Specific criteria have been established for this Master Plan to provide the necessary parameters for engineering planning and analysis. These criteria are generally consistent with the planning values used by the Corps of Engineers in its feasibility level studies. In later detailed studies, the design specifications would be subject to change depending on actual physical conditions (e.g., wave climate and beach width) at the site.

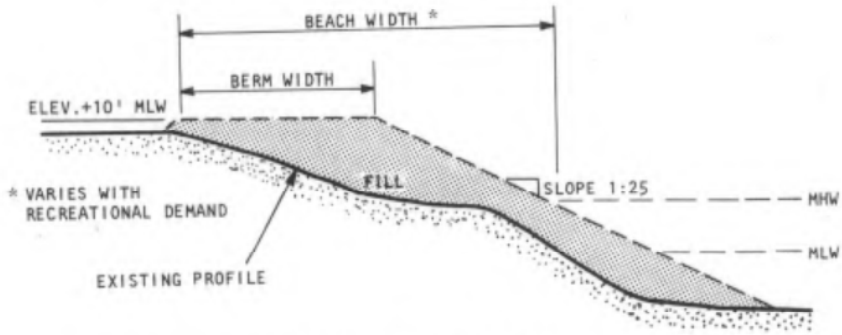
The following design criteria and assumptions were established with regard to the selected alternative engineering plans:

- A 50-year program life is assumed for economic evaluations.
- For storm erosion protection designs, beaches will have a 100-foot berm width on shoreline without groins and a 75-foot berm width on shoreline with functional groins (see Figure VI.A-1).
- Recreational beaches shall be of sufficient surface area to provide a maximum of 100 square feet per person for recreational use. This value, as recommended in the State Comprehensive Outdoor Recreation Plan (SCORP), (NJDEP, 1977), is higher than the 75-square-feet-per-person criterion used by the Corps of Engineers in its design procedures.
- An average beach user turnover rate of 2.0 is assumed in the daily beach capacity estimates. This value is consistent with the Corps' estimating procedure.
- Beach berm and dry beach slope areas are used in the computation of recreational capacity.
- Recreational beach shall only be added to an existing beach where there is public access.
- A nourished storm erosion protection beach shall have a slope paralleling the original beach profile and a berm elevation of 10 feet above Mean Low Water (MLW) (see Figure VI.A-1).
- Where recreational development designs require beach expansions to accommodate demand, final design berm elevations are planned at +10-foot MLW level to maintain a dry berm during normal high tide conditions.
- Dune maintenance and development are provided through a program of sand fence installation and dune grass planting. No newly constructed dune fields are planned for inclusion in beach fill design cross-sections.
- Normal structural maintenance costs are estimated by using a uniform series of annual payments which is equivalent to the cost of replacing a structure at the end of its 50-year economic life. This assumes that the structure is in excellent condition to start with, if not, initial repair (initial maintenance) costs are added to the project.

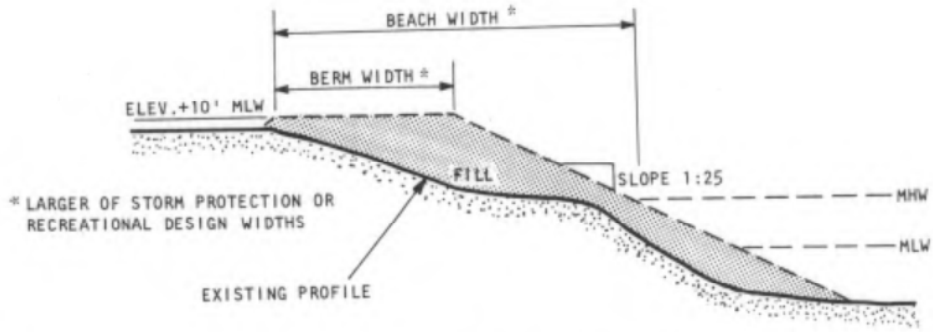
TYPICAL DESIGN BEACH PROFILES



STORM EROSION PROTECTION ALTERNATIVE



RECREATIONAL DEVELOPMENT ALTERNATIVE



COMBINATION ALTERNATIVE

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FIGURE VI.A-1

- Estimates of initial structural maintenance (repair) costs for each reach are taken from a State study entitled Shore Protection Structure, Public Access and Evaluation (NJDEP, Office of Shore Protection, January 1977). Cost estimates provided in that study have been upgraded to 1980 dollars for inclusion in the Master Plan.

In addition to the specific criteria identified above, several assumptions were necessary to substitute for unknown or inadequate data. These assumptions include oceanographic, demographic, economic, and environmental data as summarized below:

- Offshore sand sources identified by the U.S. Army Coastal Engineering Research Center have grain size distributions which are compatible with the native beach sands. Offshore and backbay areas containing reported workable quantities of suitable sands are identified on Table VI.A-1. The location of offshore source areas is shown on Figure VI.A-2.
- A nourishment overfill factor of 1.3, typical of suitable beach fill materials, is used — based on the assumption that adequate quantities of such borrow material are available.
- Coastal processes in each reach will not be significantly altered naturally or by man except as recommended in the Master Plan.
- Well-designed groin fields reduce erosion rates by approximately 25 percent. The effectiveness of existing groin fields may vary from this estimate due to various local factors.
- A rate of return of 9 percent is used in the economic analysis.
- Recreational beach demand data are assumed to be valid as extrapolated to the year 2030, based on SCORP data (NJDEP, 1977) and Corps of Engineers Planning documents, and carrying-capacity estimates for major access routes to reaches.
- Recreational demands can be adequately met by providing a beach capacity based on a mean between the projected average and peak daily beach use estimates.
- Recreational beach demand can be satisfied by incremental increases in capacity at approximately 10-year intervals, resulting in a step function increase in capacity from the existing levels to those projected for the future.
- Dredging contracts can be let with sufficient volumes to attract dredging contractors in a competitive situation. One million cubic yards is assumed to represent a minimum size for an attractive project. Smaller projects in adjacent reaches may be combined to meet this guideline. Minor adjustments in the schedules for renourishment and berm expansion can also be made so that these two beachfill steps are concurrent.
- Adequate dredging equipment will be available to economically obtain sand from offshore sources.

TABLE VI .A-1

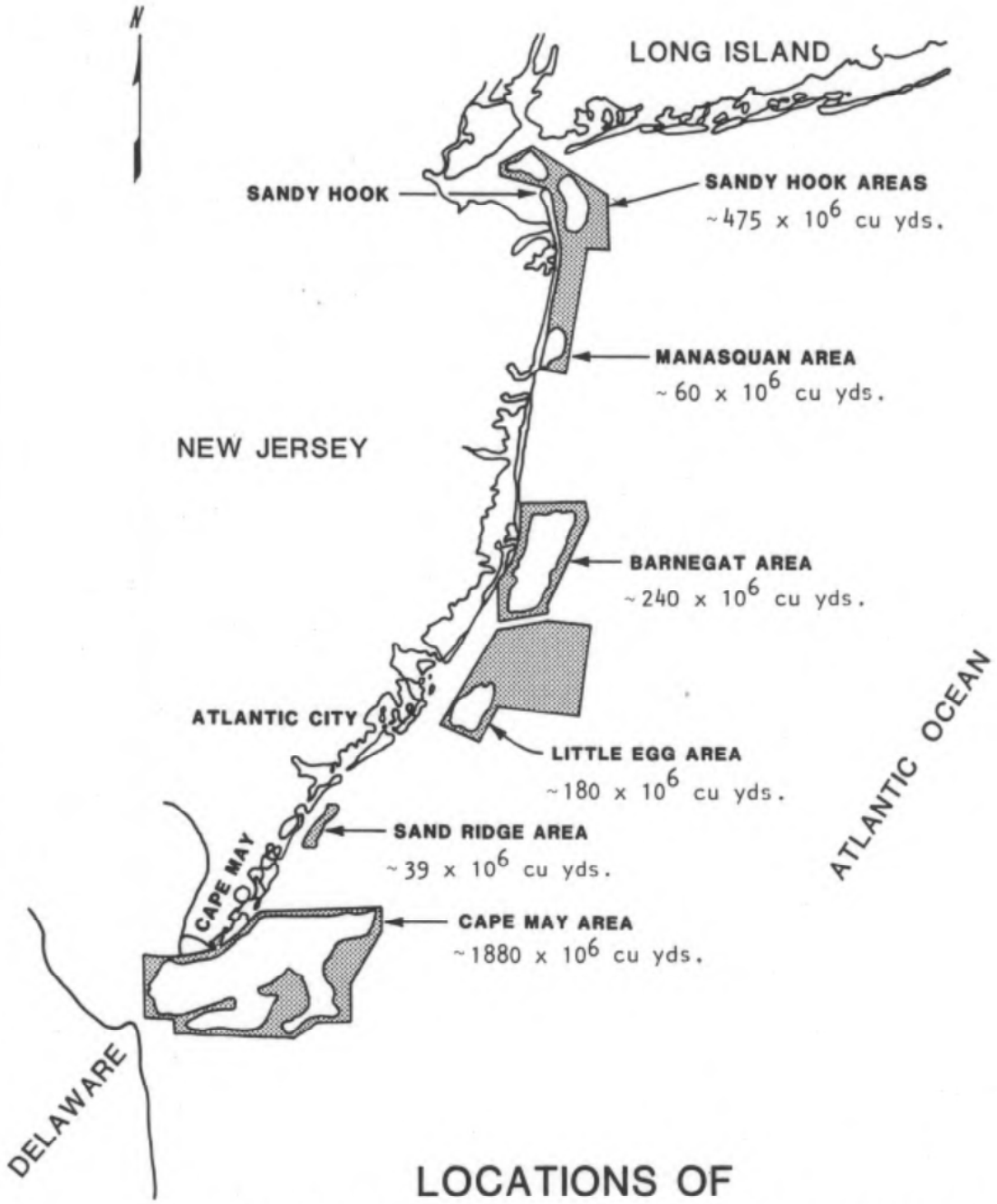
LOCATION OF REPORTED SUITABLE SAND BORROW AREAS

Reach	Reach Name	Offshore*	Backbay**
1	Raritan Bay	Sandy Hook Offshore Area	Lower New York Harbor areas and Shrewsbury Bar near Plum Island, also tip of Sandy Hook
2	Sandy Hook to Long Beach	Sandy Hook Offshore Area	Lower New York Harbor areas and Shrewsbury Bar near Plum Island, also tip of Sandy Hook
3	Long Beach to Shark River Inlet	Sandy Hook Offshore Area	Wreck Pond, Deal Lake, and Stockton Lake bottoms
4	Shark River Inlet to Manasquan Inlet	Sandy Hook and Manasquan Offshore Area	
5 & 6	Manasquan Inlet to Barnegat Inlet	Manasquan and Barnegat Offshore Areas	
7	Long Beach Island	Barnegat and Little Egg Offshore Areas	Numerous backbay areas west of Long Beach Island
8	Brigantine Island	Little Egg Offshore Area	Brigantine Island backbay side
9	Absecon Island	Little Egg Offshore Area	Backbay area west of Longport
10	Peck Beach	Sand ridge areas off Southern Peck Beach	Backbay areas of Great Egg Harbor Bay and Inlet
11	Ludlam Island	Ridge areas off Northern Ludlam Beach	Backbay areas in Ludlam Bay, west of Whale Beach, and Townsend Inlet
12	Seven Mile Beach	Cape May Offshore Area	Backbay areas west of Avalon and Stone Harbor
13	Five Mile Beach	Cape May Offshore Area	
14	Cape May Inlet to Cape May Point	Cape May Offshore Area	Western Cape May Harbor and along south side of Cape May Canal
15 & 16	Delaware Bay and River	Cape May Offshore Area	None identified

*See Figure VI.A-2 for major offshore borrow areas.
**Backbay sand resource areas are not recommended for use in the beach nourishment programs discussed this chapter.

Sources:

Duane (October 1969); National Park Service (1978); USACOE, Philadelphia District (1966, 1970, 1972 and 1974b); USACOE, Philadelphia District (September 1976); NJDEP, Bureau of Coastal Engineering, personal communication, Bernard Moore.



LOCATIONS OF MAJOR OFFSHORE BORROW AREAS

FIGURE VI.A-2

2. Alternative Reach Engineering Plans

Five alternative reach engineering plans have been developed and evaluated for application to the New Jersey ocean shoreline:

- o Storm Erosion Protection
- o Recreational Development
- o Combination Storm Erosion Protection and Recreational Development
- o Limited Shoreline Restoration
- o Maintenance Program.

These alternatives represent a range of engineering objectives for erosion control — from a comprehensive program which maximizes erosion protection and recreational benefits to a minimum program of maintenance of existing structures. In each of the engineering concepts, specific actions are recommended so as to achieve the design objective in a cost-effective and efficient manner. Economic evaluations were performed in the selection of competing technical options.

a. Storm Erosion Protection

This alternative concept has as its objective the protection of property and community infrastructure from probable erosion damage following a major storm. Flood protection design is not provided by this alternative. Beach berms are raised to elevations which provide a dry beach under normal high tide and wave runup conditions. Dunes are not added to provide flooding and overwash protection, but maintenance and continued development of existing dunes are provided through a program of beach grass planting and sand fence installation.

For the purposes of this study, the design storm has been selected from the historical record and has an approximate recurrence interval of 50 years. Stabilization is accomplished through nonstructural techniques (beach fill, dune maintenance, etc.) to the maximum practical extent in accordance with New Jersey Coastal Management Program policies. Structural shore protection plans are only conditionally acceptable under this program; they are appropriate and essential along certain heavily urbanized portions of the New Jersey coast. Structural measures including seawalls, bulkheads, breakwaters, and groins are specified only when nonstructural approaches are infeasible or impractical.

Both structural and nonstructural techniques are applied so as to provide a buffer of sufficient resistance to limit erosion losses of public/private property or infrastructure during a design storm. Generally, exposed beaches with berm widths of 100 feet and groin-protected beaches with berm widths of 75 feet represent suitable means of erosion protection under such conditions. The limited use of seawalls and bulkheads (as infilling) satisfies this protection requirement in areas that are heavily developed.

The storm erosion protection alternative also provides for the maintenance of the erosion buffer. Beach nourishment at periodic intervals is provided to replace erosion losses so that the full protective benefit of the design berm is preserved during the planning period; additionally, the use of beach fill also provides recreational beach benefits. Maintenance of existing functional shore protection structures and modification of those structures that are functionally deficient are also included as considerations in this alternative.

b. Recreational Development

This alternative concept has as its objective the satisfaction of projected recreational demand. The primary means of achieving this goal is through use of beach fill, with a minimum amount of structural stabilization. This approach allows the use of a phased recreational development plan, wherein beach widths are periodically expanded to meet recreational demand. Opportunities are thus provided during the 50-year planning period to adjust the planned beach expansion to meet actual recreational demand. Maintenance of beach widths, through periodic nourishment and maintenance of functional structures, is also provided under this alternative.

Specific locations within reaches for the development of recreational beach areas are chosen with appropriate consideration of convenient public access. Areas with public ownership of beach area and riparian lands and with convenient access to the beach and parking and support facilities are given preference.

For the purposes of planning and estimation, projected recreational demands in terms of beach users per day were developed from SCORP (NJDEP, 1977) and from Corps of Engineers planning documents (USACOE, Philadelphia District, 1966, 1970, 1972, 1974b, 1976b). The SCORP data are presented on a county-by-county basis. Corps data were used to estimate the percentage contribution of each reach to each county's recreation demand. These percentages were then used to transfer the SCORP projections from a county to a reach. Major State or Federal recreational areas (i.e., Gateway National Recreational Area and Island Beach State Park) were considered in the analysis. Only a beach's recreational demand in excess of capacity was apportioned among the remaining beaches in a reach.

The SCORP projections, adjusted to the reach level, were then extrapolated to cover the 50-year planning period. Upper limits on recreational demand were estimated by elevating the carrying capacities of major access routes to each reach.

The carrying capacities of the various major highways linking the shorefront reaches to the mainland were estimated as follows. First, the major highways leading to a beach were identified and characterized (two or four lanes). The carrying capacities of two- and four-lane highways were estimated from level-of-service characteristics (average speed, vehicles per lane, etc., assumed to occur during peak hours on weekend days), assuming peak weekend summer driving conditions. A capacity conversion of peak-hour traffic flow to daily flow was used (American Association of State Highway Officials, 1966). This capacity was estimated in total number of passenger vehicles accommodated per day (average daily traffic on peak days), assuming three people per car under average conditions.

The capacity in vehicles per day times three persons per vehicle then yielded the total number of persons that two- and four-lane highways can accommodate on peak summer weekend days. The capacities were determined to be 66,000 people per peak day on a four-lane highway and 16,500 people per peak day on a two-lane highway; transport by bus was not considered.

The 1980 peak day recreation demand was then compared to the total carrying capacity of all major highways leading into a reach. If the recreational demand was greater than the carrying capacity of the highways (using the optimum assumption that all persons on the road are going to the beach), this difference (in percentage) was assumed to be comprised of persons who had already traveled to the beach by other means or at other times or who were residents of the reach.

The percentage difference between the 1980 peak day recreational demand and the highway carrying capacity was then assumed to remain constant over time. This proportion was kept constant since it was assumed that the composition of day vs. overnight users and the mix of recreational services (entertainment, amusements etc.) within a reach would not significantly change over time. This percentage was then multiplied by the projected peak day recreational demand in the year 2030. To this number (people in 2030 who would get to the beach by other means or during nonpeak days or who were residents) was added the carrying capacity of two- and four-lane highways that would result if 5 percent of the vehicles were assumed to be buses. The assumption of 5 percent bus use (change in modal split) would result in increased highway carrying capacity. It was further assumed that no additional highways to the various reaches (particularly the barrier islands) would be constructed. Thus, changing the modal split (i.e., increasing the use of mass transit) was seen to be the easiest way of increasing accessibility to the various reaches. This sum was assumed to represent the carrying capacity – that is, the maximum number of beach users who would be able to be present on a peak day at any time during the 50-year planning period. This carrying capacity was then compared to the projected peak day demand curve for each reach. It was assumed that peak day recreational demand could not exceed the carrying capacity of the local transportation system, thus establishing the upper bound constraint on recreational development.

Specific plans for the maintenance and expansion of the beach berms were then prepared to satisfy the resulting demand over time. The reach designs for the recreational beach are based on satisfying a beach demand which is the mean of the peak day demand and the average day demand. In this way, all of the average day demand (about two-thirds of the beach season) is fully satisfied. The design also has reserve capacity to absorb most but not all of the peak day demand (about one-third of the beach season). An area provision of 100 square feet per person and a daily turnover rate of two persons per day were used to determine standard beach capacity (NJDEP, 1977). The beach area used in estimation is the dry beach area of the berm and beach shore. Berm elevations are planned at a +10-foot MLW level to maintain a dry berm during normal high tide conditions.

Figure VI.A-3 represents a schematic of design beach capacity for a typical recreational reach plan. Average and peak day demands show increases over time, while the existing beach capacity decreases through loss of sand by erosion. The plan provides for periodic beach width expansion over time. This avoids present day expenditures of funds for beach facilities which may not be fully used for another 30 to 40 years. In the example, an initial beach fill increases the beach area to generally satisfy the design beach demand during the first 10-year period. This beach width is then generally maintained at the same level through periodic nourishment. If required, further increases in beach width would occur at approximately 10-year intervals. The spacing of expansions at such intervals provides sufficient time to monitor the performance of the beach fill and the growth of recreational demand. Opportunities are thus provided to readjust beach expansion plans throughout the planning period. Nourishment schedules and volumes can also be adjusted so that nourishment and expansion operations can be conducted simultaneously. This generally provides a fill volume of adequate size to attract bidding interest.

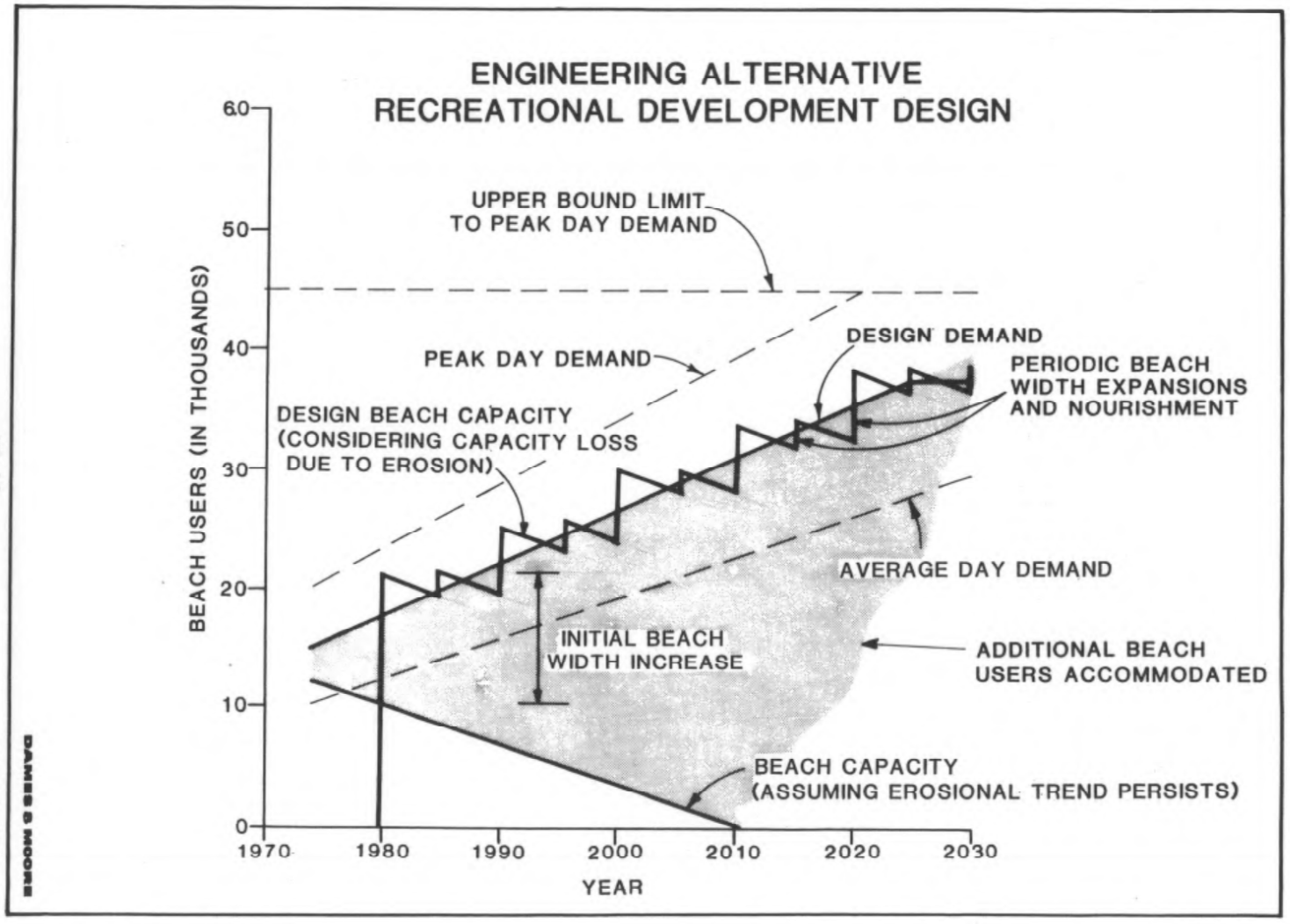

ENGINEERING ALTERNATIVE
RECREATIONAL DEVELOPMENT DESIGN
UPPER BOUND LIMIT
TO PEAK DAY DEMAND
PEAK DAY DEMAND
DESIGN DEMAND
PERIODIC BEACH
WIDTH EXPANSIONS
AND NOURISHMENT
DESIGN BEACH CAPACITY
(CONSIDERING CAPACITY LOSS
DUE TO EROSION)
AVERAGE DAY DEMAND
INITIAL BEACH
WIDTH INCREASE
ADDITIONAL BEACH
USERS ACCOMMODATED
BEACH CAPACITY
(ASSUMING EROSIONAL TREND PERSISTS)
BEACH USERS (IN THOUSANDS)
60
50
40
30
20
10
0
1970
1980
1990
2000
2010
2020
2030
YEAR
DAMES & MOORE

FIGURE VI.A-3

c. Combination Storm Erosion Protection and Recreational Development

This alternative has the objective of providing the full benefits of both storm erosion protection and recreational development, as described above. The design which results in the wider beach at a particular location controls. The design can also change through the planning period. For example, a storm erosion protection plan can be the controlling design during the initial years of a project; as recreation demand grows, the beach may reach a point where the storm beach provides insufficient recreational capacity. Then the design would shift to a recreational design and periodic beach expansions would be provided.

d. Limited Restoration

This alternative is provided to create a level of storm erosion protection or recreation beyond that obtainable from a minimum maintenance program, but less than the full benefits provided by the other alternatives discussed above. The emphasis of the limited restoration alternative is on nonstructural solutions.

In keeping with the reach concept, the objective of the limited restoration program is to stabilize the critically eroding areas of a reach by bringing the rate of erosion to the same level as other areas of the reach. This is primarily accomplished through restoration of the beach width along with periodic maintenance of the beach. Special consideration is given to the protection of public lands and infrastructure.

e. Maintenance Program

This alternative represents a program of structural repair and maintenance. The primary objectives are to prevent existing shore protection structures from losing their functional and structural integrity and to provide nourishment material to compensate for that which is eroded during severe storms. In other words, beach renourishment is applied only as a reactionary effort rather than as preventive maintenance. The structural maintenance is performed on a preventive basis. The cost estimates for this program include the maintenance costs for structures only. No costs are included for post-storm restoration of the beach berm due to the unpredictable magnitude and frequency of storm damage.

B. ALTERNATIVE ENGINEERING PLANS AND COSTS

1. Reach 1 — Raritan Bay

The lack of significant littoral drift in the bayshore system, the regionally varying degree of erosion, and tidal flooding problems along the bayshore suggest a case-by-case approach to shore protection planning rather than the reach plan approach provided for oceanfront beaches. Local needs and the conditions of existing erosion and flood control projects will require consideration of the economic feasibility for individual projects.

Beach fill and maintenance work is required at several areas in this reach. These include Perth Amboy, Old Bridge Township, Aberdeen Township, Union Beach Borough, Keyport Borough, Keansburg Borough, Leonardo, and Belford (Middletown Township. These projects and their estimated costs are listed in Table VI.B-1.

The Old Bridge Township beach is a completed Federal project. Under assurance agreements signed in 1963 between the Army Corps of Engineers and the State, the State accepted maintenance responsibility of this beach. The Old Bridge project in Table VI.B-1 would satisfy this responsibility. The State has similar responsibilities for the Keansburg, Middletown, and Old Bridge beaches.

Projects of a structural nature are also required in areas subject to storm wave damage and tidal flooding. These projects are also identified in Table VI.B-1. A general location map for this reach is provided on Figure VI.B-1.

TABLE VI.B-1

RARITAN BAY – REACH 1
TYPICAL PROJECTS UNDER CONSIDERATION

County/Municipality	Project Description	Estimated Cost (1980 Dollars)
Middlesex		
o Perth Amboy City	Beach fill along 2400 ft. of shore	$ 640,000
	Bulkhead rehabilitation along 2500 ft. of shore	1,500,000
o Old Bridge Township	Beach fill along 9500 ft. of shore	3,840,000
Monmouth		
o Aberdeen Township	Embankment stabilization at site of fossil dig	300,000
	Recreational beach fill along 1000 ft., dunes and grass planting along 2500 ft. and beach fill along 3500 ft. of seawall	1,200,000
o Union Beach	Recreational beach fill along 12,700 ft. of shore, dune and and structure maintenance	2,000,000
o Keyport Borough	Beach fill along 3000 ft. of shore	900,000
	Rehabilitation of 4 groins, 370 ft. of bulkhead and 300 ft. of seawall	560,000
o Middletown Township	Replacement of Comptons Creek bulkhead with a stone seawall	900,000
	Dune restoration between Pews Creek and Comptons Creek	200,000
o Keansburg	Recreational beach fill west of Point Comfort	400,000
	Timber Groins	200,000
o Leonardo & Belford	Beach fill and dune development	1,000,000
o Atlantic Highlands	Maintenance of groins and bulkheads	225,000

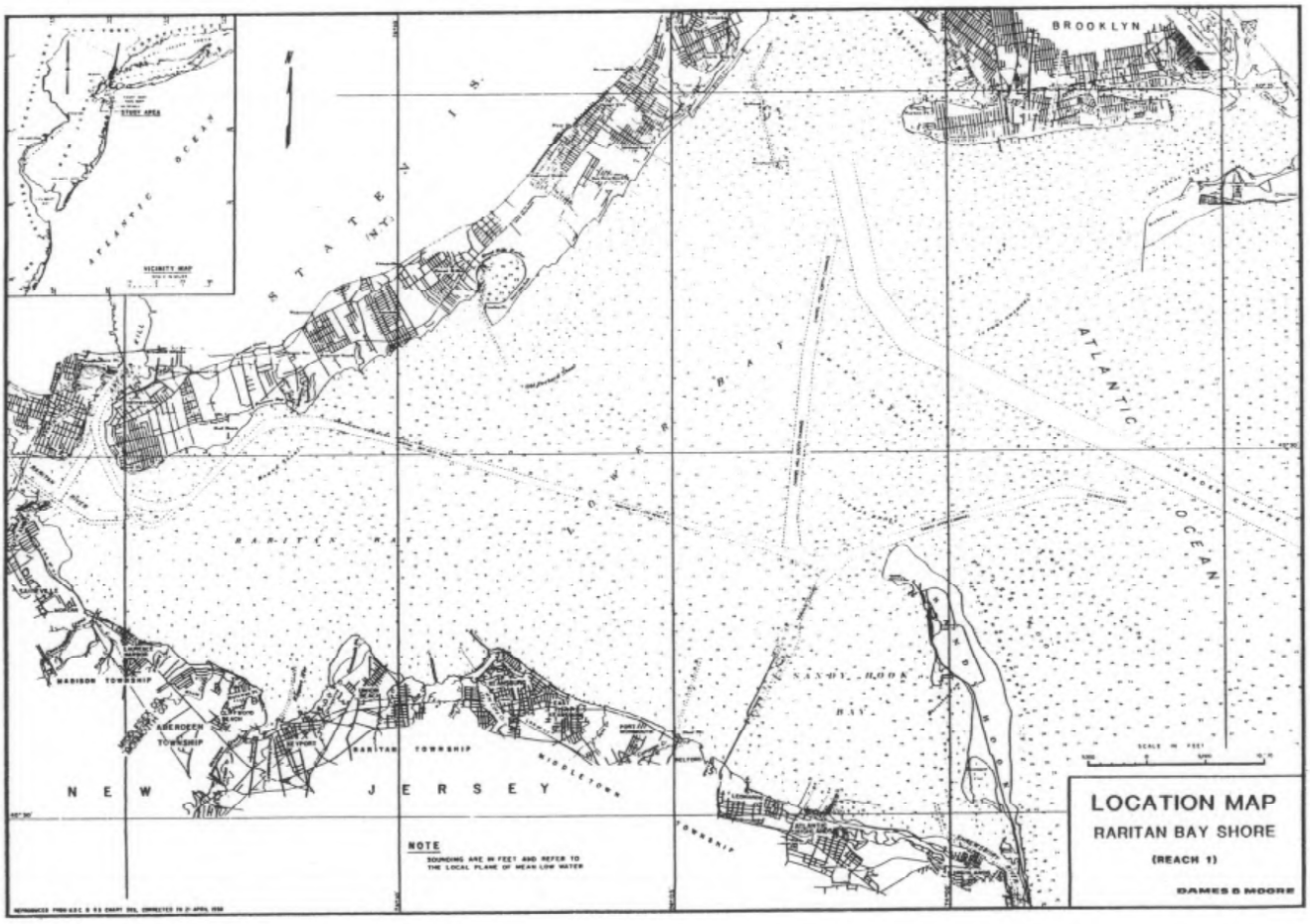

BROOKLYN
STATEN ISLAND
ATLANTIC OCEAN
RARITAN BAY
SANDY HOOK BAY
MADISON TOWNSHIP
ABERDEEN TOWNSHIP
RARITAN TOWNSHIP
MIDDLETOWN TOWNSHIP
N E W J E R S E Y
NOTE
SOUNDING ARE IN FEET AND REFER TO THE LOCAL PLANE OF MEAN LOW WATER
LOCATION MAP
RARITAN BAY SHORE
(REACH 1)
DAMES & MOORE

FIGURE VI.B-1

2. Reach 2—Sandy Hook to Long Branch

Alternative engineering plans proposed for Reach 2 are provided schematically on Figure VI.B-2. Cost component summaries and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-2.

a. Alternative 1 — Storm Erosion Protection

Most of this reach is presently protected by means of a seawall. Limited beach area is trapped seaward of the seawall by groins of many types. The proposed plan for storm erosion protection consists of completing the seawall coverage at the southern end of Monmouth Beach and providing for regular and post-storm maintenance of the seawall and groins.

Beach fill protection was not judged to be practical at the southern terminus of the seawall because of the limited extent of the area requiring protection. The relatively small volumes of sand required for the initial beach fill as well as periodic renourishment would not result in an attractive project for commercial dredgers. Implementation of such a plan could probably be accomplished only by coupling this work with other fill projects at high unit rate costs, if at all. For this reason, structural protection means are proposed rather than fill.

Periodic beach nourishment with materials from offshore sources is proposed at 10-year intervals as the means of maintaining the existing beach width. Maintenance of the existing functional groins, seawalls, and new seawall section is also proposed under this alternative plan.

b. Alternative 2 — Recreational Development

Approximately 25 percent of the oceanfront is owned by public or quasi-public groups which provide beach access to the general public. Most of the accessible oceanfront is located in Sea Bright. This alternative consists of developing the recreational potential of public access areas by establishing beaches, and extending their widths periodically to keep up with demand. The beach would be initially filled to a width of 116 ft. and periodically expanded in uniform increments, at 10-year intervals, to a total beach width of 240 ft. (100 ft. berm width at +10 ft. MLW) by the year 2030.

The primary area to be developed under this alternative is the southern portion of Sea Bright where a beach berm would be established. Two sections of the shoreline in this area, one located north of Rumson Bridge and the other north of Sea Bright/Long Branch Borough line, are presently suffering from lack of beach and have severe local erosion problems. Extension of the downdrift groins, and new groin construction to complete the groin field in a uniform fashion, are proposed for these sections so as to minimize local erosion and to create a beach area for long-term recreational development. Construction of three groins at the northern end of Sea Bright near Highland Bridge would trap some amounts of sand to create a limited recreational beach. The actual locations of the proposed new groins would be determined at the later design phase after detail investigation of the local beach condition are completed.

The estimated demand and design capacities (in beach user days) for this reach are:

	1980	2030
Average Day Demand	26,000	45,200
Peak Day Demand	71,600	124,200
Design Daily Capacity	52,400	88,100

Periodic beach nourishment is proposed as the means of maintaining the beaches at the design or natural widths. Allowances for maintenance of the existing seawalls and groins, and the new groins are also provided.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

For this reach, this alternative is a simple combination of the Storm Erosion Protection and Recreational Development plans described above (see Table VI.B-2 and Figure VI.B-2).

d. Alternative 4 — Limited Restoration

By definition, this alternative emphasizes nonstructural solutions limited to localized areas of critical erosion where public lands, facilities or infrastructure are threatened. No areas within the reach satisfy all these criteria. Therefore, a maintenance program including the maintenance of the existing seawalls and groins, and periodic beach nourishment is proposed.

e. Alternative 5 — Maintenance Program

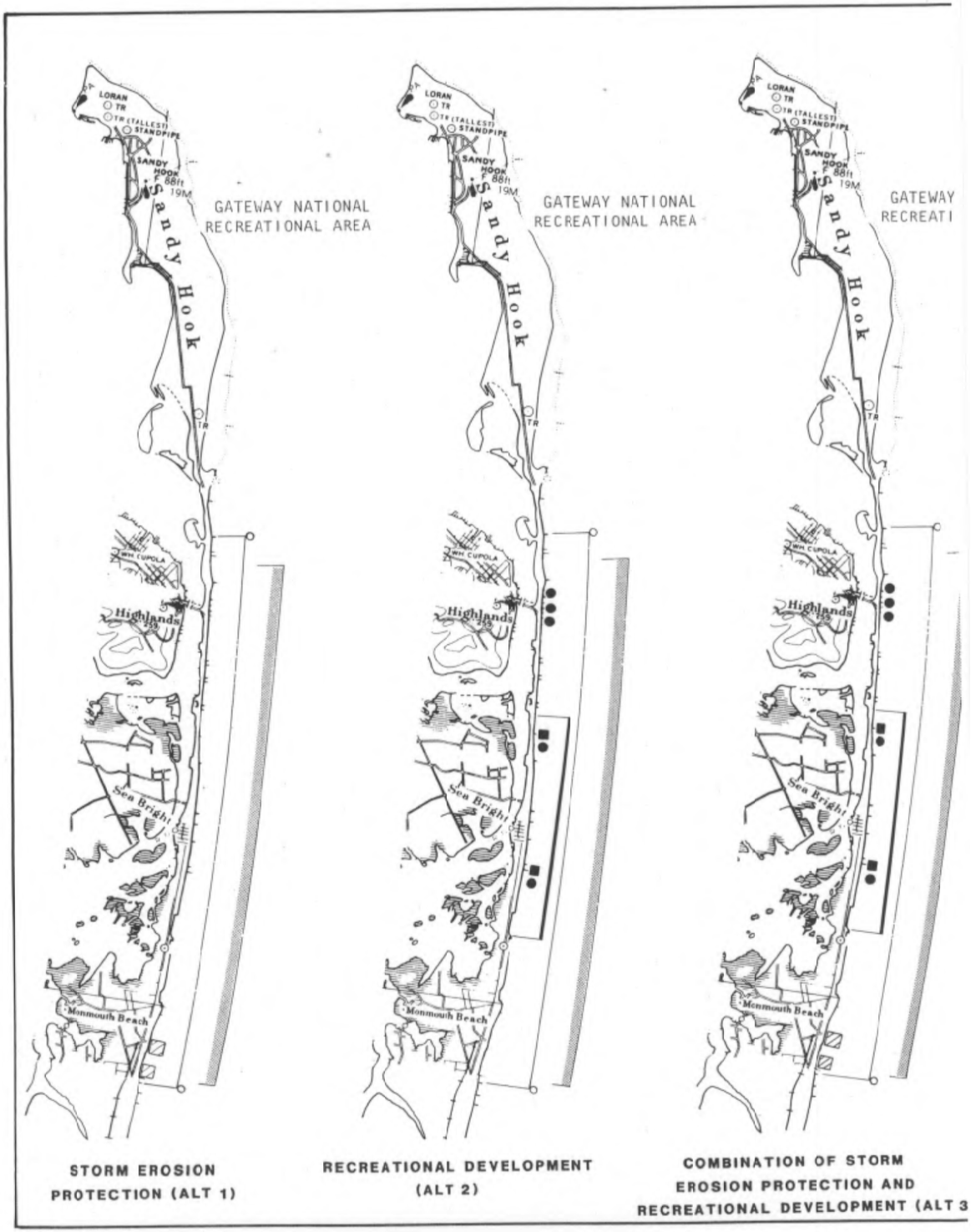
Initial repairs of existing functional structures is proposed to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to approximately 16 groins and 2300 linear feet of seawall.

Periodic maintenance of the existing functional structures, including the seawall and groins, is also recommended throughout the planning period to ensure their integrity. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. The beach berm would be repaired only after the occurrence of significant storm damage.

TABLE VI.B-2

REACH 2 - SANDY HOOK TO LONG BRANCH

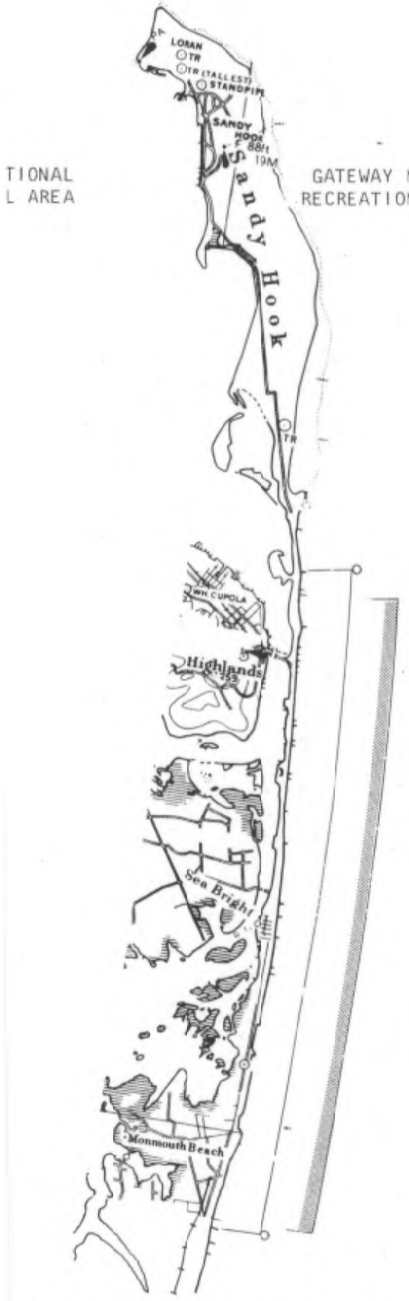
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Structural Improvements		
	o Seawall extension (900 L.F. of new construction)	$ 1,800,000	$ 1,800,000
	Beach Nourishment		
	o 1,105,000 cu. yd. at 10-year intervals		4,096,000
	Initial Structural Repairs (see Alternative 5)	3,709,000	3,709,000
	Maintenance of Structure		
	o Seawall maintenance (25,150 L.F. of new and existing seawall)		698,000
	o 16 existing groins		99,000
	TOTALS	$ 5,509,000	$ 10,402,000
2 Recreational Development	Structural Improvements		
	o Construct 5 new groins	$ 2,315,000	$ 2,315,000
	o Modification of 2 groins	926,000	926,000
	Beach Fill		
	o Initial fill of 1,460,000 cu. yd. for a beach width of 116'	8,962,000	8,962,000
	o Periodic beach expansions (710,000 cu. yd. at 10-year intervals) for a total beach width of 240' (berm width 100' at +10 MLW) by year 2030		3,551,000
	Beach Nourishment		
	o 1,105,000 cu. yd. at 10-year intervals		4,096,00
	Initial Structural Repairs (see Alternative 5)	3,709,000	3,709,000
	Maintenance of Structures		
	o 16 existing groins, 5 new groins		130,000
	TOTALS	$ 15,912,000	$ 23,689,000
3 Combination Storm Erosion Protection and Recreational Development	Structural Improvements		
	o Seawall extension (900 L.F. of new construction)	$ 1,800,000	$ 1,800,000
	o 5 new groins	2,315,000	2,315,000
	o Modification of 2 groins	926,000	926,000
	Beach Fill (see Alternative 2)		
	o Initial in-place fill: 1,460,000 cu. yd.	8,962,000	8,962,000
	o Periodic berm expansion (710,000 cu. yd. at 10-year intervals)		3,551,000
	Beach Nourishment		
	o 1,105,000 cu. yd. at 10-year intervals		4,096,000
	Initial Structural Repair (see Alternative 5)	3,709,000	3,709,000
	Maintenance of Structures		
	o Seawall maintenance (25,150 L.F. of new and existing structures)		698,000
	o 16 existing groins, 5 new groins		130,000
	TOTALS	$ 17,712,000	$ 26,187,000
4 Limited Restoration Program	Beach Nourishment		
	o 1,105,000 cu. yd. at 10-year intervals		$ 4,096,000
	Initial Structural Repairs (see Alternative 5)	$ 3,709,000	3,709,000
	Maintenance of Existing Functional Structures		
	o Seawall maintenance (24,250 L.F.)		674,000
	o Groin maintenance (16 existing groins)		99,000
	TOTALS	$ 3,709,000	$ 8,578,000
5 Maintenance Program	Initial Structural Repairs		
	o Repairs to 16 groins and 2300 L.F. of stone seawall	$ 3,709,000	$ 3,709,000
	Maintenance of Existing Functional Structures		
	o Seawall maintenance (24,250 L.F. existing seawall)		674,000
	o Groin maintenance (16 existing groins)		99,000
	TOTALS	$ 3,709,000	$ 4,482,000



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (ALT 3



TIONAL
L AREA

GATEWAY NATIONAL
RECREATIONAL AREA

N

REACH 2 - SANDY HOOK TO LONG BRANCH

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES
- PERIODIC BEACH NOURISHMENT
- INITIAL FILL TO A BEACH WIDTH OF 116' AND STEP INCREASE IN BEACH WIDTH TO 240' (BERM WIDTH OF 100' AT +10'MLW) BY YEAR 2030
- SEAWALL EXTENSION
- NEW GROINS
- GROIN MODIFICATION

LIMITED RESTORATION PROGRAM
(ALT 4)

DAMES & MOORE

FIGURE VI.B-2

3. Reach 3 — Long Branch to Shark River Inlet

Proposed alternative engineering plans for Reach 3 are summarized schematically on Figure VI.B-3. The costs components and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-3.

a. Alternative 1 — Storm Erosion Protection

The northern portions of this reach are currently protected by intermittent segments of seawall or bulkheading and a more or less continuous groin field. This groin field continues through the southern portions of the reach together with the trapped sand berm, the groin field comprises the existing shoreline protection. Schemes of protection consisting of installation of bulkheading/seawall extension in the north and extending the berm width to 75 ft. in the south, were compared with a uniform use of beach fill throughout the reach. The beach fill option combined with extension of the bulkhead between South Long Branch and Allenhurst proved to be a more economical approach. New groins in Ocean Grove north of the Ocean Grove-Bradley Beach Borough Line (Neptune Township at south borough line), Allenhurst (at Ellen Avenue), and one groin extension in Bradley Beach (at Park Place Avenue) are proposed under this alternative in order to provide more uniformity in length and spacing of the groins in this area. Two groins, one located at northern end of Avon (Sylvan Lake) and the other located south of Deal Lake, should be notched or lowered to allow littoral drift to nourish the downdrift beaches.

This alternative also calls for maintenance of the beach width where required through periodic beach nourishment at 5-year intervals. Maintenance of the new groins and bulkheads as well as the existing groin field, bulkheads and seawalls is also recommended.

b. Alternative 2 — Recreational Development

About 60 percent of the oceanfront of this reach is controlled by public or quasi-public groups which provide beach access to the general public. Because there is no significant problem with transportation access to these areas, the proposed alternative is to develop a recreational beach to meet project recreational demands through the year 2030. The beach demand estimates and design capacity (in beach user days) for this reach are:

	1980	2030
Average Day Demand	65,200	113,200
Peak Day Demand	178,200	309,100
Design Daily Capacity	161,200	220,100

Recreational beach development for this alternative is planned in the northern and southern portions of the reach as shown in Figure VI.B-3. The southern beach development extends from the northern jetty of Shark River Inlet to about 3,600 ft. south of Deal Lake in Deal. The northern recreational beach development area extends from North Long Branch to 2,500 ft. north of Lake Takanasse in Long Branch. Modification of groins at Sylvan Lake and Deal Lake is also proposed for this alternative plan. The new groin construction and extension are not included in this plan because the wide berms would provide adequate protection in these areas.

The initial design capacity is satisfied by the present beach width. Beach nourishment, using material from offshore sources, serves as a means of maintaining the beach design width during the life of the project. Periodic expansion of the beach width, starting in the year 2010, is planned to accommodate the growth in beach demand. The beach would be expanded from the existing width to a total average width of about 270 ft. (128 ft. berm at +10 ft. MLW), in uniform increments at 10-year intervals. This would provide an increase in recreational capacity from the 1980 design capacity of 161,200 beach user days to a daily capacity of 220,100 user days in the year 2030. This alternative provides for maintenance of the existing functional protective structures both within the beach development areas as well as the unimproved areas of Deal and Long Branch.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

This alternative is a combination of the Alternative 1 and Alternative 2 plans for this reach. A beach berm with a minimum width of 75 ft. (beach width 215 ft.) would be provided along the entire length of the reach. The design beaches at the recreational development areas would be expanded to a width of 270 ft. as described in Alternative 2 above. The maintenance component of the plan includes provision for structural and periodic beach fill maintenance.

d. Alternative 4 — Limited Restoration

In this alternative plan, beach fills are proposed in the public access areas to a minimum berm width of 75 ft. (beach width 215 ft.). Beach nourishment is proposed as a means of maintaining the beaches at the new design or natural width. Maintenance of existing functional structures is also recommended. Modification (notching or lowering) of groins at Sylvan Lake and Deal Lake is also included.

e. Alternative 5 — Maintenance Program

Initial repairs to existing functional structures is provided to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to approximately 41 groins, 4000 linear feet of bulkheading, and 450 linear feet of seawall.

Periodic maintenance of the existing functional structures, including 64 groins, and 16,600 linear feet of bulkheads and seawalls, is also provided throughout the planning period to ensure their integrity. Initial and subsequent periodic structural maintenance work is a component of all five of the alternatives for this reach. The beach berm would be repaired only after the occurrence of significant storm damage.

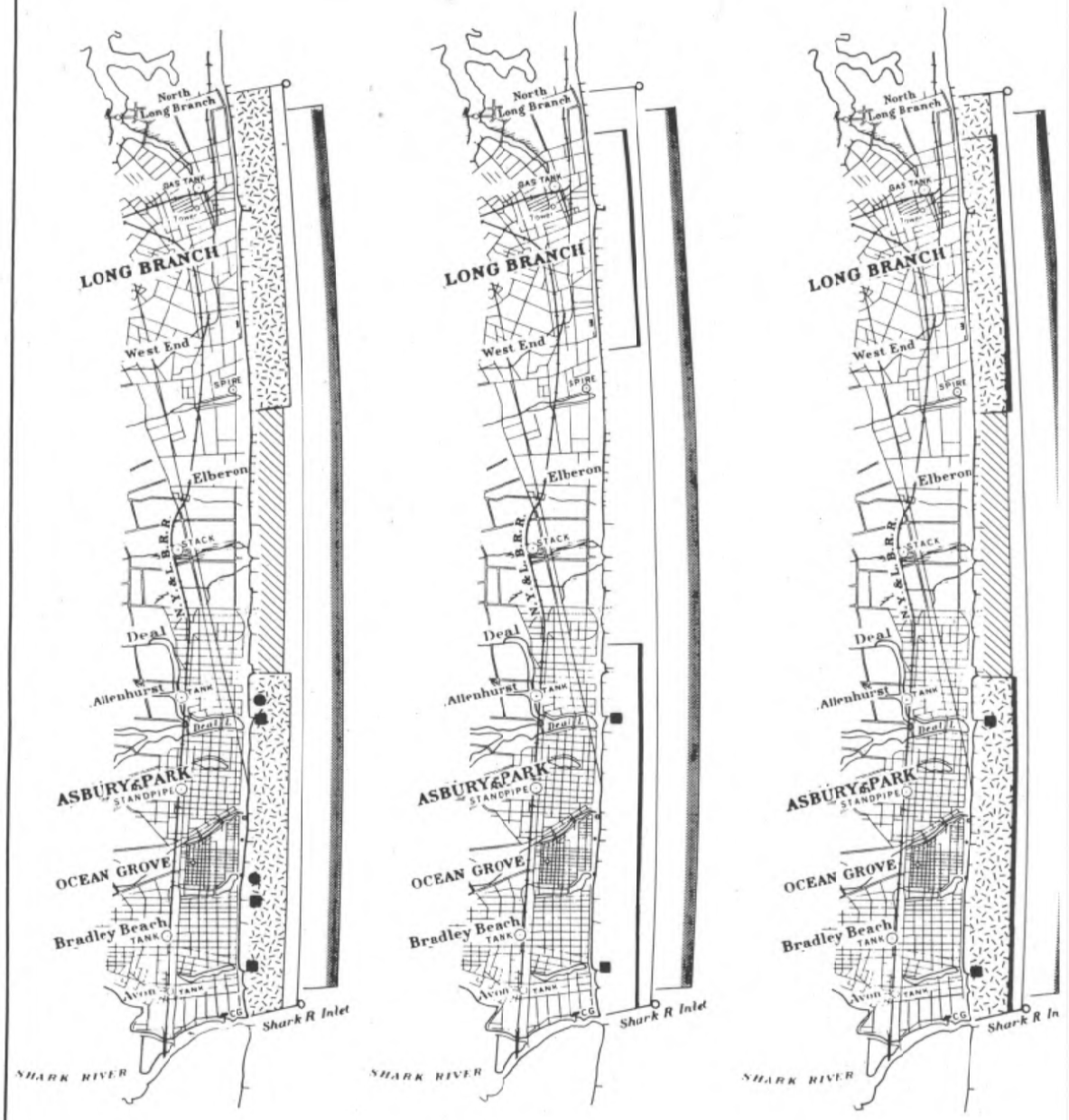
TABLE VI.B-3

REACH 3 - LONG BRANCH TO SHARK RIVER INLET

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o 75' berm at +10' MLW (beach width 215') from Monmouth/Long Branch Borough line to Takanasse Lake (In-place fill: 1,597,000 cu. yd.)	$ 9,700,000	$ 9,700,000
	o 75' berm at +10' MLW (beach width 215') from Allenhurst to southern end of reach (In-place fill: 1,162,000 cu. yd.)	7,360,000	7,360,000
	Beach Nourishment		
	o 845,000 cu. yd. at 5-year intervals		8,430,000
	Structural Improvements		
	o Complete timber bulkheading between South Long Branch and Allenhurst (approximately 6,700 L.F.)	2,680,000	2,680,000
	o Construction of 2 new groins	926,000	926,000
	Structural Modifications		
	o Notching or lowering of 2 groins	100,000	100,000
	o Extension of 1 groin	463,000	463,000
	Initial Structural Repairs (see Alternative 5)	11,170,000	11,170,000
	Maintenance of Structures		
	o 64 existing groins		397,000
	o 2 new groins		12,000
	o New bulkheading (6,700 L.F.)		36,000
	TOTALS	$ 32,399,000	$ 41,272,000
2 Recreational Development	Beach Fill		
	o Periodic beach expansions (1,764,000 cu. yd. starting in 2010 at 10-year intervals) to a total beach width of 270' (berm width 125' at +10' MLW) by year 2030		$ 1,279,000
	Beach Nourishment		
	o 845,000 cu. yd. at 5-year intervals		8,430,000
	Structural Modifications		
	o 2 Groins (notching or lowering)	$ 100,000	100,000
	Initial Structural Repairs (see Alternative 5)	11,170,000	11,170,000
	Maintenance of Existing Functional Structures		
	o 64 existing groins		397,000
	o 5700 L.F. timber bulkheading in Long Branch		76,000
	o 1350 L.F. stone seawall in Deal		36,000
	o 500 L.F. steel bulkhead in Deal		7,000
	TOTALS	$ 11,270,000	$ 21,272,000
3 Combination Storm Erosion Protection and Recreational Development	Beach Fill		
	o Beach fill for storm protection design requirements (see Alternative 1) (Initial in-place fill: 2,759,000 cu. yd.)	$ 17,060,000	$ 17,060,000
	o Periodic beach expansions (1,269,000 cu. yd. from 2020 to 2030 in 10-year intervals)		359,000
	Beach Nourishment		
	o 845,000 cu.yd. at 5-year intervals		8,430,000
	Structural Modifications		
	o Notching or lowering of 2 groins	100,000	100,000
	Structural Improvements		
	o Completion of timber bulkhead between South Long Branch and Allenhurst (approximately 6,700 L.F.)	2,680,00	2,680,000
	Initial Structural Repairs (see Alternative 5)	11,170,000	11,170,000
	Maintenance of Structures		
	o 64 groins		397,000
	o New bulkheading		36,000
	TOTALS	$ 31,010,000	$ 40,238,000

TABLE VI.B-3 (Continued)

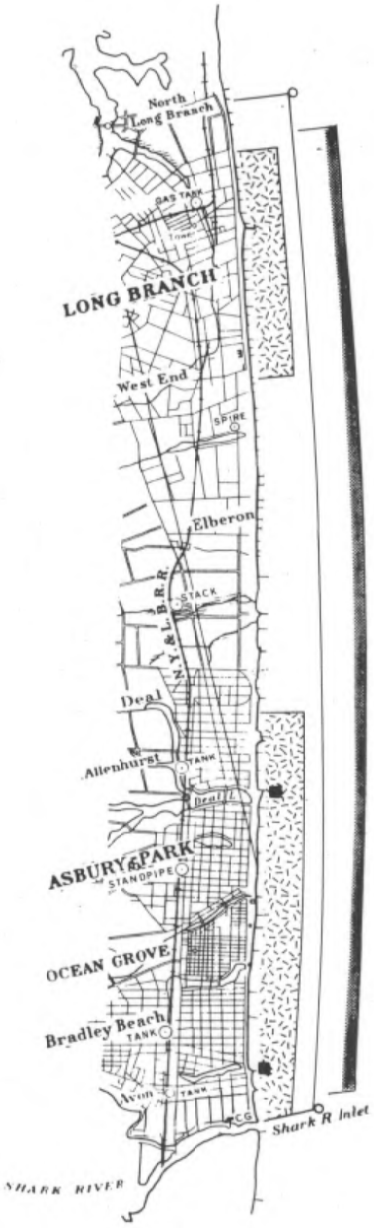
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
4 Limited Restoration Program	Beach Fill		
	o Beach fill in public access areas to 75' berm width (215' beach width) Initial fill of 1,192,000 cu. yd.	$ 8,621,000	$ 8,621,000
	Beach Nourishment		
	o 845,000 cu. yd. at 5-year intervals		8,430,000
	Structural Modifications		
	o Notching or lowering of 2 groins	100,000	100,000
	Initial Structural Repairs (see Alternative 5)	11,170,000	11,170,000
	Maintenance of Existing Structures		
	o Seawalls and bulkheads in Long Branch and Deal		119,000
	o 64 existing groins		397,000
	TOTALS	$ 19,891,000	$ 28,837,000
5 Maintenance Program	Initial Structural Repairs		
	o Repairs to 41 groins, 4000 L.F. of timber bulkhead, and 450 L.F. of seawall	$ 11,170,000	$ 11,170,000
	Maintenance of Existing Functional Structures		
	o Seawalls and bulkheading (16,600 L.F. total)		316,000
	o 64 existing groins		397,000
	TOTALS	$ 11,170,000	$ 11,883,000



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (AL



LIMITED RESTORATION PROGRAM
(ALT 4)

REACH 3 - LONG BRANCH TO SHARK RIVER INLET

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000
3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES
- PERIODIC BEACH NOURISHMENT
- STEP INCREASE IN BEACH WIDTH TO 270'(BERM WIDTH OF 128' AT +10' MLW) BY YEAR 2030
- BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)
- EXTENSION OF TIMBER BULKHEADS
- INITIAL FILL TO STORM PROTECTION DESIGN REQUIREMENTS AND STEP INCREASE IN BEACH WIDTH TO 270' BY YEAR 2030
- NEW GROINS
- GROIN MODIFICATION

DAMES & MOORE

FIGURE VI.B-3

4. Reach 4 — Shark River Inlet to Manasquan Inlet

The alternative engineering plans proposed for Reach 4 are presented schematically on Figure VI.B-4. The cost breakdown and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-4.

a. Alternative 1 — Storm Erosion Protection

A fairly uniform groin field exists throughout this reach. These structures appear to be reasonably effective in holding available sand on the beach. The proposed plan for this alternative provides a minimum berm width of 75 ft. (beach width 215 ft.) throughout the groin field as the principle means of protection. The berm width is maintained by periodic beach nourishment with materials from offshore borrow sources at 5-year intervals. Modifications of three high profile groins located at northern end of Spring Lake (Pitney Avenue), at borough line of Sea Girt and Spring Lake (Brown Avenue), and at northern end of Manasquan (south of Stockton Lake) is also proposed. Notching or lowering of these groins would allow littoral drift to nourish the downdrift beaches. Maintenance of the existing groin field is provided to insure the continued functional performance of these structures.

b. Alternative 2 — Recreational Development

Most of the shorefront of this reach is controlled by public or quasi-public groups which provide for access to the shore for the general public. The area also provides for access convenience through boardwalks and near-shore parking. This alternative provides for maintenance of a recreational beach for the entire reach. Limited by transportation considerations, the design beach capacity is planned to meet projected demands through the year 2000. The beach demand estimates and the design beach capacities (in beach user days) are:

	1980	2000
Average Day Demand	49,200	64,100
Peak Day Demand	139,300	180,400
Design Daily Capacity	131,200	131,200

The present available beach area, if maintained, will meet the projected daily demands throughout the project life as determined by averaging the peak and average day demands. Therefore, no beach expansions are required for this alternative plan. Periodic beach nourishment is proposed to maintain the beach widths where required.

Modification of three groins, as recommended in Storm Erosion Protection Alternative above, is also proposed for this alternative plan. This alternative also provides for the maintenance of the existing functional groin field to insure the continued functional performance of these structures throughout the planning period.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

This alternative combines elements of both the Storm Erosion Protection and Recreational Development alternatives over the life of the project. The initial actions under this plan are from the Storm Erosion Protection alternative above because beach capacity of the storm berm (minimum berm width 75 ft. at +10 ft.

MLW) is greater than the initial design daily recreation capacity. The storm berm controls the design for the remaining years of the project period.

This alternative also includes modification of three existing groins, maintenance of the design beach width through beach nourishment, and continued maintenance of the groin field as for the Storm Erosion Protection and Recreational Development alternatives above.

d. Alternative 4 — Limited Restoration

This alternative is identical to the Storm Erosion Protection Plan (Alternative 1) for this reach. Most of the beach fill for this alternative would be applied to the critically eroding beaches in the southern portion of the reach. Only limited fill would be required to bring the northern beach areas up to a minimum 75 ft. berm width (beach width 215 ft.) design standard. Modification of three existing groins is proposed. Maintenance of the existing groin field as well as restoration of the beach berm after significant storm damage are also recommended.

e. Alternative 5 — Maintenance Program

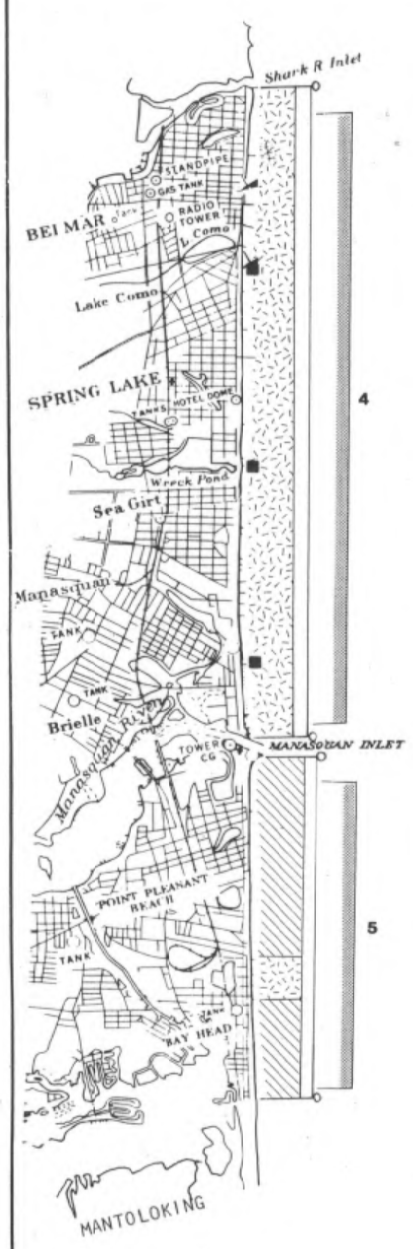
Under this alternative, initial repairs to existing functional structures is proposed to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to approximately 23 groins. Periodic maintenance of the existing functional structures, including the 28 existing groins, is also recommended during the planning period to ensure their integrity. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. The beach berm would be repaired only after the occurrence of significant storm damage.

TABLE VI.B-4

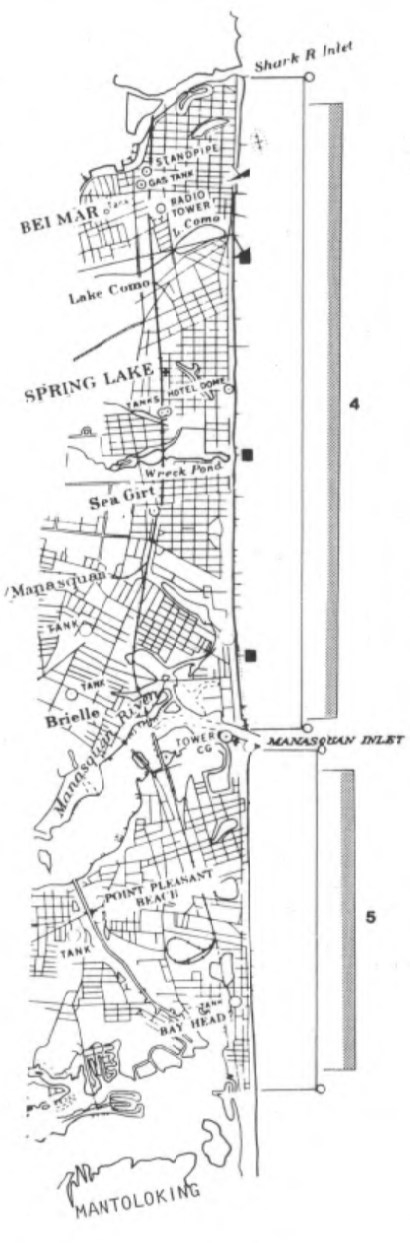
REACH 4 - SHARK RIVER INLET TO MANASQUAN INLET

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (215' beach width) Initial in-place fill: 2,900,000 cu. yd.	$ 16,712,000	$ 16,712,000
	Beach Nourishment		
	o 975,000 cu. yd. at 5-year intervals		9,416,000
	Structural Modifications		
	o 3 Groins (notching or lowering)	150,000	150,000
	Initial Structural Repairs (see Alternative 5)	3,424,000	3,424,000
	Maintenance of Existing Functional Structures		
	o 28 groins		174,000
	TOTALS	$ 20,286,000	$ 29,876,000
2* Recreational Development	Beach Nourishment		
	o 975,000 cu. yd. at 5-year intervals		$ 9,416,000
	Structural Modifications		
	o 3 Groins (notching or lowering)	$ 150,000	150,000
	Initial Structural Repairs (see Alternative 5)	3,424,000	3,424,000
	Maintenance of Existing Functional Structures		
	o 28 groins		174,000
	TOTALS	$ 3,574,000	$ 13,164,000
3 Combination Storm Erosion Protection and Recreational Development	Beach Fill		
	o Beach fill to 75' berm width (215' beach width) (Initial quantity: 2,900,000 cu. yd.)	$ 16,712,000	$ 16,712,000
	Beach Nourishment		
	o 975,000 cu. yd. at 5-year intervals		9,416,000
	Structural Modifications		
	o 3 Groins (notching or lowering)	150,000	150,000
	Initial Structural Repairs (see Alternative 5)	3,424,000	3,424,000
	Maintenance of Existing Functional Structure		
	o 28 groins		174,000
	TOTALS	$ 20,286,000	$ 29,876,000
4 Limited Restoration Program	SAME AS ALTERNATIVE 1 ABOVE	$ 20,286,000	$ 29,876,000
5 Maintenance Program	Initial Structural Repairs		
	o 23 groins	$ 3,424,000	$ 3,424,000
	Maintenance of Existing Functional Structures		
	o 28 groins		174,000
	TOTALS	$ 3,424,000	$ 3,598,000

*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).



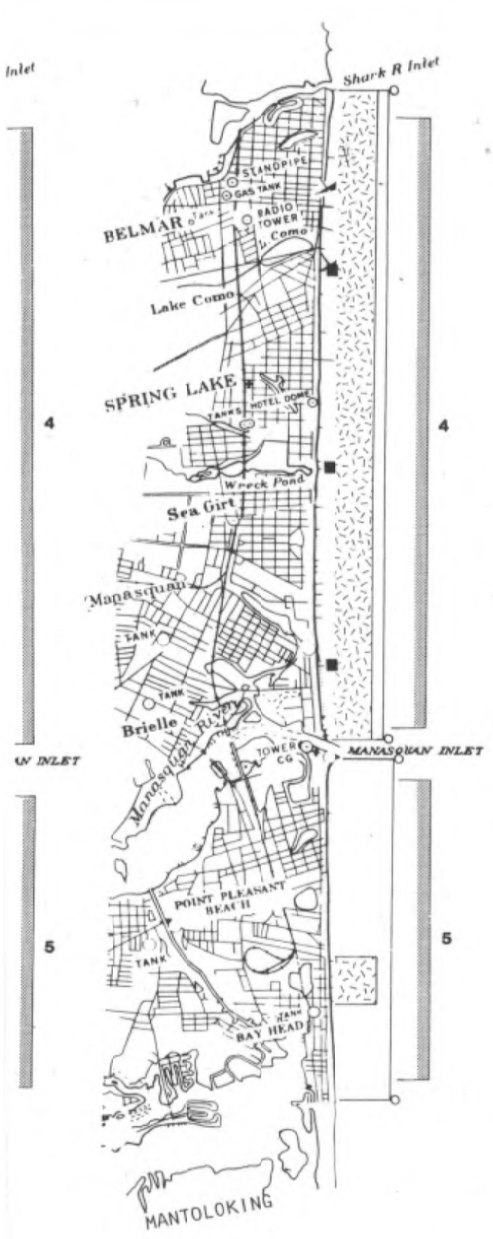
STORM EROSION PROTECTION (ALT 1)



RECREATIONAL DEVELOPMENT (ALT 2)



COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (AL



LIMITED RESTORATION PROGRAM
(ALT 4)

N

REACH 4 – SHARK RIVER INLET TO MANASQUAN INLET

AND

REACH 5 – MANASQUAN INLET TO MANTOLOKING

NAUTICAL MILES
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YARDS
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3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNE MAINTENANCE IN REACH 5
- PERIODIC BEACH NOURISHMENT
- BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (240' BEACH WIDTH)
- GROIN MODIFICATION

DAMES & MOORE

FIGURE VI.B-4

5. Reach 5 — Manasquan Inlet to Mantoloking

Alternative engineering plans for Reach 5 are shown schematically on Figure VI.B-4. The cost components and total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-5.

a. Alternative 1 — Storm Erosion Protection

Limited groin fields exist in Bayhead-Point Pleasant Beach. This alternative plan provides storm erosion protection utilizing beach fill to a berm width of 75 ft. (beach width 215 ft.) in the groin-protected areas and a berm width of 100 ft. (beach width 240 ft.) elsewhere. Periodic beach nourishment is proposed at 10-year intervals for maintaining the beach width, where required, using sand from offshore borrow sources. Maintenance components of this plan provide for upkeep of the existing functional groin field at Bayhead and maintenance of dunes as in Alternative 5 below.

b. Alternative 2 — Recreational Development

The oceanfront of this reach is controlled by public or quasi-public groups which provide beach access to the general public. For this alternative recreational beach maintenance is proposed along the entire reach. Considering transportation limitations, the proposed recreational development alternative would meet the demands through the year 2012. The recreational beach demand estimates and design capacities for this reach (in beach user days) are:

	1980	2012
Average Day Demand	14,200	21,600
Peak Day Demand	45,200	66,700
Design Daily Capacity	84,600	84,600

The present and future design daily capacities for this reach are satisfied by the existing available beach area. Therefore, no beach expansions are proposed for this alternative plan. The projected demands will be satisfied by the existing beach capacity if it is maintained throughout the planning period. Periodic beach nourishment is proposed at 10-year intervals as the means of maintaining the existing beach width throughout the economic life of the program. Maintenance of dunes and the existing functional groins are also provided under this plan.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection alternative is the controlling design for the beach fill under the Combination plan. As under Alternative 1, a minimum berm width of 75 ft. (beach width 215 ft.) is provided in the existing groin field and a berm width of 100 ft. (beach width of 240 ft.) is provided at other locations.

Periodic beach nourishment would serve as the means to maintain the design beach where required. Allowances for the maintenance of dunes and the existing functional groin are also provided under this alternative.

d. Alternative 4 — Limited Restoration

This alternative plan provides an initial beach fill with a minimum berm width of 75 ft. in the vicinity of the functional groin field at Bayhead-Point Pleasant Beach where local erosion rate is relatively high. Beach nourishment is proposed to maintain the design berm width. Maintenance items in this alternative plan include upkeep of the existing groin fields and dune maintenance as in Alternative 5 below.

e. Alternative 5 — Maintenance Program

Initial repairs to existing functional structures is provided to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 2 groins. Periodic maintenance of the existing functional structures, including the 6 existing groins, is also recommended during the planning period to ensure their integrity. Initial and periodic structural maintenance work is a component of all five of the alternatives for this reach.

Placement of 5 acres of dune grass, 400 linear feet of sand fencing, and subsequent replacement of sand fencing at 3-year intervals are also proposed. For this alternative the beach berm would be repaired only after the occurrence of significant storm damage.

TABLE VI.B-5

REACH 5 - MANASQUAN INLET TO MANTOLOKING

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (215' beach width) in groin protected area of Bayhead-Point Pleasant Beach and 100' berm width (240' beach width) elsewhere (Initial in-place fill: 1,305,000 cu. yd.)	$ 8,130,000	$ 8,130,000
	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		3,669,000
	Initial Structural Repairs (see Alternative 5)	490,000	490,000
	Maintenance of Dunes and Existing Functional Structures		
	o 6 groins		37,000
	o Placement of dune grass (5.0 acres) and sand fencing (4,000 L.F.) and replacement of sand fencing at 3-year intervals	38,000	75,000
	TOTALS	$ 8,658,000	$ 12,401,000
2* Recreational Development	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		$ 3,669,000
	Initial Structural Repairs (see Alternative 5)	$ 490,000	490,000
	Maintenance of Dunes and Existing Functional Structures		
	o 6 groins		37,000
	o Dune grass, sand fencing and replacement as in Alternative 1	38,000	75,000
	TOTALS	$ 528,000	$ 4,271,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 8,658,000	$ 12,401,000
4 Limited Restoration Program	Beach Fill		
	o 75' berm width at +10' MLW (beach width 215') in groin protected areas of Bayhead-Point Pleasant Beach (Initial in-place fill: 368,100 cu. yd.)	$ 3,086,000	$ 3,086,000
	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		3,669,000
	Initial Structural Repairs (see Alternative 5)	490,000	490,000
	Maintenance of Dunes and Existing Functional Structures		
	o 6 groins		37,000
	o Dune grass, sand fencing and replacement as in Alternative 1	38,000	75,000
	TOTALS	$ 3,614,000	$ 7,357,00
5 Maintenance Program	Initial Structural Repairs		
	o 2 groins	$ 490,000	$ 490,000
	Maintenance of Dunes and Existing Functional Structures		
	o 6 groins		37,000
	o Dune grass, sand fencing and replacement as in Alternative 1	38,000	75,000
	TOTALS	$ 528,000	$ 602,000 *

*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).

6. Reach 6 — Mantoloking to Barnegat Inlet

Alternative engineering plans for Reach 6 are shown schematically on Figure VI.B-5 and VI.B-6. The cost components and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-6. No engineering plans are proposed for Island Beach State Park at the southern end of this reach.

a. Alternative 1 — Storm Erosion Protection

Limited functional groin fields exist at Lavallette. This alternative plan provides storm erosion protection utilizing beach fill to a 75 ft. minimum berm width (beach width 215 ft.) in the groin-protected areas and 100 ft. minimum berm width (beach width 240 ft.) elsewhere. The beach fill plan covers only the developed portion of the beach. Island Beach State Park occupying the southern portion of the reach, would be maintained in a natural state. The nodal zone for sediment transport on the New Jersey coast is located in the general vicinity of Mantoloking.

Periodic beach nourishment is proposed at 7-year intervals for maintaining the design beach widths. Maintenance components of this plan provide for upkeep of the existing functional groin field at Lavallette, and dune grass and sand fence placement as discussed in Alternative 5 below.

b. Alternative 2 — Recreational Development

About 80 percent of the ocean front of this reach is controlled by public or quasi-public interests which provide beach access to the general public. Limited by transportation considerations, the recreational beach maintenance is proposed to meet demands through the year 2013. The recreational beach demand estimates and design capacities for this reach (in beach user days) are:

	1980	2013
Average Day Demand	42,600	65,500
Peak Day Demand	135,300	198,800
Design Daily Capacity	282,500	282,500

The present and future daily demands are satisfied by the existing available beach area if it is maintained throughout the planning period. Therefore, no beach expansions are proposed for this alternative plan. Periodic beach nourishment at 7-year intervals would serve as the means of maintaining the natural beach width.

Allowances for the maintenance of dunes and the existing groin fields is also proposed under this alternative.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection alternative would be the controlling design for the initial beach fill under the combination alternative. A minimum berm width of 75 ft. (beach width 215 ft.) would be provided in the groin-protected areas, and a 100 ft. berm (beach width 240 ft.) would be provided elsewhere.

Periodic beach nourishment at 7-year intervals would serve as the means to maintain the design beach width. Maintenance of dunes and the existing functional groin fields is also proposed.

d. Alternative 4 — Limited Restoration

This alternative provides an initial beach fill with a berm width of 75 ft. (beach width 215 ft.) in the vicinity of the groin-protected areas of Lavallette. Beach nourishment is proposed at 7-year intervals to maintain the design beach width (except Island Beach State Park). Structural maintenance items include upkeep of the existing groin field and dunes as proposed in Alternative 5 below.

e. Alternative 5 — Maintenance Program

Under this alternative initial repair of existing functional structures is provided to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 2 groins at Lavallette. Periodic maintenance of the existing functional structures, including the 9 groins at Lavallette, is provided to ensure their integrity throughout the planning period. The initial and periodic maintenance work is a component of all five of the alternatives for this reach.

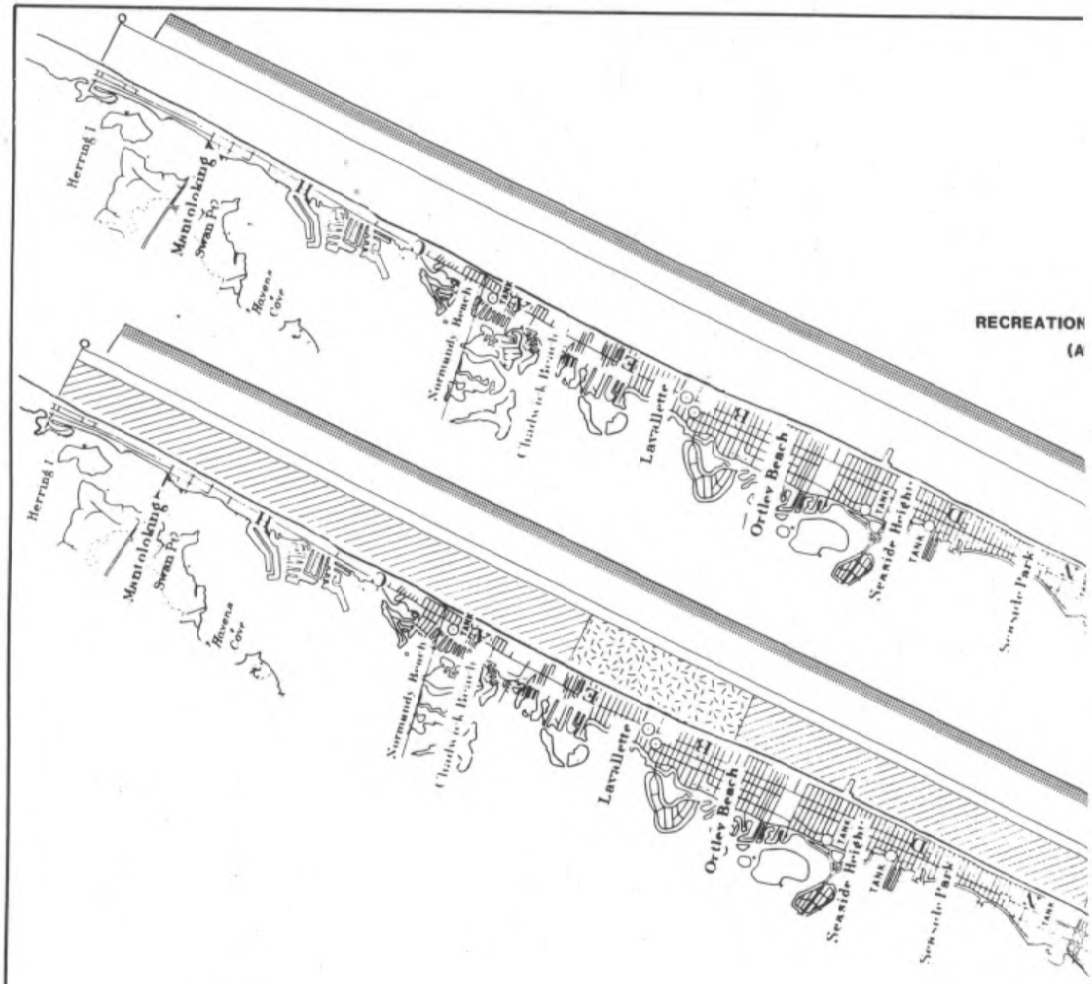
For dune maintenance, placement of about 20 acres of dune grass and 19,600 linear feet of sand fencing, and subsequent replacement of sand fencing at 3-year intervals is proposed. The beach berm is to be repaired only after the occurrence of significant storm damage.

TABLE VI.B-6

REACH 6 - MANTOLOKING TO BARNEGAT INLET

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (215' beach width) in groin protected area of Lavallette and 100' berm width at +10' MLW (240' beach width) elsewhere (Initial in-place fill: 2,374,000 cu. yd.)	$ 13,880,000	$ 13,880,000
	Beach Nourishment		6,926,000
	o 1,138,000 cu. yd. at 7-year intervals		
	Initial Structural Repairs (see Alternative 5)	549,000	549,000
	Maintenance of Dunes and Existing Structures		56,000
	o Lavallette – 9 groins o Placement of dune grass (20 acres) and sand fencing (19,600 L.F.) and replacement of sand fencing at 3-year intervals	159,000	339,000
	TOTALS	$ 14,588,000	$ 21,750,000
2* Recreational Development	Beach Nourishment		$ 6,926,000
	o 1,138,000 cu. yd. at 7-year intervals		
	Initial Structural Repairs (see Alternative 5)	$ 549,000	549,000
	Maintenance of Dunes and Existing Functional Structures		56,000
	o Lavallette – 9 groins o Dune grass, sand fencing and replacement as in Alternative 1	159,000	339,000
	TOTALS	$ 708,000	$ 7,870,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 14,588,000	$ 21,750,000
4 Limited Restoration Program	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (215' beach width) in groin protected areas of Lavallette (Initial in-place fill: 697,000 cu. yd.)	$ 4,855,000	$ 4,855,000
	Beach Nourishment		6,926,000
	o 1,138,000 cu. yd. at 7-year intervals		
	Initial Structural Repairs (see Alternative 5)	549,000	549,000
	Maintenance of Dunes and Existing Functional Structures		56,000
	o Lavallette – 9 groins o Dune grass, sand fencing and replacment as in Alternative 1	159,000	339,000
	TOTALS	$ 5,563,000	$ 12,725,000
5 Maintenance Program	Initial Structural Repairs		
	o 2 groins at Lavallette	$ 549,000	$ 549,000
	Maintenance of Dunes and Existing Functional Structures		56,000
	o Lavallette – 9 groins o Dune grass, sand fencing and replacement as in Alternative 1	159,000	339,000
	TOTALS	$ 708,000	$ 944,000

*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).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Manolokung
Swan Pt.
Havens Cove
Normandy Beach
Lavallette
Ortley Beach
Seaside Heights
Seaside Park
RECREATION
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KEY:
MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNES
PERIODIC BEACH NOURISHMENT
BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)
BEACH FILL TO 100' BERM WIDTH (240' BEACH WIDTH)
NO ACTION PROPOSED FOR ISLAND BEACH STATE PARK

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EROSION
ON (ALT 1)

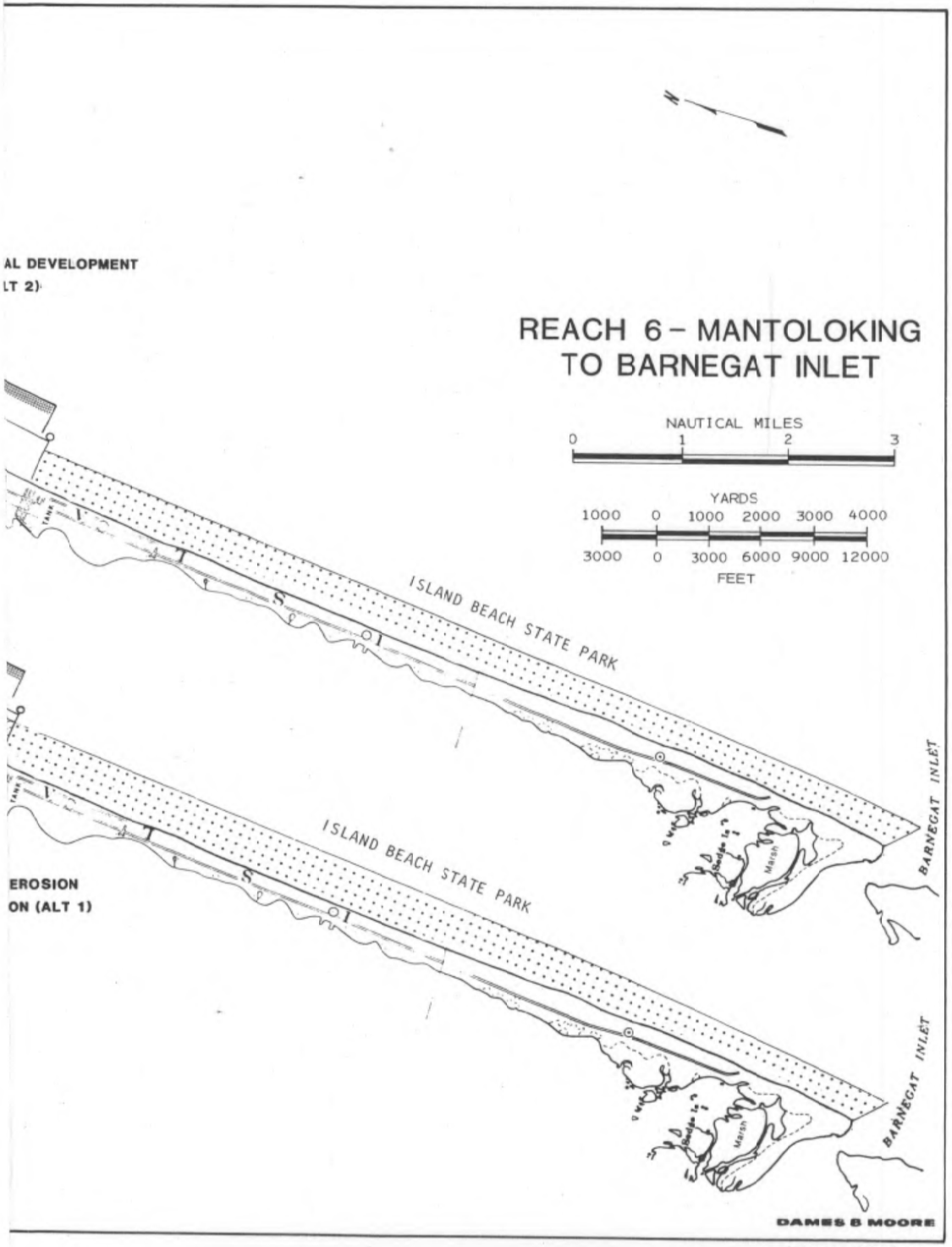
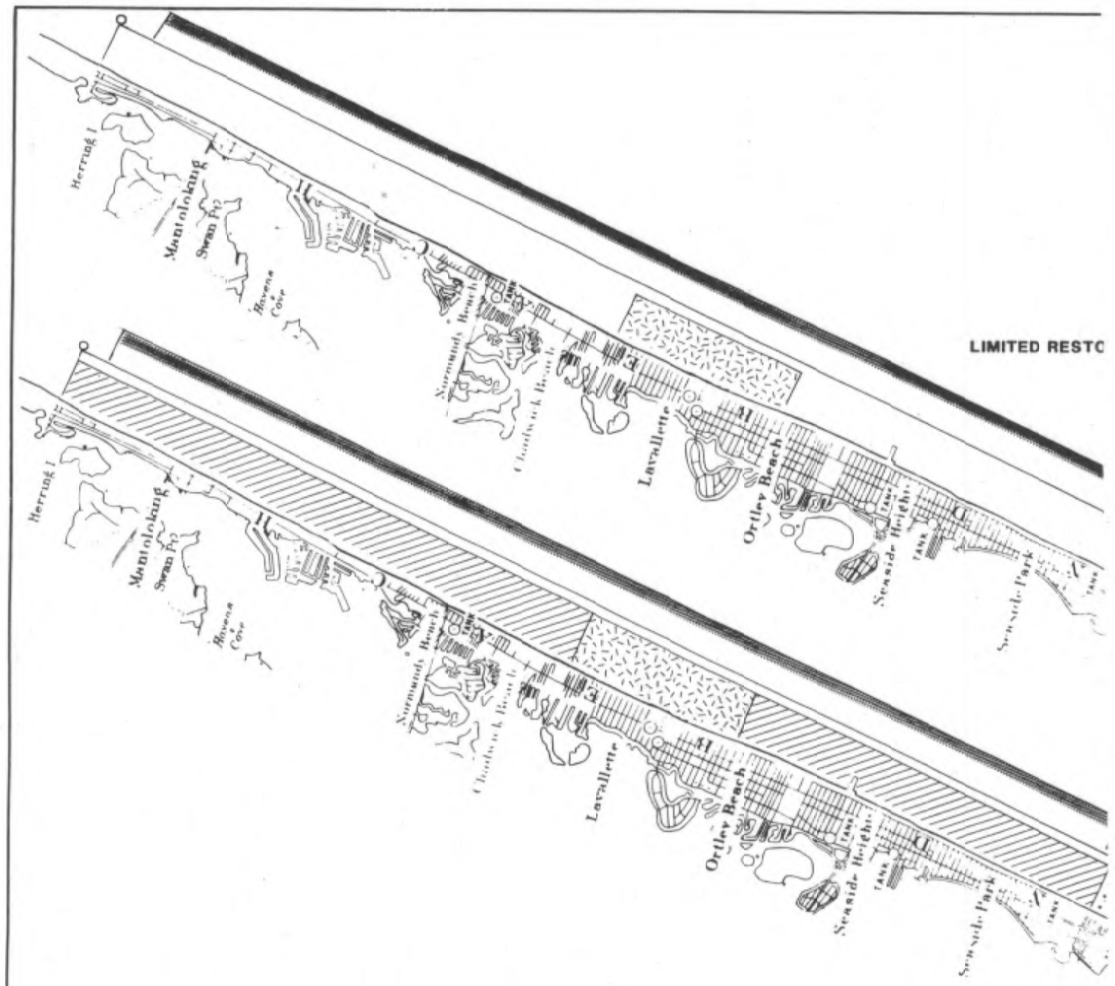


FIGURE VI.B-5



KEY:

MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNES

PERIODIC BEACH NOURISHMENT

BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)

BEACH FILL TO 100' BERM WIDTH (240' BEACH WIDTH)

NO ACTION PROPOSED FOR ISLAND BEACH STATE PARK

COMBINATION
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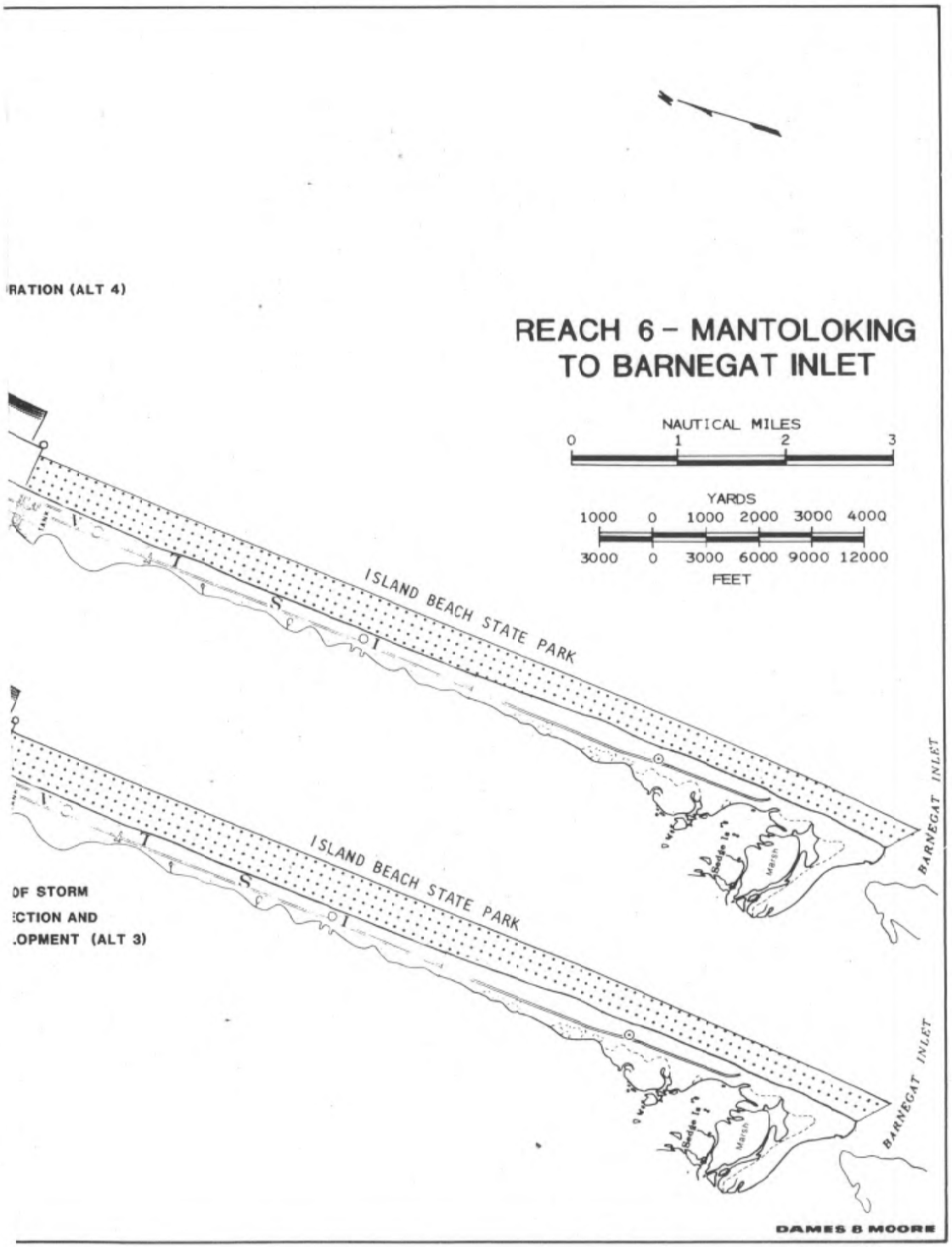


FIGURE VI.8-6

7. Reach 7 — Barnegat Inlet to Little Egg Inlet (Long Beach Island)

The alternative engineering plans for the ocean beach along Reach 7 are provided schematically on Figure VI.B-7 and VI.B-8. Cost components and the total estimated present worth cost for each of the five alternatives discussed below are provided in Table VI.B-7. No action is proposed for Brigantine National Wildlife Refuge at the southern end of the reach.

a. Alternative 1 — Storm Erosion Protection

A groin field exists along most of the ocean shoreline of this reach. The only exceptions to this are the accreting area south of the jetty at Barnegat Light and the undeveloped Holgate unit of Brigantine National Wildlife Refuge at the southern tip of Long Beach Island. This alternative plan provides a 75 ft. minimum berm width (beach width 215 ft.) throughout the groin field area.

A problem area exists immediately downdrift of the terminal groin at Holgate. Sand trapping by this groin has resulted in localized erosion on the undeveloped Federal properties to the south. Since this area has previously experienced inlet breaching, continued erosion in that area could again result in the formation of an inlet there. The exact location of an inlet breach, should one occur, cannot be predicted at this time. No direct action is proposed in the Master Plan to deal with this erosion situation because it occurs on undeveloped lands.

Periodic beach nourishment is proposed at 8-year intervals as the means of maintaining the design beach berm width where required. Sand from offshore borrow sources would be used to nourish the beach. Proposed structural maintenance includes initial and periodic repair work on the existing groin field. Dune maintenance in the form of sand fence installation (about 97,900 L.F.) and dune grass planting (about 220 acres) is also proposed.

b. Alternative 2 — Recreational Development

Almost all of Long Beach Island shoreline is ungranted. Public access and convenience features are also dispersed over the island so that no portion of the island is favored over another for purposes of recreational development. This alternative plan provides for recreational beach maintenance along the entire developed length of the island (Holgate unit of Brigantine Wildlife Refuge not included). Considering carrying capacity limitations for this island, periodic beach maintenance is required to satisfy the estimated demands through the year 2025. The present and future demands are satisfied by the existing available beach area, which can accommodate the design daily capacity if maintained. The existing beach width, if maintained, would satisfy the projected recreational demand for the 50-year planning period. The beach demand estimates and design capacities (in beach user days) for this reach are:

	1980	2025
Average Day Demand	108,900	177,900
Peak Day Demand	260,300	425,400
Design Daily Capacity	364,200	364,200

Periodic beach nourishment is proposed as the means of maintaining the existing beach width.

Structural maintenance items under this alternative include initial and periodic repair work on the existing groin field. As in Alternative 1, dune maintenance in the form of sand fence installation and dune grass planting is also included.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

This alternative plan provides an initial beach berm to satisfy the storm erosion protection design of a 75 ft. minimum berm width in groin protected areas. This existing beach width satisfies the projected recreational demand for the entire 50-year planning period. Therefore, no beach expansion other than the initial beach development is proposed. The design plan applies for the entire developed length of the island (Holgate unit of Brigantine National Wildlife Refuge not included). Beach nourishment is proposed as the means of maintaining the design beach width.

Structural maintenance, including initial and subsequent periodic repair work on the existing groin field, is also proposed. Also, dune maintenance, in the form of sand fence installation and dune grass planting, as proposed in Alternative 1, is included in this alternative.

d. Alternative 4 —Limited Restoration

This alternative plan provides storm erosion protection for the Holgate section of Long Beach Township at the southern developed portion of the island. This critically eroding area would be restored to a minimum berm width of 75 ft. (beach width 215 ft.). The beach would be tapered in width to meet the existing berm at the Beach Haven Borough line. Beach nourishment is proposed as the means of maintaining the restored and existing beach widths.

Structural maintenance under this alternative includes initial and subsequent periodic repair work on the entire groin field. Dune maintenance in the form of sand fence installation and dune grass planting, as proposed in Alternative 1, is also included in this alternative.

e. Alternative 5 — Maintenance Program

Initial repair of existing functional structures is proposed to bring them up to a uniform level of integrity throughout the reach. This work includes repairs to approximately 15 groins. Periodic maintenance of the existing functional structures, including 98 existing groins, is also proposed to ensure their integrity throughout the planning period. The initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. Repair of the beach berm is proposed only after the occurrence of major storm damage.

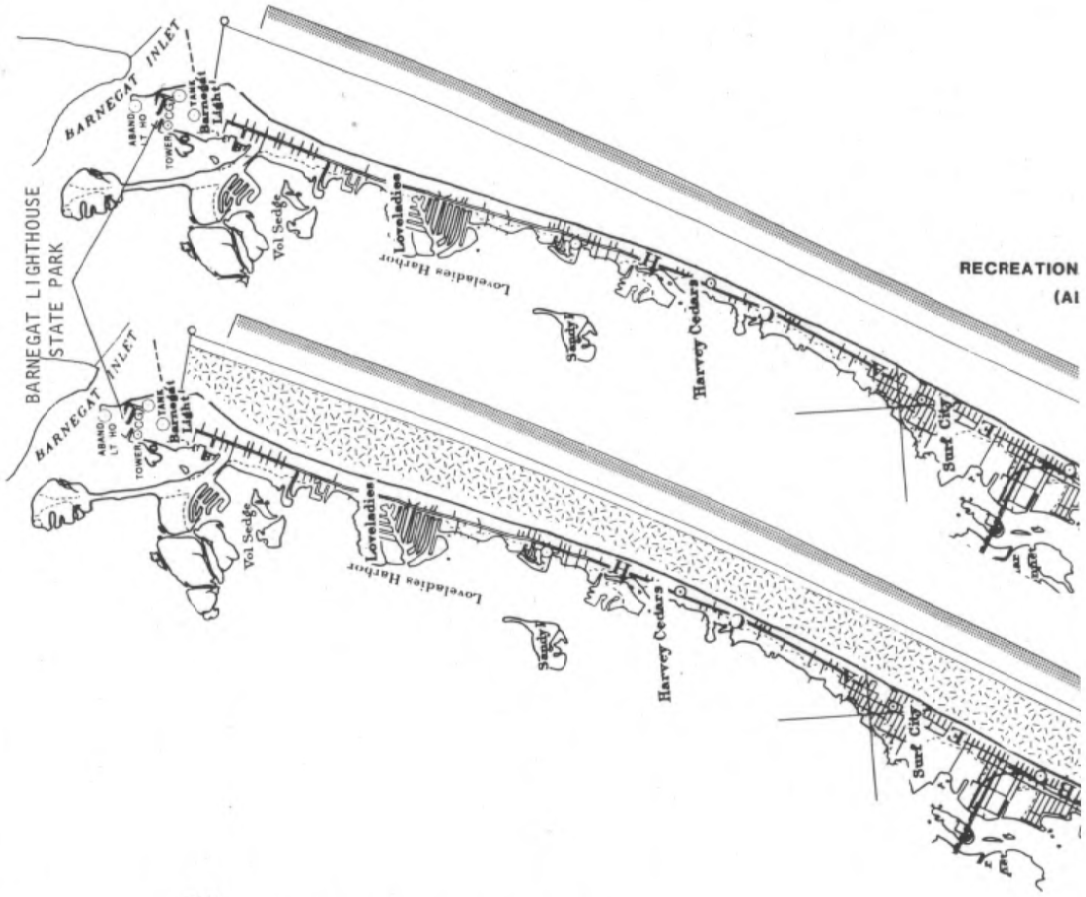
Dune maintenance in the form of sand fence installation and dune grass planting, as proposed in Alternative 1, is also provided under this alternative.

TABLE VI.B-7

REACH 7 - LONG BEACH ISLAND
(BARNEGAT INLET TO LITTLE EGG INLET)

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (215' beach width) along the entire reach (Initial in-place fill: 2,986,000 cu. yd.)	$ 17,175,000	$ 17,175,000
	Beach Nourishment		
	o 1,019,000 cu. yd. at 8-year intervals		6,172,000
	Initial Structural Repairs (see Alternative 5)	2,214,000	2,214,000
	Maintenance of Dunes and Existing Functional Structures		
	o 98 existing groins		608,000
	o Placement of about 220 acres of dune grass, 27,900 L.F. of sand fence and replacement of fence at 3-year intervals	1,424,000	2,327,000
	TOTALS	$ 20,813,000	$ 28,496,000
2* Recreational Development	Beach Nourishment		
	o 1,019,000 cu. yd. at 8-year intervals		$ 6,172,000
	Initial Structural Repairs (see Alternative 5)	$ 2,214,000	2,214,000
	Maintenance of Dunes and Existing Functional Structures		
	o 98 existing groins		608,000
	o Dune grass, sand fencing, and replacement as in Alternative 1	1,424,000	2,327,000
	TOTALS	$ 3,638,000	$ 11,321,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 20,813,000	$ 28,496,000
4 Limited Restoration Program	Beach Fill		
	o Beach fill to 75' berm with at 10+ MLW (215' beach width) in Long Beach Township (Holgate) (Initial in-place fill: 321,000 cu. yd.)	$ 2,832,000	$ 2,832,000
	Beach Nourishment		
	o 1,019,000 cu. yd. at 8-year intervals		6,172,000
	Initial Structural Repairs (see Alternative 5)	2,214,000	2,214,000
	Maintenance of Dunes and Existing Functional Structures		
	o 98 existing groins		608,000
	o Dune grass and sand fencing as in Alternative 1	1,424,000	2,327,000
	TOTALS	$ 6,470,000	$ 14,153,000
5 Maintenance Program	Initial Structural Repairs		
	o 15 groins	$ 2,214,000	$ 2,214,000
	Maintenance of Dunes and Existing Functional Structures		
	o 98 existing groins		608,000
	o Dune grass and sand fencing as in Alternative 1	1,424,000	2,327,000
	TOTALS	$ 3,638,000	$ 5,149,000

*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).



KEY:

MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES AND DUNES

PERIODIC BEACH NOURISHMENT

BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)

STORM
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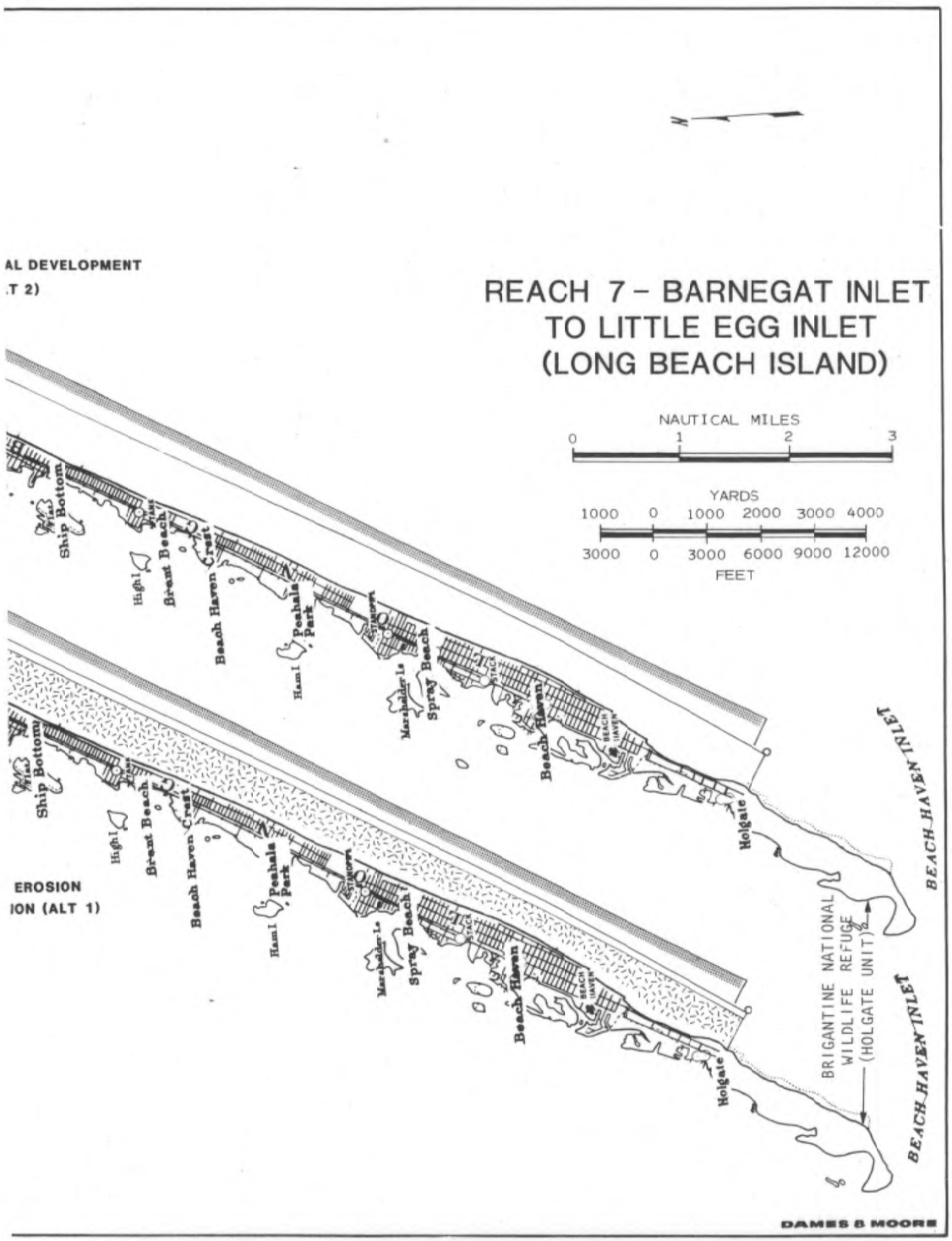
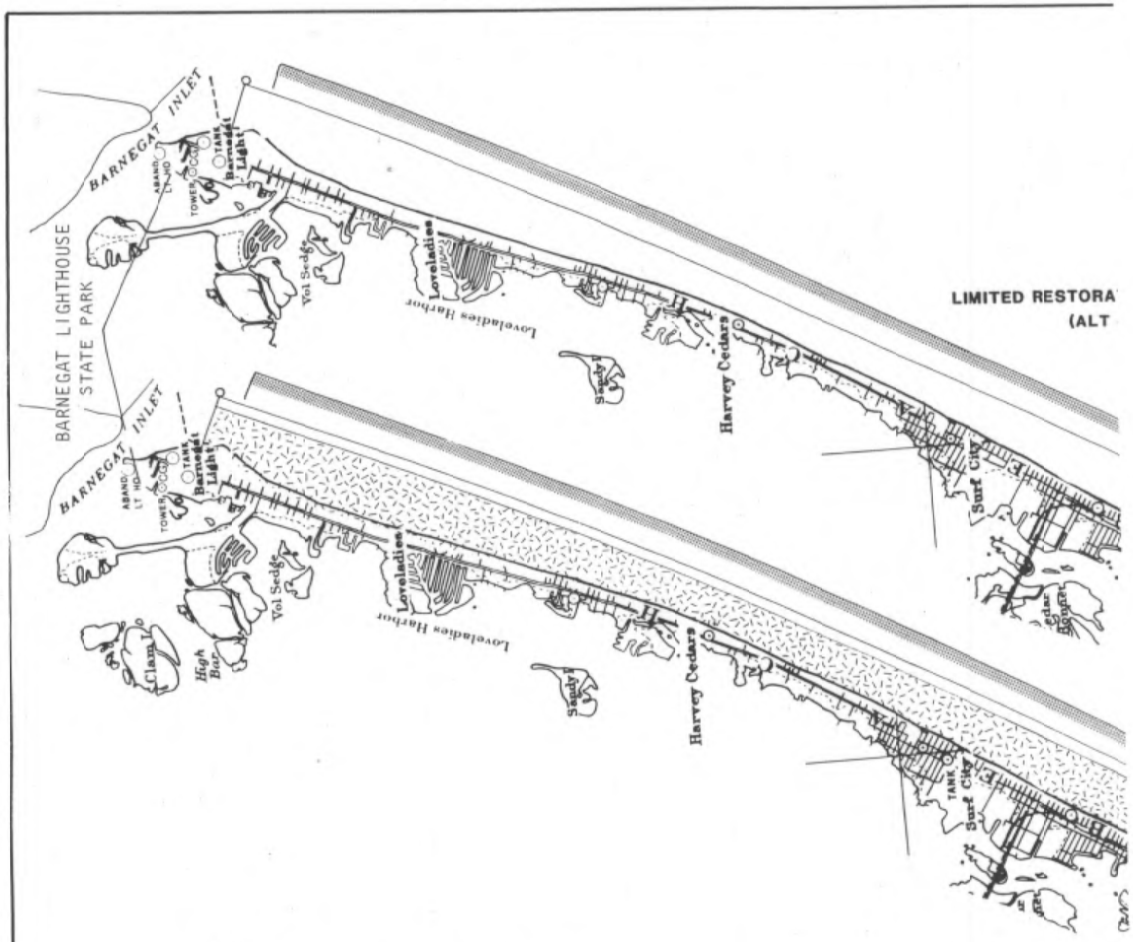


FIGURE VI.B-7


BARNEGAT INLET
BARNEGAT LIGHTHOUSE STATE PARK
BARNEGAT INLET
Loveladies
Vol Sedge
Loveladies Harbor
Sandy
Harvey Cedars
Surf City
Loveladies
Vol Sedge
Loveladies Harbor
Clam
High Bar
Sandy
Harvey Cedars
Surf City
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KEY:
MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURE AND DUNES
PERIODIC BEACH NOURISHMENT
BEACH FILL TO 75' BERM WIDTH (215' BEACH WIDTH)
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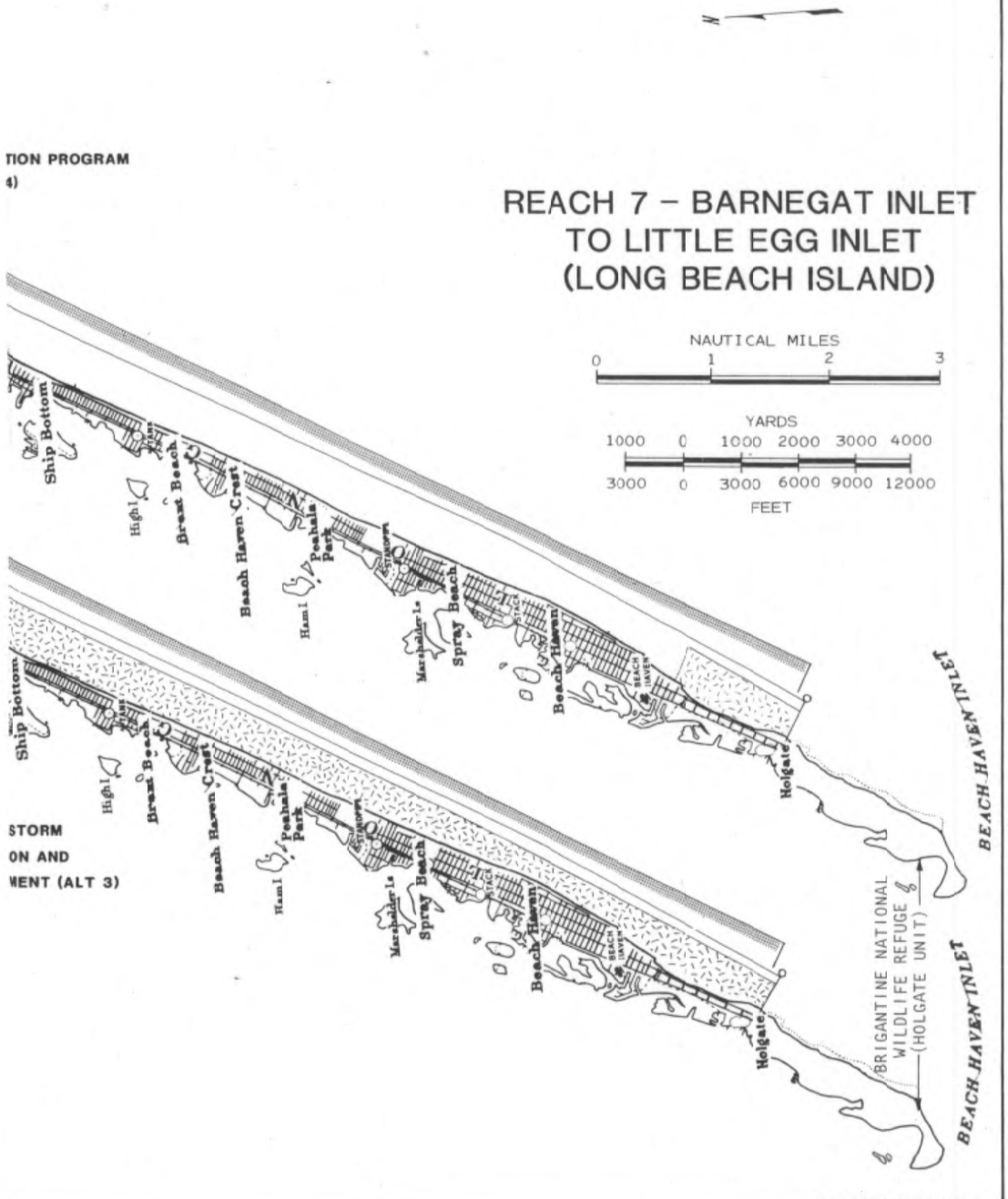
4)

REACH 7 – BARNEGAT INLET TO LITTLE EGG INLET (LONG BEACH ISLAND)



STORM
ON AND
MENT (ALT 3)

DAMES & MOORE

FIGURE VI.B-8

8. Reach 8 — Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island)

Proposed alternative engineering plans for the ocean beach along Brigantine Island are provided below. No engineering plans are provided for Pullen Island which is the last remaining undisturbed barrier island on the New Jersey coast. The undeveloped northern portion of the island is occupied by the North Brigantine State Natural Area. This area would also be left in its natural state under all alternatives developed for this reach. A summary of cost components and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-8. The alternative erosion control plans for Reach 8 are provided schematically on Figure VI.B-9.

a. Alternative 1 — Storm Erosion Protection

This alternative provides for storm erosion protection for the developed areas of Brigantine Island. An existing groin field extending from North 14th Street to 42nd Street would be restored to a minimum berm width of 75 ft. (beach width 255 ft.). The area south of 42nd Street to the northern jetty of Absecon Inlet would be provided with a berm having a minimum width of 100 ft. at elevation to +10 ft. MLW where required. Periodic beach nourishment is proposed at 10-year intervals as the means of maintaining the design berm widths.

For this alternative, structural maintenance includes initial repair and subsequent periodic maintenance work on the existing groins. Dune maintenance, including placement of 22,100 linear feet of sand fence and 38 acres dune grass planting, is also provided.

b. Alternative 2 — Recreational Development

The projected recreational demands (in beach user days) for Brigantine are:

	1980	2030
Average Day Demand	7,000	11,700
Peak Day Demand	10,800	18,300
Design Daily Capacity	44,800	44,800

The existing capacity of the 21,500 ft. of beach between North 14th Street and 42nd Street, is sufficient, if properly maintained, to satisfy the design requirements throughout the planning period. Therefore, no beach expansion is required to satisfy projected recreational demands during the 50-year project planning period. The area south of 42nd Street provides an additional area with recreational potential. Convenient access and nearby parking facilities or shuttle bus service would be required, however, to fully utilize that area. Periodic beach nourishment is proposed as the means of preserving the existing width.

Structural maintenance under this alternative includes initial and subsequent periodic maintenance work on the existing groin field. Dune maintenance in the form of sand fence installation and dune grass planting is also included in this plan.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreation Development

The Storm Erosion Protection (Alternative 1) design applies for this alternative. The plan components and costs are identical to the earlier described plan. As described above, the projected recreational demands for Brigantine are satisfied if the existing beach is maintained. The development and maintenance of a storm erosion protection berm would provide beach capacity in excess of the recreational design standards for this reach.

d. Alternative 4 — Limited Restoration

This alternative plan provides for restoration of the beach berm to a minimum width of 75 ft. (beach width 255 ft.) over the developed shoreline of Brigantine (from North 14th Street to 30th Street). The natural berm width to the south would not be modified. Beach nourishment is proposed as the means of maintaining the restored and natural beach widths.

Maintenance items include initial and periodic repair work on the existing groin field and dune maintenance in the form of sand fence installation and dune grass planting.

e. Alternative 5 — Maintenance Program

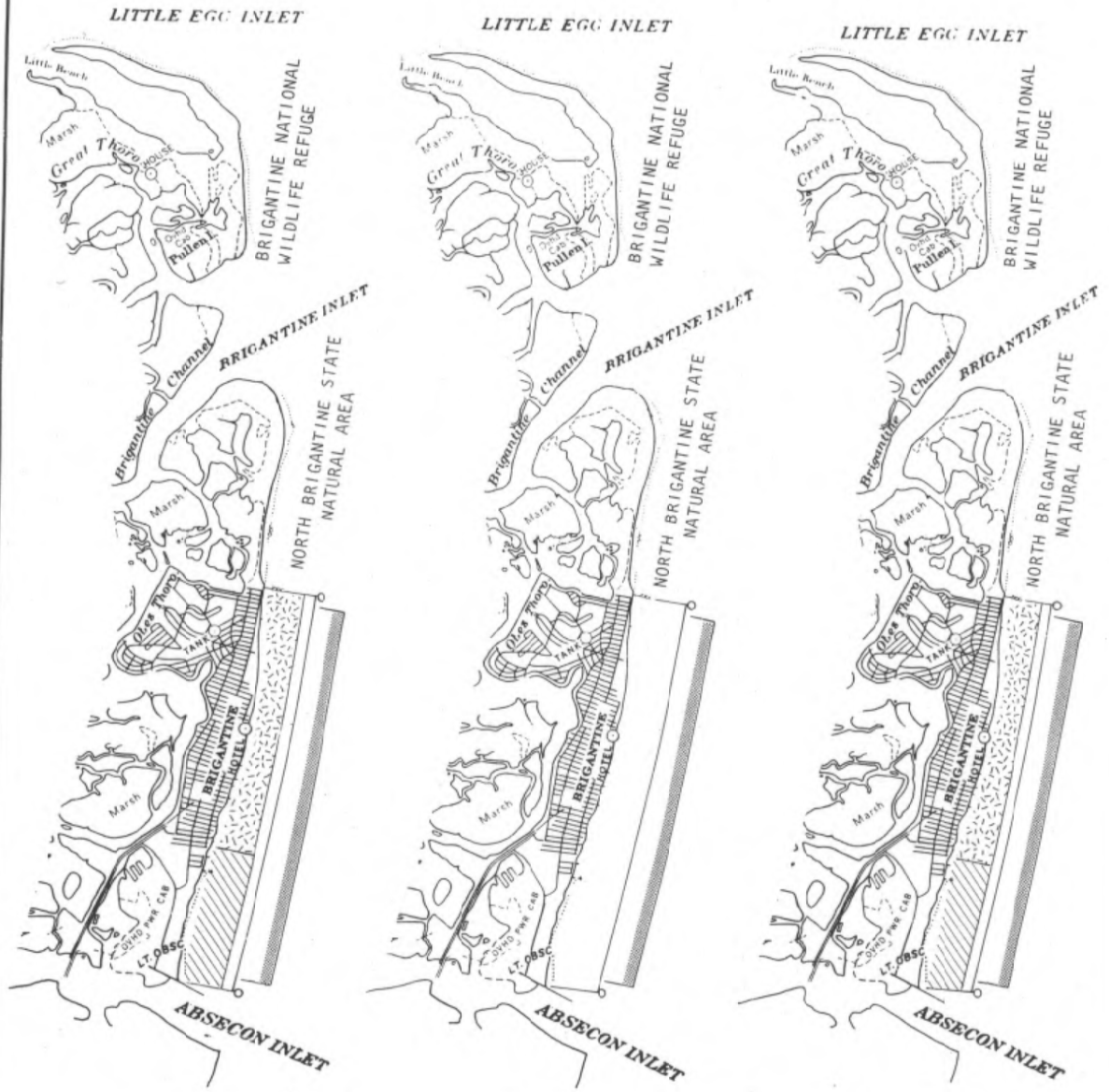
Initial repair of existing functional structures is proposed to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 5 groins and approximately 360 linear feet of bulkheading. Periodic maintenance of the existing functional structures, including 8 existing groins and 4200 linear feet of timber bulkhead, is also provided to ensure their integrity throughout the planning period. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. Repairs to the beach berm are proposed only after the occurrence of significant storm damage. Dune maintenance in the form of sand fence installation and dune grass planting, as discussed for Alternative 1, is also recommended.

TABLE VI.B-8

REACH 8 - PULLEN ISLAND AND BRIGANTINE ISLAND
(LITTLE EGG INLET TO ABSECON INLET)

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (255' beach width) from N. 14th Street to 42nd Street From 42nd Street south to Absecon Inlet jetty beach, fill to 100' minimum berm width at +10' MLW (280' beach width) where required. (Initial in-place fill: 1,406,000 cu. yd.)	$ 8,671,000	$ 8,671,000
	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		3,669,000
	Initial Structural Repairs (see Alternative 5)	439,000	439,000
	Maintenance of Dunes and Existing Functional Structures		
	o 8 existing groins		50,000
	o Placement of about 38 acres of dune grass, 22,100 L.F. sand fence and replacement of fencing on 3-year intervals	263,000	468,000
	TOTALS	$ 9,373,000	$ 13,297,000
2* Recreational Development	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		$ 3,669,000
	Initial Structural Repairs (see Alternative 5)	$ 439,000	439,000
	Maintenance of Dunes and Existing Functional Structures		
	o 8 existing groins		50,000
	o Timber bulkheading (4,200 L.F.)		23,000
	o Dune grass and sand fencing as in Alternative 1	263,000	468,000
	TOTALS	$ 702,000	$ 4,649,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 9,373,000	$ 13,297,000
4 Limited Restoration Program	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (255' beach width) from N. 14th Street to 30th Street (Initial in-place quantity: 1,221,500 cu. yd.)	$ 7,682,000	$ 7,682,000
	Beach Nourishment		
	o 962,000 cu. yd. at 10-year intervals		3,669,000
	Initial Structural Repairs (see Alternative 5)	439,000	439,000
	Maintenance of Dunes and Existing Functional Structures		
	o 8 existing groins		50,000
	o Dune grass and sand fencing as in Alternative 1	263,000	468,000
	TOTALS	$ 8,384,000	$ 12,308,000
5 Maintenance Program	Initial Structural Repairs		
	o 5 groins and 360 L.F. of timber bulkhead	$ 439,000	$ 439,000
	Maintenance of Dunes and Existing Functional Structures		
	o 8 existing groins		50,000
	o Timber bulkheading (4,200 L.F.)		23,000
	o Dune grass and sand fencing as in Alternative 1	263,000	468,000
	TOTALS	$ 702,000	$ 980,000

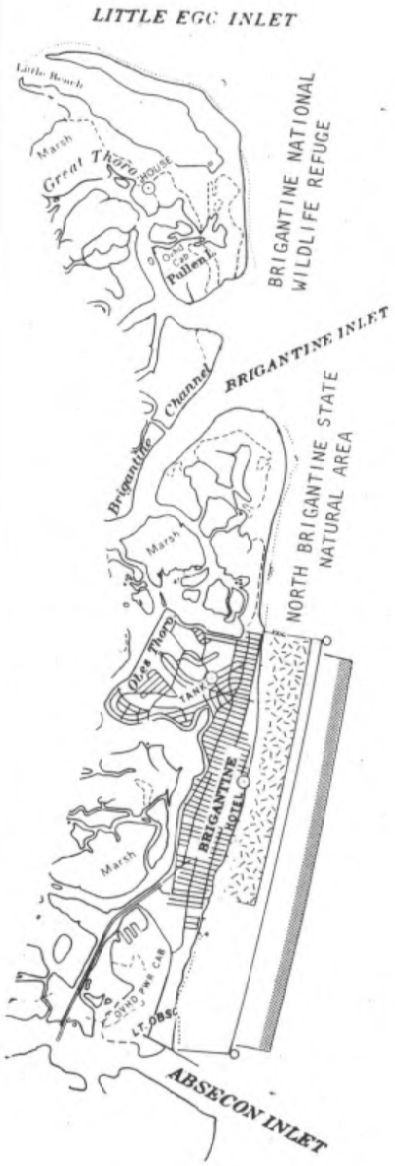
*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (ALT 3)



LIMITED RESTORATION PROGRAM
(ALT 4)

REACH 8 – LITTLE EGG INLET TO ABSECON INLET (PULLEN ISLAND AND BRIGANTINE ISLAND)

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- BEACH FILL TO 75' BERM WIDTH (255' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (280' BEACH WIDTH)

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FIGURE VI.B-9

9. Reach 9 — Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)

Alternative engineering plans for Reach 9 are provided schematically in Figure VI.B-10. The cost components and total estimated present worth costs for each of the five alternatives discussed below are provided in Table VI.B-9.

a. Alternative 1 — Storm Erosion Protection

A groin field is located at the northern end of the island. The proposed plan for this alternative provides a minimum berm width of 75 ft. (beach width 195 ft.) in this area. Exposed beach areas to the south of the groin field are to be provided with a berm having a minimum width of 100 ft. (beach width 220 ft.).

Periodic beach nourishment is proposed at 3-year intervals as the means of maintaining the restored beaches. Structural maintenance under this alternative includes initial repair work on the existing structures and periodic upkeep of the functional groins.

b. Alternative 2 — Recreational Development

The Recreational Development plan for this reach provides for an initial beach fill for a recreational beach with the dimensions illustrated schematically on Figure VI.B-10. The Recreational Development plan evaluated in the Draft Shore Protection Master Plan provided for a wider initial beach and periodic beach expansions to accommodate projected recreational demand. Since the original design demand and beach width values for Absecon Island were considered to be anomalous as compared to other southern barrier island reaches, the Recreational Development beach design dimensions were reduced to minimize potential adverse impacts on the Absecon Inlet area. Under the modified plan, no periodic beach expansions are proposed after the proposed initial beach fill. As in the original plan, periodic beach nourishment at 3-year intervals would be used to maintain the recreational beach throughout the economic life of the program. The beach demand estimates and capacity (in beach user days) of the design recreational beach are:

	1980	2015
Average Day Demand	263,200	390,000
Peak Day Demand	375,500	556,500
Design Daily Capacity	341,100	473,300

Structural maintenance items under this alternative include initial and subsequent periodic maintenance work on the existing functional structures.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Recreational Development (Alternative 2) design applies for this alternative. The plan components and costs are identical to those in Alternative 2 above.

d. Alternative 4 — Limited Restoration

Most of the critical erosion area within this reach is at Longport. This alternative plan provides a storm erosion protection design berm width of 100 ft. (beach width 220 ft.) along the entire Longport shorefront. The berm would be tapered at its northern end to meet the existing berm at Margate City and the remaining northern portion of this reach. Beach nourishment is proposed at 3-year intervals as the means of maintaining the restored and natural berms at their desired widths.

Under this alternative, maintenance includes initial and periodic repair of the existing functional structures.

e. Alternative 5 — Maintenance Program

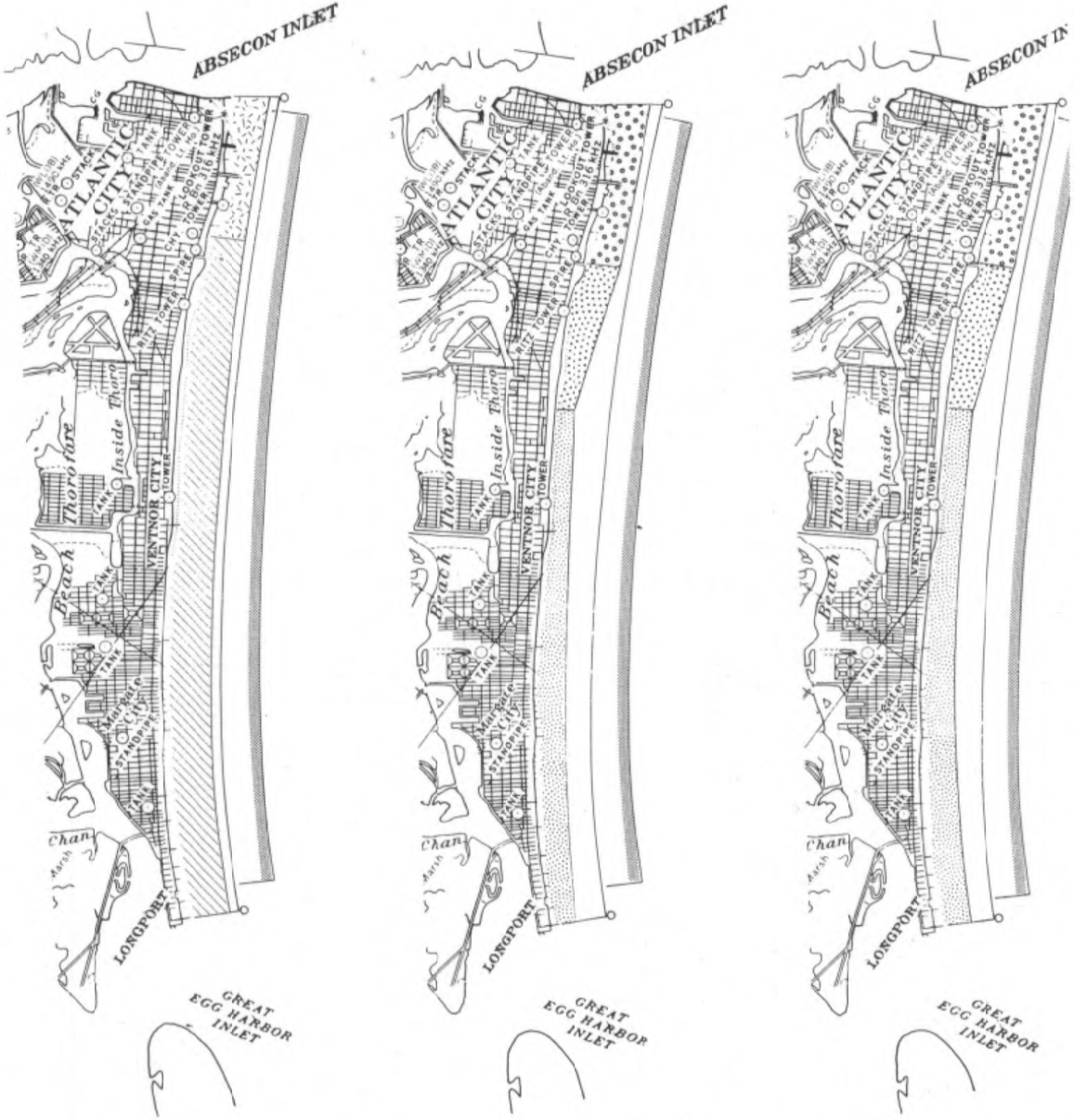
Initial repair of existing functional structures is proposed to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 7 groins, approximately 1950 linear feet of bulkhead, and 1550 linear feet of concrete seawall in Longport.

Periodic maintenance of the existing functional structures, including 7 existing groins, 16,860 linear feet of timber bulkhead, 4770 linear feet of concrete bulkhead, 2100 linear feet of concrete seawall (at Longport), and 300 linear feet of stone revetment is also provided throughout the planning period to ensure their integrity. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. Beach berm repair is proposed only after the occurrence of significant storm damage.

TABLE VI.B-9

REACH 9 - ABSECON ISLAND
(ABSECON INLET TO GREAT EGG HARBOR INLET)

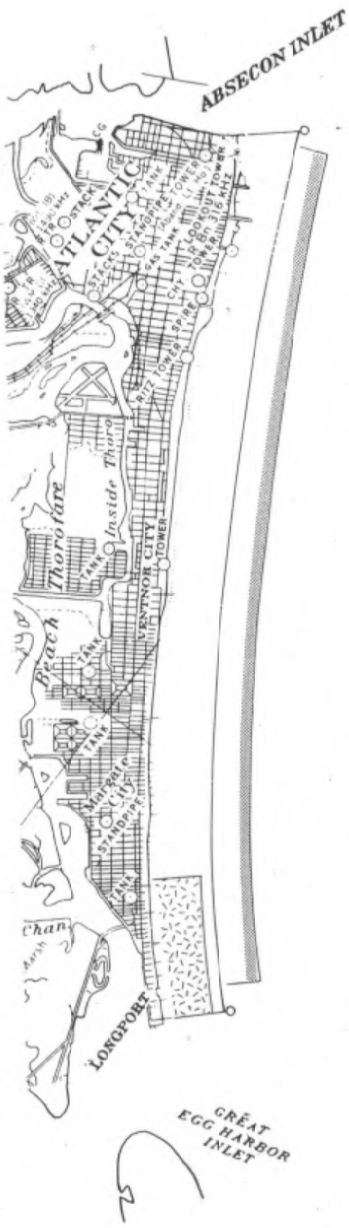
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o 75' berm width at +10' MLW (195' beach width) in groin field at Atlantic City and 100' berm width (220' beach width) elsewhere. (Initial in-place fill: 676,000 cu. yd.)	$ 4,742,000	$ 4,742,000
	Beach Nourishment		
	o 975,000 cu. yd. at 3-year intervals		17,192,000
	Initial Structural Repairs (see Alternative 5)	3,302,000	3,302,000
	Maintenance of Existing Functional Structures		
	o 7 existing groins		43,000
	TOTALS	$ 8,044,000	$ 25,279,000
2 Recreational Development	Beach Fill		
	o Initial fill in Atlantic City 400' berm width at +10'MLW (520' beach width), tapered to a 150' berm width (270' beach width) at Jackson Street, and 150' berm width elsewhere. (In-place fill quantity: 1,319,200 cu. yd.)	$ 8,204,00	$ 8,204,000
	Beach Nourishment		
	o 975,000 cu. yd. at 3-year intervals		17,192,000
	Initial Structural Repairs (see Alternative 5)	3,302,000	3,302,000
	Maintenance of Existing Functional Structures		
	o 7 existing groins		43,000
	TOTALS	$ 11,506,000	$ 28,741,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 2 ABOVE	$ 11,506,000	$ 28,741,000
4 Limited Restoration Program	Beach Fill		
	o Initial fill to 100' berm width at +10' MLW (195' beach width) in Longport (In-place fill quantity: 238,000 cu. yd.)	$ 2,385,000	$ 2,385,000
	Beach Nourishment		
	o 975,000 cu. yd. at 3-year intervals		17,192,000
	Initial Structural Repairs (see Alternative 5)	3,302,000	3,302,000
	Maintenance of Existing Functional Structures		
	o 7 existing groins		43,000
	o 4770 L.F. of concrete bulkhead and 12,400 L.F. of timber bulkhead (from Atlantic City to Margate)		95,000
	TOTALS	$ 5,687,000	$ 23,018,000
5 Maintenance Program	Initial Structural Repairs		
	o 7 groins, 1950 L.F. of timber bulkheading and 1550 L.F. of concrete seawall	$ 3,302,000	$ 3,302,000
	Maintenance of Existing Functional Structures		
	o 7 existing groins		43,000
	o 16,860 L.F. of timber bulkheading		90,000
	o 4,770 L.F. of concrete bulkheading		30,000
	o 2,100 L.F. of concrete seawall		21,000
	o 300 L.F. of stone revetment		1,000
	TOTALS	$ 3,302,000	$ 3,487,000



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (ALT 3)



REACH 9 - ABSECON INLET TO GREAT EGG HARBOR INLET (ABSECON ISLAND)

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES
- PERIODIC BEACH NOURISHMENT
- BEACH FILL TO 75' BERM WIDTH (195' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (220' BEACH WIDTH)
- BEACH FILL TO 400' BERM WIDTH (520' BEACH WIDTH) FROM THE NORTHERN END OF THE REACH TO MISSOURI AVENUE
- BEACH FILL TAPERED FROM 400' BERM AT MISSOURI AVENUE TO 150' BERM AT JACKSON STREET
- BEACH FILL TO 150' BERM WIDTH (270' BEACH WIDTH)

LIMITED RESTORATION PROGRAM (ALT 4)

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FIGURE VI.B-10

10. Reach 10 — Great Egg Harbor Inlet to Corson Inlet (Peck Beach)

The proposed alternative engineering plans for Peck Beach are provided schematically on Figure VI.B-11. A summary of cost components and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-10.

a. Alternative 1 — Storm Erosion Protection

The northern portion of Peck Beach is protected by a functional groin field which extends to Sea View Road. Extension and modification of this groin field is proposed for the improvement of its performance. The groins at 5th and 9th Streets should be modified. The coast parallel spurs on the 5th Street groin do not contribute to the sand holding effectiveness of this groin and should be removed. The hook-shaped groin at 9th Street should be replaced with a conventional groin oriented perpendicular to the shore. The groin field should also be extended to protect the eroded area downdrift of the existing field. This extension should include the rebuilding of the existing timber groin at 17th Street and the addition of two new groins in the vicinity of 19th and 21st Streets.

Once the recommended groin field extension and modifications are complete, beach fill would be placed to supplement the existing beach berm. The northern 17,200 ft. of shore protected by the groin field should be upgraded to a minimum berm width of 75 ft. (beach width 255 ft.). The remaining 20,700 ft. of exposed beach should be provided with a berm having a minimum width of 100 ft. (beach width 280 ft.).

Periodic beach nourishment is proposed at 5-year intervals as the means of maintaining the design berm widths. Maintenance under this alternative includes work on the existing structures and newly constructed groins, and dune maintenance in the form of sand fence installation and dune grass planting.

b. Alternative 2 — Recreational Development

Public access and convenience features such as the boardwalk and near-shore parking facilities are concentrated along the northern portion of the island. Here an initial recreational beach width of 170 ft. (berm width 8' at +10' MLW) would be developed there along the 10,500 ft. length of shore between Morningside Road at Beach Boulevard to 21st Street. At the southern end of the reach, the recreational beach would be tapered to meet the existing berm which would control for the remainder of the reach. Considering the carrying capacity limitations of the reach, the recreational beach development is planned to meet the demands at year 2010. Periodic expansion of the recreational beach is planned at 10-year intervals to keep pace with the estimated growth in recreational demand. The last beach fill is planned at year 2010 for a total width of 360 ft. (beach width 180' at 10' MLW). The beach demand estimates and design capacities (in beach user days) for this reach are:

	1980	2010
Average Day Demand	89,900	127,000
Peak Day Demand	103,400	146,100
Design Daily Capacity	103,400	143,300

No new groin construction or modification of existing groins is included in this alternative. The wide recreational berm would provide protection to those areas which would normally require structural protection. Periodic maintenance of the existing functional groin field is included.

Beach nourishment is proposed at 5-year intervals as the means of maintaining the recreational and natural berms at their design and existing widths respectively. Structural maintenance plans include initial and periodic repair work on the existing structures as well as dune maintenance as described in Alternative 5.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection alternative controls the initial beach fills along the entire reach. Along the northern portion of the reach a minimum berm width of 75 ft. (beach width 255 ft.) is provided in the existing groin field area; a minimum initial berm width of 100 ft. (beach width 280 ft.) is provided in the remaining portion of the reach. Periodic expansion of the beach along the northern sector is proposed after a 10-year period. The recreational beach would be expanded uniformly at 10-year intervals until the year 2010. The recreational beach should be developed along the 10,500 ft. length of shore between Morningside Road at Beach Boulevard to 21st Street. For the southern sector, the recreational beach would be tapered to meet the storm erosion protection berm which is recommended for the remainder of the reach.

No new groin construction or modification is included in this alternative plan. The proposed recreational beach would protect those areas which have been identified as needing improved structural protection under other alternative plans. Periodic maintenance of the existing groin field is, however, included.

Beach nourishment is proposed at 5-year intervals as the means of maintaining the recreational and storm erosion protection berms at their design widths. Maintenance items include periodic repair work on the existing structures as well as dune maintenance including dune grass and sand fence installation.

d. Alternative 4 — Limited Restoration

This alternative provides storm erosion protection for the critically eroding beach area from North Street south to 29th Street. The groin field area from North Street to 15th Street would receive a 75 ft. minimum berm width (beach width 255 ft.). The berm would then be tapered out to a 100 ft. minimum width (beach width 280 ft.) which would extend to 29th Street. The existing beach would be unaltered along the remaining portions of the reach.

As with the other alternatives above, beach nourishment is proposed as the means of maintaining the restored and natural berm widths. Under this alternative, structural maintenance would include initial and periodic repair work on the existing functional structures. Dune maintenance, including placement of about 18,500 linear feet of sand fence and 32 acres of dune grass planting, is also included.

e. Alternative 5 — Maintenance Program

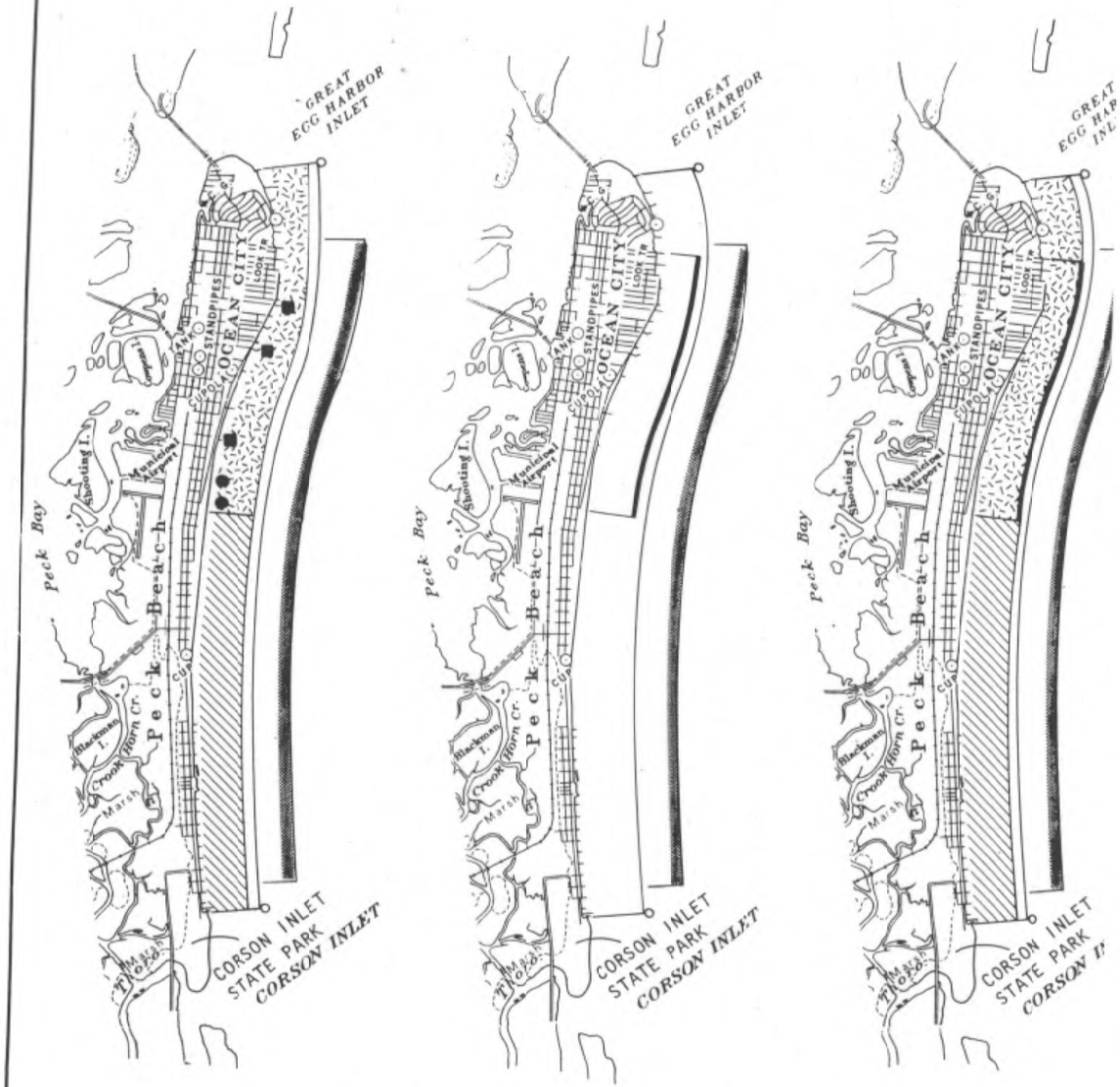
Under this alternative, initial repairs of existing functional structures is provided to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 3 groins and approximately 1000 linear feet of bulkheading. Periodic maintenance of the existing functional structures, including 20 existing groins and 12,000 linear feet of timber bulkhead, is proposed throughout the planning period to ensure their integrity. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. Beach berm repair is proposed only after the occurrence of significant storm damage.

Dune maintenance including placement of about 18,500 linear feet of sand fencing and 32 acres of dune grass planting, is also provided under this and all other alternatives for this reach.

TABLE VI.B-10

REACH 10 - PECK BEACH (GREAT EGG HARBOR INLET TO CORSON INLET)

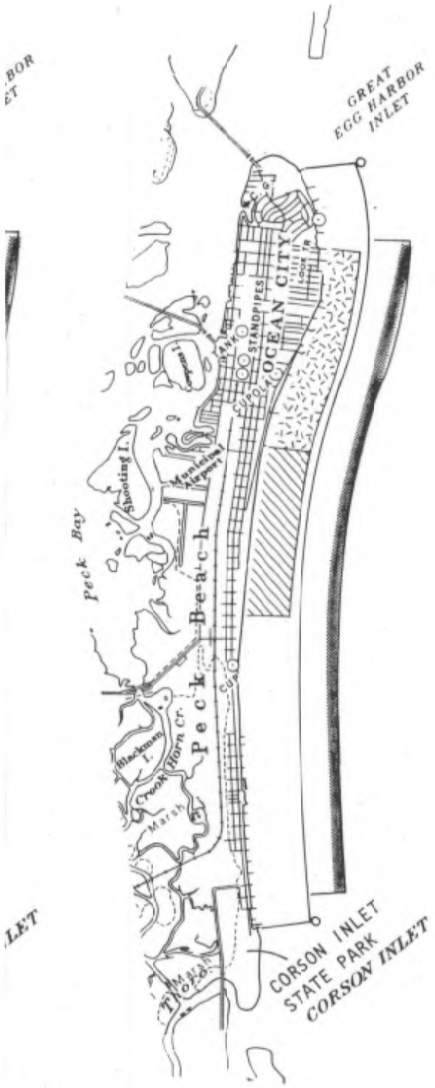
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Initial fill to 75' berm width at +10' MLW (255' beach width) in northern groin field and 100' berm width (280' beach width) elsewhere. (Total in-place fill volume: 2,870,000 cu. yd.)	$ 16,550,000	$ 16,550,000
	Beach Nourishment		10,895,000
	o 1,170,000 cu. yd. at 5-year intervals		
	Structural Improvements	2,320,000	2,320,000
	o 2 new groins and modification of 3 groins		
	Initial Structural Repairs (see Alternative 5)	433,000	433,000
	Maintenance of Dunes and Existing Functional Structures		120,000
	o 20 groins		
	o Placement of about 32 acres of dune grass, 18,500 L.F. of sand fence and replacement of sand fence at 3-year intervals	220,000	390,000
	TOTALS	$ 19,523,000	$ 30,708,000
2 Recreational Development	Beach Fill		
	o Initial fill in northern public access area for a beach width of 170'. (In-place fill volume: 314,000 cu. yd.)	$ 2,794,000	$ 2,794,000
	o Periodic expansion in beach width in 10-year intervals (585,000 cu. yd. each expansion to year 2010) for a total beach width of 360' (berm width 180' at +10' MLW)		2,877,000
	Beach Nourishment		10,895,000
	o 1,170,000 cu. yd. at 5-year intervals		
	Initial Structural Repairs (see Alternative 5)	433,000	433,000
	Maintenance of Dunes and Existing Structures		184,000
	o 20 groins and 12,000 L.F. of timber bulkhead	220,000	390,000
	o Dune grass and sand fencing as in Alternative 1		
	TOTALS	$ 3,447,000	$ 17,573,000
3 Combination Storm Erosion Protection and Recreational Development	Beach Fill		
	o Initial fill to storm erosion protection design berm width indicated in Alternative 1 above	$ 16,550,000	$ 16,550,000
	o Periodic berm expansion at 10-year intervals of 333,000 cu. yd. each expansion to year 2010		2,116,000
	Beach Nourishment		10,895,000
	o 1,170,000 cu. yd. at 5-year intervals		
	Initial Structural Repairs (see Alternative 5)	433,000	433,000
	Maintenance of Dunes and Existing Functional Structures		120,000
	o 20 groins	220,000	390,000
	o Dune grass and sand fencing as in Alternative 1		
	TOTALS	$ 17,203,000	$ 30,504,000
4 Limited Restoration Program	Beach Fill		
	o Initial fill to storm berm design widths at northern critical erosion areas. (In-place fill quantity: 1,600,000 cu. yd.)	$ 9,715,000	$ 9,715,000
	Beach Nourishment		10,895,000
	o 1,170,000 cu. yd. at 5-year intervals		
	Initial Structural Repairs (see Alternative 5)	433,000	433,000
	Maintenance of Dunes and Existing Functional Structures		184,000
	o 20 groins and 12,000 L.F. of timber bulkhead	220,000	390,000
	o Dune grass and sand fencing as in Alternative 1		
	TOTALS	$ 10,368,000	$ 21,617,000
5 Maintenance Program	Initial Structural Repairs		
	o 3 groins and 1000 L.F. of timber bulkhead	$ 433,000	$ 433,000
	Maintenance of Dunes and Existing Functional Structures		184,000
	o 20 groins and 12,000 L.F. of timber bulkhead	220,000	390,000
	o Dune grass and sand fencing as in Alternative 1		
	TOTALS	$ 653,000	$ 1,007,000



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (



REACH 10 – GREAT EGG HARBOR INLET TO CORSON INLET (PECK BEACH)

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- INITIAL FILL FOR A BEACH WIDTH OF OF 170'(BERM WIDTH 8' AT +10' MLW) AND STEP INCREASE IN BEACH WIDTH TO 360' (BERM WIDTH OF 180' AT +10' MLW) BY THE YEAR 2010
- BEACH FILL TO 75' BERM WIDTH (255' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (280' BEACH WIDTH)
- NEW GROINS
- GROIN MODIFICATION

LIMITED RESTORATION PROGRAM
(ALT 4)

ALT 3)

DAMES & MOORE

FIGURE VI.B-11

11. Reach 11 — Corsons Inlet to Townsends Inlet (Ludlam Island)

The proposed alternative engineering plans for the ocean beach of Ludlam Island are provided schematically on Figure VI.B-12. A summary of cost components and the total estimated present worth cost for the five alternatives discussed below are provided in Table VI.B-11.

a. Alternative 1 — Storm Erosion Protection

Approximately one-half of the shore front of Sea Isle City is protected by an existing groin field. This alternative plan calls for the extension of that groin field toward the southern end of Ludlam Island. Five groins are required to complete the field. Beach fill is to be placed to provide a berm width of 75 ft. (beach width 255 ft.) throughout the groin field area. The remaining portions of Ludlam Island, including Whale Beach and Strathmere, are exposed areas. Beach fill would be provided to construct a storm protection berm with a minimum width of 100 ft. (beach width 280 ft.) in these areas.

Periodic beach nourishment is proposed at 3-year intervals as the means of maintaining the beaches at their design widths. Sand from suitable offshore borrow sources would be used to nourish the beach.

Maintenance is proposed to preserve the functional and structural integrity of existing and planned protection structures. This includes initial and periodic repair work on the new and existing structures. Dune maintenance including installation of about 12,800 linear feet of sand fence and 15 acres of dune grass planting is also proposed.

b. Alternative 2 — Recreational Development

Public access and convenience features such as parking areas and the boardwalk are located at the northern portion of Sea Isle City. This alternative provides for the maintenance of a recreational beach in this area at a minimum. The projected recreational demand estimates and the design beach capacity (in beach user days) for this area are:

	1980	2025
Peak Daily Demand	27,200	44,000
Average Daily Demand	17,500	28,300
Design Daily Capacity	59,400	59,400

Reach carrying capacity considerations would limit recreational demand growth at approximately year 2025. The present and future demands are satisfied by the existing available beach area, which if maintained, will be adequate to accommodate the design daily capacity. Therefore, no beach expansion is required. Beach nourishment is proposed as a means of maintaining the existing beach widths to accomodate projected recreational demand.

Structural maintenance is included to preserve the functional and structural integrity of existing and planned shore protection structures. As discussed in Alternative 5, this involves initial and periodic repair work on the existing structure. Dune maintenance in the form of sand fence installation and dune grass planting is also provided for this alternative.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection design (Alternative 1) provides sufficient beach width and controls the design in this alternative plan. The combination alternative for this reach is identical in all respects to the previously described Storm Erosion Protection alternative plan.

d. Alternative 4 — Limited Restoration

This alternative provides for restoration of the beach areas of Strathmere and the northern portion of Sea Isle City as well as beach width maintenance for the remainder of the reach. The Strathmere area would be provided with a berm having a minimum width of 100 ft. (beach width 280 ft.). This berm would be tapered to meet the existing berm along Whale Beach. At Sea Isle City the beach restoration consists of filling the existing functional groin field area to provide a minimum storm protection berm width of 75 ft. (beach width 255 ft.). Beach nourishment is recommended as the means of maintaining the restored and existing berms at their planned and natural widths respectively.

Maintenance under this alternative include preservation of the functional and structural integrity of the existing structures through initial and periodic repair work. As in Alternative 5, dune maintenance in the form of sand fence installation and dune grass planting is also proposed.

e. Alternative 5 — Maintenance Program

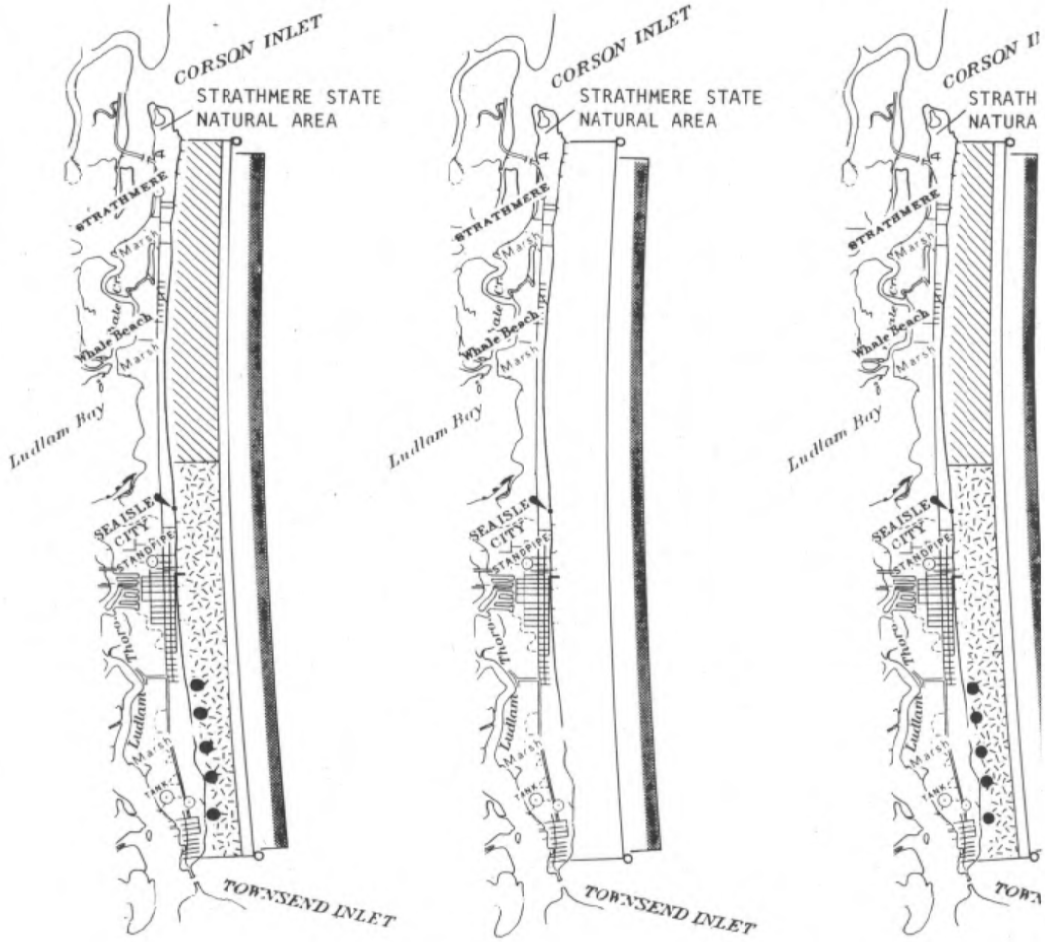
Initial repair of existing functional structures is proposed under this alternative to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 2 groins and approximately 130 linear feet of timber bulkhead. Periodic maintenance of the existing functional structures, including 18 existing groins and 10,400 linear feet of timber bulkhead, is also provided to ensure their integrity throughout the planning period. The initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. The beach berm is to be repaired only after the occurrence of major storm damage.

Dune maintenance, including placement of 12,800 linear feet of sand fence installation and 15 acres of dune grass plantings is also provided. Replacement of the sand fencing is proposed at 3-year intervals.

TABLE VI.B-11
REACH 11 - LUDLAM ISLAND (CORSONS INLET TO TOWNSEND INLET)

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Initial fill to 75' berm width at +10' MLW (255' beach width) in the Sea Isle City groin field and 100' berm width (280' beach width) elsewhere (2,951,000 cu. yd.)	$ 19,432,000	$ 19,432,000
	Beach Nourishment		
	o 1,170,000 cu. yd. at 3-year intervals		19,892,000
	Extension of Groin Field		
	o 5 new groins to the South of Sea Isle City	2,315,000	2,315,000
	Initial Structural Repairs (see Alternative 5)	389,000	389,000
	Maintenance of Dunes and Structures		
	o 18 existing groins		117,000
	o 5 new groins		31,000
	o Placement of about 15 acres of dune grass, 12,800 L.F. of sand fence and replacement of sand fence at 3-year intervals	112,000	233,000
	TOTALS	$ 22,248,000	$ 42,409,000
2* Recreational Development	Beach Nourishment		
	o 1,170,000 cu. yd. at 3-year intervals		$ 19,892,000
	Initial Structural Repairs (see Alternative 5)	$ 389,000	389,000
	Maintenance of Dunes and Existing Functional Structures		
	o 18 existing groins		117,000
	o 10,375 L.F. of timber bulkheading		56,000
	o Dune grass and sand fencing as in Alternative 1	112,000	233,000
	TOTALS	$ 501,000	$ 20,687,000
3 Combination Storm Erosion Protection and Recreational Development	Beach Fill		
	o Initial beach fill to storm protection requirements as per Alternative 1. (In-place quantity: 2,951,000 cu. yd.)	$ 19,432,000	$ 19,432,000
	Beach Nourishment		
	o 1,170,000 cu. yd. at 3-year intervals		19,892,000
	Extension of Groin Field		
	o 5 new groins	2,315,000	2,315,000
	Initial Structural Repairs (see Alternative 5)	389,000	389,000
	Maintenance of Dunes and Structures		
	o 18 existing groins		117,000
	o 5 new groins		31,000
	o Dune grass and sand fencing as in Alternative 1	112,000	233,000
	TOTALS	$ 22,248,000	$ 42,409,000
4 Limited Restoration Program	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (255' beach width) for 6,000 L.F. in north Sea Isle City and 100' berm width (280' beach width) for 7,200 L.F. in Strathmere (Initial in-place quantity: 1,091,000 cu. yd.)	$ 7,880,000	$ 7,880,000
	Beach Nourishment		
	o 1,170,000 cu. yd. at 3-year intervals		19,892,000
	Initial Structural Repairs (see Alternative 5)	389,000	389,000
	Maintenance of Dunes and Existing Functional Structures		
	o 18 existing groins		117,000
	o Dune grass and sand fencing as in Alternative 1	112,000	233,000
	TOTALS	$ 8,381,000	$ 28,511,000
5 Maintenance Program	Initial Structural Repairs		
	o 2 groins and 130 L.F. of timber bulkhead	$ 389,000	$ 389,000
	Maintenance of Dunes and Existing Functional Structures		
	o 18 existing groins		117,000
	o 10,375 L.F. of timber bulkheading		56,000
	o Dune grass and sand fencing as in Alternative 1	112,000	233,000
	TOTALS	$ 501,000	$ 795,000

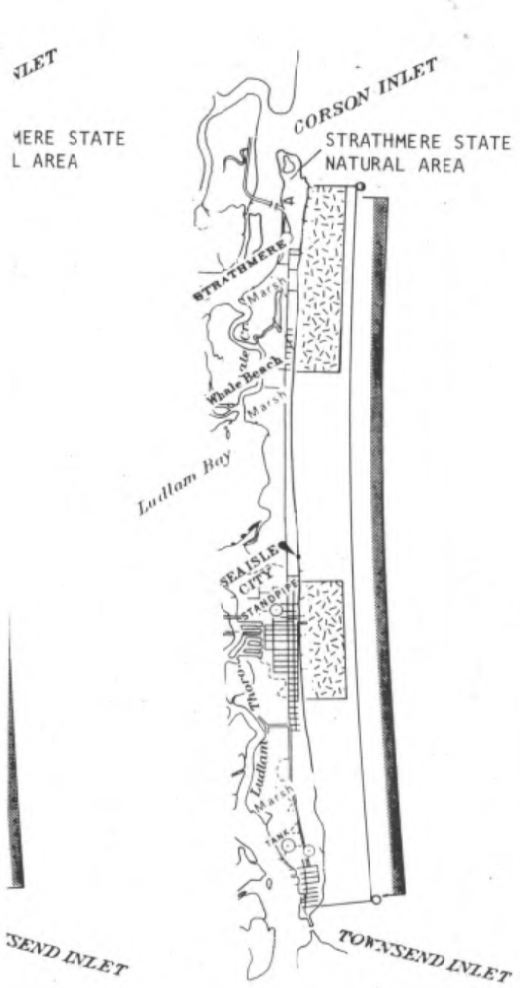
*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STOR EROSION PROTECTION A RECREATIONAL DEVELOPMENT



REACH 11– CORSONS INLET TO TOWNSEND INLET (LUDLAM ISLAND)

NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000
3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- BEACH FILL TO 75' BERM WIDTH (255' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (280' BEACH WIDTH)
- NEW GROINS

M
ID
(ALT 3)

LIMITED RESTORATION PROGRAM
(ALT 4)

DAMES & MOORE

FIGURE VI.B-12

12. Reach 12 — Townsend Inlet to Hereford Inlet (Seven Mile Beach)

The proposed alternative engineering plans for Seven Mile Beach are provided schematically on Figure VI.B-13. A summary of cost components and the total estimated present worth costs of the five alternatives discussed below are provided in Table VI.B-12. No action is proposed for Stone Harbor Point at the southern end of the reach.

a. Alternative 1 — Storm Erosion Protection

The southern portion of this reach is protected by a groin field at Stone Harbor. Undeveloped land exists south of Stone Harbor to Hereford Inlet. This alternative calls for beach fill to be placed to provide a minimum berm width of 75 ft. (beach width 255 ft.) extending throughout the existing groin field and a 100 ft. berm width (beach width 280 ft.) north of Stone Harbor to the vicinity of 25th Street in Avalon. Natural beaches would exist in the remaining portions of the reach at Stone Harbor Point and near Townsend Inlet and Hereford Inlet.

Periodic beach nourishment is proposed at 10-year intervals as the means of maintaining the beach berm at their design widths. Sand from offshore borrow sources would be used to nourish the beaches.

Structural maintenance is included in this alternative to preserve the functional and structural integrity of the existing functional structures. Dune maintenance, including placement of 27 acres of beach grass, 13,300 linear feet of sand fence and periodic replacement of sand fence is also provided.

b. Alternative 2 — Recreational Development

Under this alternative, a recreational beach is planned for the oceanfront beach. This alternative calls for beach fills along the reach segment from the vicinity of 25th Street in Avalon to the terminal structure at 127th Street in Stone Harbor. Considerating reach carrying capacity limitations, the recreational alternative is planned to satisfy demand through the year 2022. The recreational beach demand estimates and the design daily capacities (in beach user days) are:

	1980	2022
Average Day Demand	90,300	142,400
Peak Day Demand	157,900	249,100
Design Daily Capacity	132,700	200,700

The present demand is satisfied by the existing available beach area. Periodic expansion in beach width is proposed at 10-year intervals to accommodate the growth in beach use demand over the planning period. The last beach fill is planned for year 2020 to provide adequate beach area to satisfy the estimated design daily capacity at year 2022. Beach nourishment is proposed at 10-year intervals to maintain the design beaches.

Maintenance items under this alternative include preservation of the functional and structural integrity of the existing and the planned structures. Dune maintenance, including planting dune grass and sand fence installation, is also provided under this plan.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection Plan (Alternative 1) controls the initial beach fill and provides an adequate beach width to meet the projected future recreational demands. The Combination alternative plan is identical in every aspect to Storm Erosion Protection plan.

d. Alternative 4 — Limited Restoration

This alternative calls for initial beach fill to the Storm Erosion Protection design berm width in the groin protected areas of Stone Harbor where the local erosion rate is relatively high. A minimum berm width of 75 ft. (beach width 255 ft.) would be provided in this portion of the reach. The existing beach would be unaltered in the remaining portions of the island.

Beach nourishment is proposed to maintain the beaches at their design or natural widths where required. Maintenance of the existing structures, and dune maintenance in the form of dune grass placement and sand fence installation, is also provided under this alternative.

e. Alternative 5 — Maintenance Program

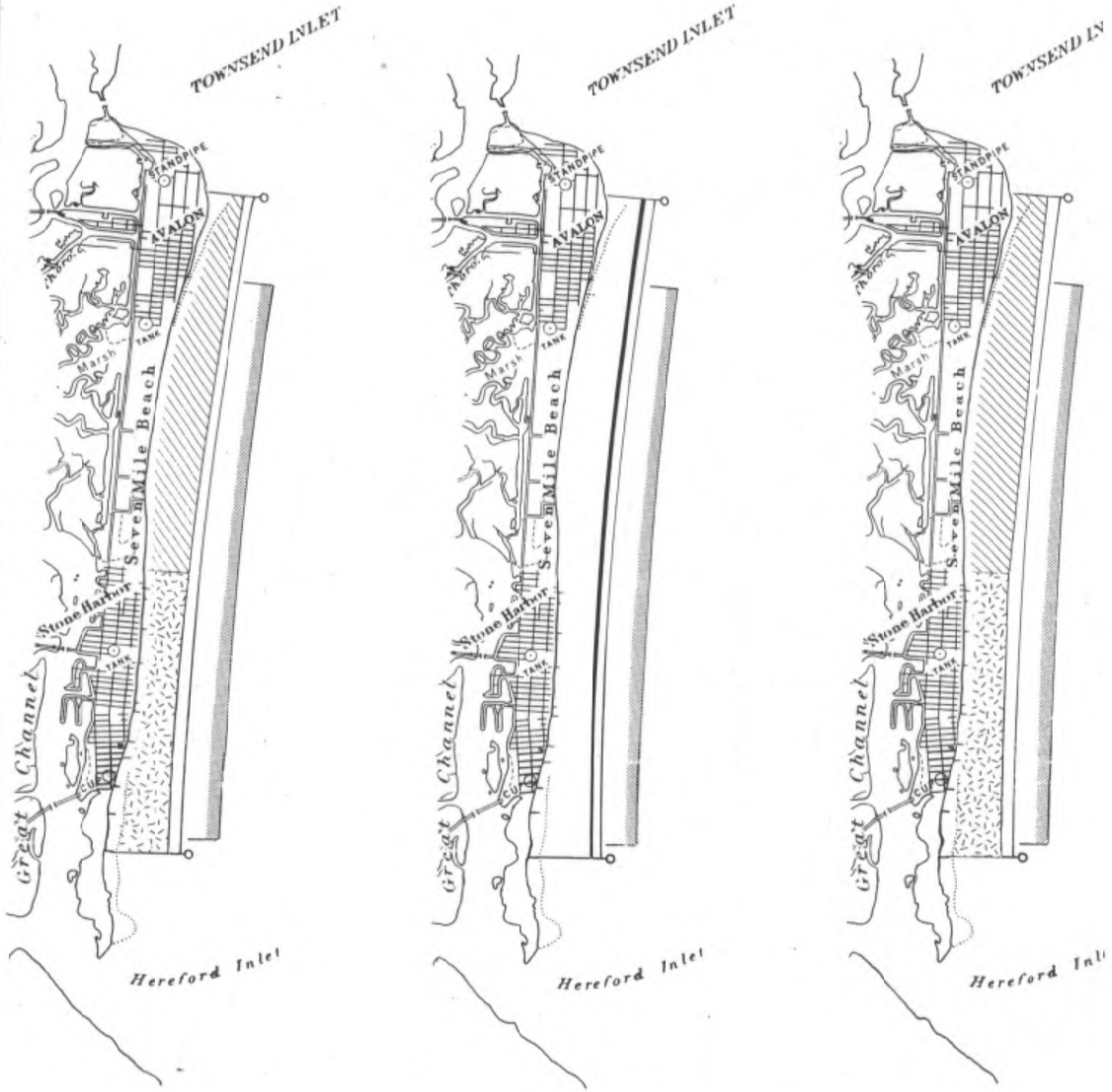
Initial repair of existing functional structures is proposed to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 1 groin and approximately 620 linear feet of timber bulkhead. Periodic maintenance of the existing functional structures, including 10 existing groins, 12,600 linear feet of timber bulkhead, and 800 linear feet of stone revetment, is also proposed to ensure their integrity throughout the planning period. Initial and subsequent periodic structural maintenance work is a component of all five of the alternatives for this reach. The beach berm would be repaired only after the occurrence of significant storm damage.

Dune maintenance, including planting of 15 acres of dune grass, installation of 12,800 linear feet of sand fence and replacement of the fence at 3-year intervals, is provided under this and all other alternatives for this reach.

TABLE VI.B-12

REACH 12-SEVEN MILE BEACH (TOWNSENDS INLET TO HEREFORD INLET)

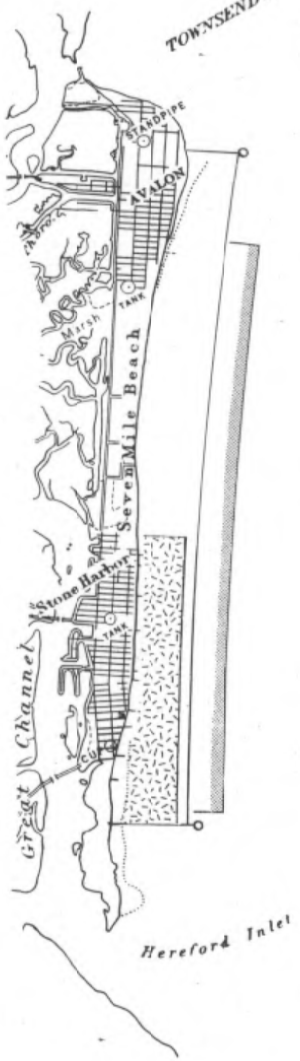
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Initial fill to 75' berm width at +10' MLW (255' beach width) in Stone Harbor and 100' berm width (280' beach width) elsewhere. (In-place quantity: 2,535,700 cu. yd.)	$ 13,702,000	$ 13,702,000
	Beach Nourishment		
	o 1,118,000 cu. yd. at 10-year intervals		4,135,000
	Initial Structural Repairs (see Alternative 5)	523,000	523,000
	Maintenance of Dunes and Existing Functional Structures		
	o 10 existing groins		62,000
	o Placement of about 27 acres of dune grass, 13,300 L.F. of sand fence and replacement of sand fence at 3-year intervals	177,000	302,000
	TOTALS	$ 14,402,000	$ 18,724,000
2 Recreational Development	Beach Fill		
	o No initial fill is required		
	o Periodic beach expansions (544, 000 cu. yd. in 10-year intervals) to a total beach width of 240' (60' berm width at +10' MLW) by the year 2020		$ 2,689,000
	Beach Nourishment		
	o 1,118,000 cu. yd. at 10-year intervals		4,135,000
	Initial Structural Repairs (see Alternative 5)	$ 523,000	523,000
	Maintenance of Dunes and Existing Functional Structures		
	o 10 existing groins		62,000
	o Dune grass and sand fencing as for Alternative 1	177,000	302,000
	TOTALS	$ 700,000	$ 7,711,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 14,402,000	$ 18,724,000
4 Limited Restoration Program	Beach Fill		
	o Beach fill to 75' berm width at +10' MLW (255' beach width) in Stone Harbor (Initial in-place fill: 1,376,200 cu. yd.)	$ 7,941,000	$ 7,941,000
	Beach Nourishment		
	o 1,118,000 cu. yd. at 10-year intervals		4,135,000
	Initial Structural Repairs (see Alternative 5)	523,000	523,000
	Maintenance of Dunes and Existing Functional Structures		
	o 10 existing groins		62,000
	o Dune grass and sand fencing as for Alternative 1	177,000	302,000
	TOTALS	$ 8,641,000	$ 12,963,000
5 Maintenance Program	Initial Structural Repairs		
	o One groin and 620 L.F. of timber bulkhead	$ 523,000	$ 523,000
	Maintenance of Dunes and Existing Functional Structures		
	o 10 existing groins		62,000
	o 12,600 L.F. of timber bulkheading		68,000
	o 800 L.F. of stone revetment		4,000
	o Dune grass and sand fencing as for Alternative 1	177,000	302,000
	TOTALS	$ 700,000	$ 959,000



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (AL



REACH 12 – TOWNSENDS INLET TO HEREFORD INLET (SEVEN MILE BEACH)

NAUTICAL MILES

0 1 2 3

YARDS

1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000

FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- STEP INCREASE IN BEACH WIDTH TO 240' (BERM WIDTH OF 60' AT +10' MLW) BY THE YEAR 2020
- BEACH FILL TO 75' BERM WIDTH (255' BEACH WIDTH)
- BEACH FILL TO 100' BERM WIDTH (280' BEACH WIDTH)

LIMITED RESTORATION PROGRAM

(ALT 4)

DAMES & MOORE

FIGURE VI.B-13

13. Reach 13 — Hereford Inlet to Cape May Inlet (Five Mile Beach)

The proposed engineering plans for Five Mile Beach are presented schematically on Figure VI.B-14. Cost component summaries and total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-13. No action is proposed for the southern most portion of the reach which belongs to the U.S. Coast Guard.

a. Alternative 1 — Storm Erosion Protection

Four functional groins exist in the southern most part of this reach. This groin field is limited and located at the undeveloped portion of the beach known as Two Mile Beach. The oceanfront beaches adjacent to the developed areas north of Two Mile Beach are not protected by groins. The existing berm elevation is generally below +10 ft. MLW. This alternative, therefore, calls for beach fills to a minimum berm width of 100 ft. at elevation +10 ft. MLW (beach width 280 ft.) where it does not already exist along the oceanfront beaches from North Wildwood to Wildwood Crest. The berm elevations of the existing wide beaches would have to be raised to +10 ft. MLW. Beach nourishment is proposed at the end of the planning period as a means of maintaining the design berm.

Maintenance to preserve the functional and structural integrity of the existing structures is also proposed under this alternative as is dune maintenance in form of dune grass planting and sand fence installation. Since an adequate storm berm is recommended for protection of the entire extent of oceanfront beach, maintenance cost of the limited groin field at Two Beach Island is not included in the estimate.

b. Alternative 2 — Recreational Development

The entire ocean frontage of this reach has been developed for recreational beach use. In this alternative plan, transportation access to beach areas has been considered and is found to limit projected growth in the recreational demands at about year 2020. The beach recreational demand estimates and the design daily capacities (in beach user days) are:

	1980	2020
Average Day Demand	143,300	329,600
Peak Day Demand	214,900	219,800
Design Daily Capacity	278,400	278,400

The present and future beach demands are satisfied by the existing available beach area which, if maintained will be adequate to accommodate the design daily capacity. Therefore, no beach expansion is proposed under this alternative plan. Beach nourishment at the end of the planning period is proposed as the means of maintaining the existing beach width.

Maintenance items would include initial and periodic maintenance of the existing timber bulkheading in Wildwood Crest and dune maintenance including planting of 24 acres of dune grass and placement of 15,200 linear feet of sand fence.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The beach fills for the Storm Erosion Protection alternative control the initial planned berm width under the Combination plan for this reach. Details of this alternative plan are identical to those of Storm Erosion Protection Plan (Alternative 1).

d. Alternative 4 — Limited Restoration

Along the central portion of this reach at the Wildwood Crest beaches, shoreline recession rates are relatively higher than other parts of the oceanfront beaches. Under this alternative plan, beach fill is proposed in this area to mitigate local erosional losses. A minimum berm width of 100 ft. (beach width 280 ft.) is proposed. The existing beach will not be filled along the remaining portion of this reach.

Beach nourishment is recommended as a means of maintaining the design and natural beach widths. Maintenance items include initial and periodic structural maintenance as well as dune maintenance as provided in Alternative 5.

e. Alternative 5 — Maintenance Program

Initial maintenance of existing functional structures is recommended to bring structures up to a uniform level of integrity throughout the reach. This work includes repairs to approximately 900 linear feet of bulkhead. Periodic maintenance of the existing functional structures, including 3000 linear feet of bulkheading, is also proposed during the planning period to ensure its integrity. Initial and subsequent periodic maintenance work is a component of all five of the alternatives for this reach. The beach berm would be repaired only after the occurrence of significant storm damage.

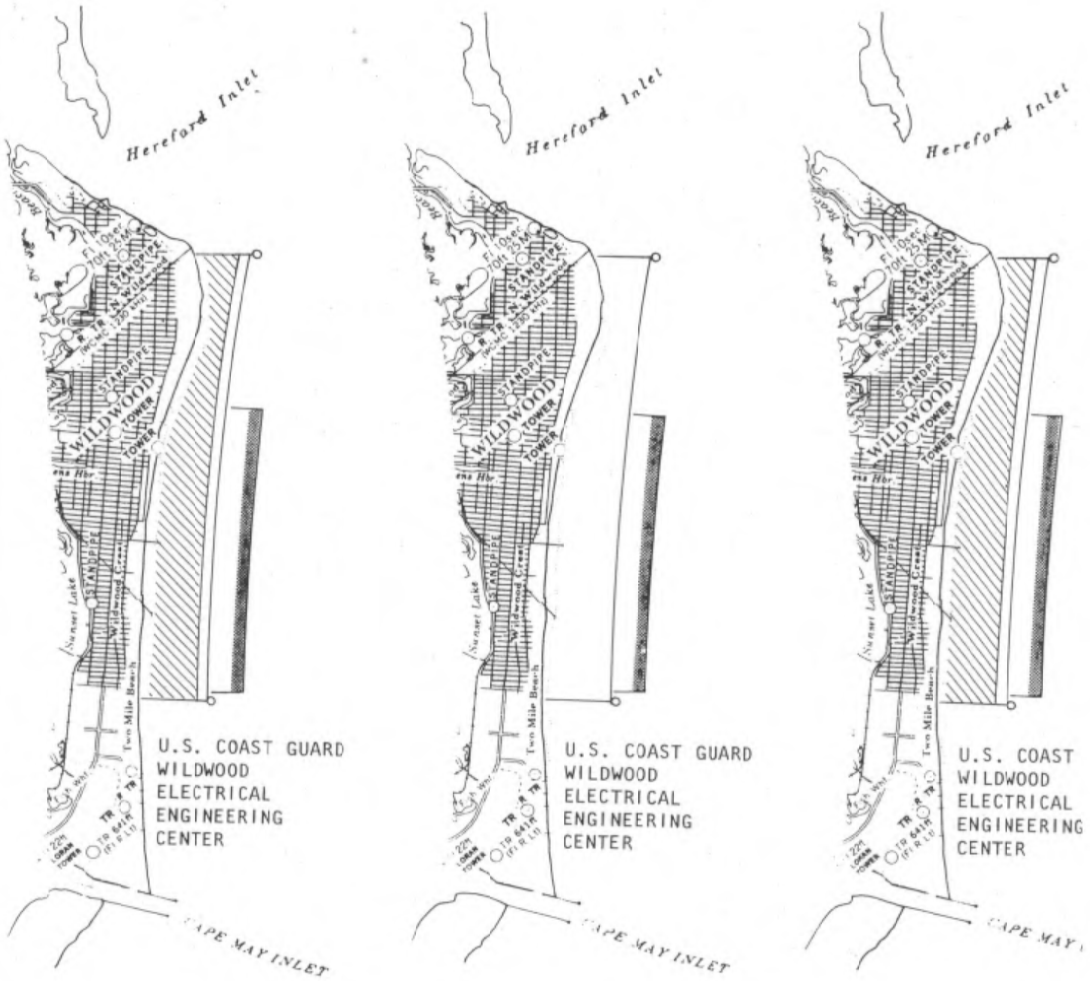
Dune maintenance, planting of 24 acres of dune grass, and placement of 15,200 linear feet of sand fence is also provided under this and all other alternatives for this reach. Replacement of sand fencing is proposed at 3-year intervals.

TABLE VI.B-13

REACH 13 - FIVE MILE BEACH (HEREFORD INLET TO CAPE MAY INLET)

Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o Initial fill to 100' berm width at +10' MLW (280' beach width) In-place quantity: 388,300 cu. yd.	$ 3,193,000	$ 3,193,000
	Beach Nourishment		
	o 845,000 cu. yd. at the end of the 50-year planning period		62,000
	Initial Structural Repairs (see Alternative 5)	584,000	584,000
	Maintenance of Dunes and Existing Functional Structures		
	o Placement of 24 acres of dune grass, 15,200 L.F. of sand fence and replacement of sand fence at 3-year intervals	168,000	311,000
	TOTALS	$ 3,945,000	$ 4,150,000
2* Recreational Development	Beach Nourishment		
	o 845,000 cu. yd. at the end of the 50-year planning period		$ 62,000
	Initial Structural Repairs (see Alternative 5)	$ 584,000	584,000
	Maintenance of Dunes and Existing Functional Structures		
	o Timber bulkheading approximately 3,000 L.F.		16,000
	o Dune grass and sand fencing as in Alternative 1	168,000	311,000
	TOTALS	$ 752,000	$ 973,000
3 Combination Storm Erosion Protection and Recreational Development	Beach Fill		
	o Initial fill to 100' berm width at +10' MLW (280' beach width) In-place quantity: 388,300 cu. yd.	$ 3,193,000	$ 3,193,000
	Beach Nourishment		
	o 845,000 cu. yd. at the end of the 50-year planning period		62,000
	Initial Structural Repairs (see Alternative 5)	584,000	584,000
	Maintenance of Dunes and Existing Functional Structures		
	o Dune grass and sand fencing as in Alternative 1	168,000	311,000
	TOTALS	$ 3,945,000	$ 4,150,000
4 Limited Restoration Program	Beach Fill		
	o Initial fill in Wildwood Crest area to 100' berm width at +10' MLW (280' beach width) In-place fill quantity: 175,700 cu. yd.	$ 2,287,000	$ 2,287,000
	Beach Nourishment		
	o 845,000 cu. yd. at the end of the 50-year planning period		62,000
	Initial Structural Repairs (see Alternative 5)	584,000	584,000
	Maintenance of Dunes and Existing Functional Structures		
	o Dune grass and sand fencing as in Alternative 1	168,000	311,000
	TOTALS	$ 3,039,000	$ 3,244,000
5 Maintenance Program	Initial Structural Repairs		
	o 900 L.F. of timber bulkhead	$ 584,000	$ 584,000
	Maintenance of Dunes and Existing Functional Structures		
	o Timber bulkheading (approximately 3,000 L.F.)		16,000
	o Dune grass and sand fencing as in Alternative 1	168,000	311,000
	TOTALS	$ 752,000	$ 911,000

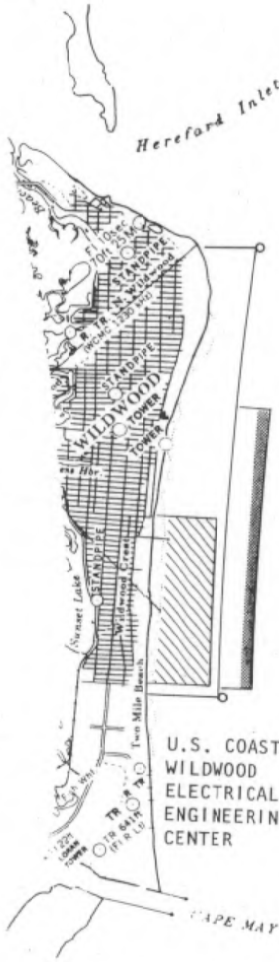
*Existing beach width, if maintained, would satisfy the recreational demand throughout the entire planning period (50 years).



STORM EROSION PROTECTION (ALT 1)

RECREATIONAL DEVELOPMENT (ALT 2)

COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (



GUARD

INLET

REACH 13 - HEREFORD INLET TO CAPE MAY INLET (FIVE MILE BEACH)

NAUTICAL MILES

0 1 2 3

YARDS

1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- BEACH FILL TO 100' BERM WIDTH (280' BEACH WIDTH)

LIMITED RESTORATION PROGRAM
(ALT 4)

ALT 3)

DAMES & MOORE

FIGURE VI.B-14

14. Reach 14 — Cape May Inlet to Cape May Point

Alternative engineering plans evaluated for Reach 14 are provided schematically on Figure VI.B-15. Cost component summaries and the total estimated present worth costs for the five alternatives discussed below are provided in Table VI.B-14.

a. Alternative 1 — Storm Erosion Protection

Two distinct types of shoreline are found in this reach. The first consists of the developed, groin and seawall protected coast such as those at Cape May City and Cape May Point. The second consists of the unprotected eroding beaches at Lower Township and at the U.S. Coast Guard Base north of Cape May City. The Storm Erosion Protection Plan for the first type of shoreline consists of placement of beach fill to a minimum berm width of 75 ft. at elevation +10 ft. MLW within the limits of the existing groin fields. Periodic beach nourishment is proposed at 3-year intervals as the means of maintaining the design berm widths. The beaches at Cape May City and Cape May Point would be nourished by sand taken from suitable offshore borrow sources.

The unprotected beaches of this reach are severly eroded. Groins at the extreme ends of these areas have acted as hardened headlands and have contributed to the formation of embayments in these areas. These areas are slowly approaching a crenulate-shaped form which tends to become stabilized when the shoreline becomes parallel to the characteristic wave approach direction at the shore (Silvester, 1976). In this case, there is no longshore component of wave energy available to drive the littoral drift. Everts (1979) studied this concept as one of several possible means of curbing the erosion problems at Lower Township. Silvester's method was used to estimate the amount of beach material which would be eroded before an equilibrium configuration is finally reached. The proposed plan for these areas incorporates the concept of the stable crenulate-bay. Recognizing that additional erosion would occur before the areas reach equilibrium, this plan calls for purchase of the acreage which would be lossed, as well as a 100 ft. buffer strip, to allow temporary land losses to storms. Improvements to the groins which are located at the ends of the eroded areas are also proposed. Such modifications would involve adding spurs to the landward ends of the groins to prevent flanking of the structure. The terminal groin at Cape May City already has such a spur and would probably not need further modification.

The maintenance program for this alternative includes the maintenance of the both existing and planned new and modified structures, as well as dune maintenance in the form of dune grass planting and sand fence installation in Lower Township and Cape May Point.

b. Alternative 2 — Recreational Development

Recreational beach development is recommended for the beaches at Cape May City and Cape May Point. Due to carrying capacity limitations, the recommended berm development is designed to satisfy the demands only to the year 2013. The recreational beach demand estimates and the design daily capacities (in beach user days) for this reach are:

	1980	2013
Average Day Demand	27,200	39,500
Peak Day Demand	43,600	63,300
Design Daily Capacity	37,800	52,400

Periodic expansions in berm width is proposed at 10-year intervals to accommodate the growth in beach use demand over the project life. The last beach expansion would occur in the year 2010 for a total beach width of 144 ft. This would provide adequate beach area to satisfy the estimated design capacity for the year 2013.

Beach nourishment is proposed as the means of maintaining the design beach widths. This alternative also includes maintenance of the existing structures as well as dune maintenance in Lower Township and Cape May Point. The dune maintenance includes the planting of dune grass and sand fence placement as in Alternative 5 below.

c. Alternative 3 — Combination of Storm Erosion Protection and Recreational Development

The Storm Erosion Protection Plan design controls the initial beach fill and provides an adequate beach to meet the projected recreational demand. Components of this alternative plan include: groin modifications for beach stabilization purposes in the U.S. Coast Guard property area and the Lower Township; beach nourishment and maintenance of the existing and new structures, are the same as recommended for the Storm Erosion Protection plan (Alternative 1).

d. Alternative 4 — Limited Restoration

Beach fills are recommended to be placed in the groin-protected areas of Cape May City and Cape May Point to provide a 75 ft. berm width at +10 ft. MLW. The other components of this alternative plan are identical to those recommended for Storm Erosion Protection (Alternative 1) except that modification of groins in the U.S. Coast Guard property area and Lower Township, to stabilize the unprotected beaches, is not included in this alternative plan.

e. Alternative 5 — Maintenance Program

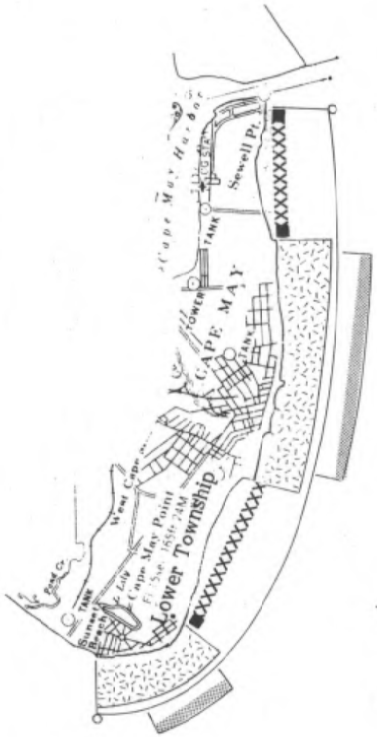
Initial repair of existing functional structures is recommended to bring these structures up to a uniform level of integrity throughout the reach. This work includes repairs to 3 groins and approximately 2050 linear feet of seawall. Periodic maintenance of the existing functional structures, including 22 existing groins, 4100 linear feet of timber bulkhead, and 9400 linear feet of stone seawall is also provided during the planning period to ensure their integrity. The beach berm would be repaired only after the occurrence of significant storm damage.

Dune maintenance, including planting of 21 acres of beach grass and installation and periodic replacement of 10,200 linear feet of sand fencing, is also proposed under this and all other alternatives for this reach.

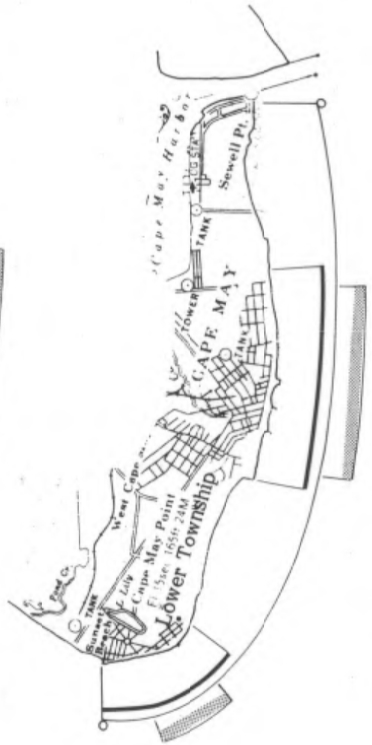
TABLE VI.B-14

REACH 14 - CAPE MAY INLET TO CAPE MAY POINT

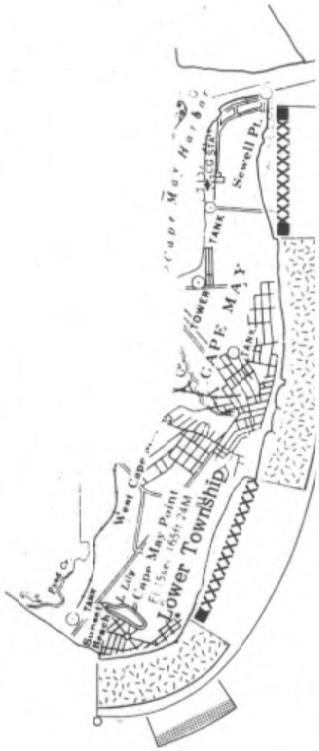
Alternative	Cost Components	Estimated Initial Costs	Estimated Present Worth Cost Totals
1 Storm Erosion Protection	Beach Fill		
	o 75' design berm width (at +10' MLW) in Cape May City and Cape May Point groin fields (Total initial fill quantity: 2,268,000 cu.yd.) Corresponding beach widths are 255' and 165' in Cape May City and Cape May Point, respectively.	$ 13,310,000	$ 13,310,000
	Beach Nourishment		
	o 1,158,000 cu. yd. at 3-year intervals		19,730,000
	Structural Modifications		
	o 3 groins	1,389,000	1,389,000
	Initial Structural Repairs (see Alternative 5)	865,000	865,000
	Maintenance of Dunes and Existing Structures		
	o 22 existing groins		131,000
	o Placement of 14 acres dune grass, install 6,200 L.F. (Cape May Point) of sand fence and 7 acres dune grass 4,000 L.F. sand fence (Lower Twp.) and replacement of sand fence at 3-year intervals	139,000	227,000
	Purchase Value of Land - (Erodible lands to attain shoreline equilibrium plus 100' storm berm)		
	o Lower Township (18.6 acres at $5,000/acre)	93,000	93,000
	o U.S. Coast Guard land (18.4 acres at $5,000/acre)	92,000	92,000
	TOTALS	$ 15,888,000	$ 35,837,000
2 Recreational Development	Beach Fill		
	o Initial fill for recreational development in Cape May City and Cape May Point groin fields for a 104' beach width (approximately 10' berm width at +10' MLW) (Total in place quantity: 1,431,000 cu. yd.)	$ 8,804,000	$ 8,804,000
	o Periodic berm expansion in 10-year intervals (341,000 cu. yd.) until the year 2010 for a total beach width of 144' (berm width at +10' MLW = 30' in Cape May City and 54' in Cape May Point)		1,983,000
	Beach Nourishment		
	o 1,158,000 cu. yd. at 3-year intervals		19,730,000
	Initial Structural Repairs (see Alternative 5)	865,000	865,000
	Maintenance of Dune and Existing Functional Structures		
	o 22 existing groins		131,000
	o Dune grass and sand fencing as in Alternative 1	139,000	227,000
	TOTALS	$ 9,808,000	$ 31,740,000
3 Combination Storm Erosion Protection and Recreational Development	SAME AS ALTERNATIVE 1 ABOVE	$ 15,888,000	$ 35,837,000
4 Limited Restoration Program	Beach Fill		
	o Initial fill to 75' berm width at +10' MLW (255' beach width) at Cape May City and 75' berm width (165' beach width) at Cape May Point groin fields. (Total in-place quantity: 2,268,000 cu. yd.)	$ 13,310,000	$ 13,310,000
	Beach Nourishment		
	o 1,158,000 cu. yd. at 3-year intervals		19,730,000
	Initial Structural Repair (see Alternative 5)	865,000	865,000
	Maintenance of Dunes and Existing Structures		
	o 22 existing groins		131,000
	o Dune grass and sand fencing as in Alternative 1	139,000	227,000
	TOTALS	$ 14,314,000	$ 34,263,000
5 Maintenance Program	Initial Structural Repairs		
	o 3 groins and 2050 L.F. of stone seawall	$ 865,000	$ 865,000
	Maintenance of Dunes and Existing Structures		
	o 22 existing groins		131,000
	o 4,100 L.F. of timber bulkheadings		22,000
	o 9,400 L.F. of stone seawall		252,000
	o Dune grass and sand fencing as in Alternative 1	139,000	227,000
	TOTALS	$ 1,004,000	$ 1,497,000



STORM EROSION PROTECTION (ALT 1)

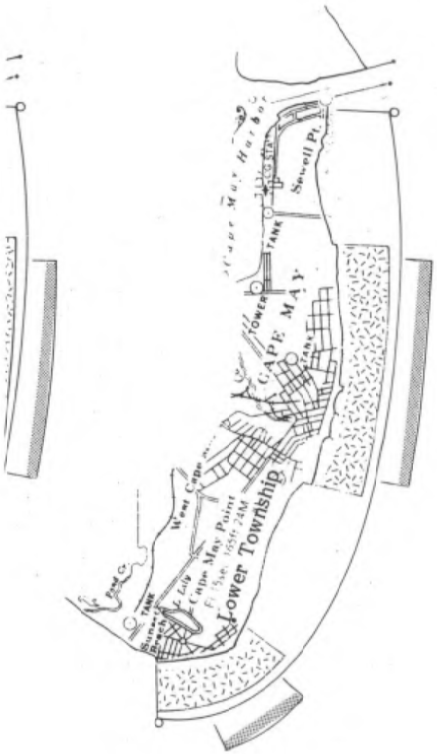


RECREATIONAL DEVELOPMENT (ALT 2)



COMBINATION OF STORM EROSION PROTECTION AND RECREATIONAL DEVELOPMENT (A

REACH 14 – CAPE MAY INLET TO CAPE MAY POINT



NAUTICAL MILES
0 1 2 3

YARDS
1000 0 1000 2000 3000 4000

3000 0 3000 6000 9000 12000
FEET

KEY:

- MAINTENANCE OF THE EXISTING FUNCTIONAL AND NEW STRUCTURES AND DUNES
- PERIODIC BEACH NOURISHMENT
- INITIAL FILL FOR A BEACH WIDTH OF 104' (~10' BERM WIDTH AT +10' MLW) AND STEP INCREASE IN BEACH WIDTH TO 144' BY THE YEAR 2010
- BEACH FILL TO 75' BERM WIDTH (BEACH WIDTH 255' IN CAPE MAY INLET AND 165' IN CAPE MAY POINT)
- XXXXX GROIN MODIFICATION FOR DEVELOPMENT OF EQUILIBRIUM BEACH FORMS

LIMITED RESTORATION PROGRAM
(ALT 4)

LT 3)

DAMES & MOORE

FIGURE VI.B-15

15. Reaches 15 and 16 — Delaware Bay and Delaware River

The Delaware bayshore communities have experienced erosion damage over a long period of time. In the 1930's some of them had large beaches and were popular resort areas. However, a large amount of protective beach was lost along the bay communities during the November 1950 storm. Continued erosion has been experienced along bay shore damage centers which are listed in Table VI.B-15. The situation has progressed to the stage where homes are destroyed by both erosion and flooding during recurring storms.

The Corps of Engineers has prepared plans to remedy this situation and has evaluated their economic feasibility. Beach fill is included in all plans evaluated by the Corps; supplemental stone revetment work was evaluated for Money Island; and timber groin construction and sand fence installation was evaluated for the remaining areas. All these projects have been found to be economically unfeasible with benefit/cost ratios of 0.65:1 or less (Corps of Engineers, 1979).

Some shore protection work has been completed by the State along Delaware Bay. A stone jetty was constructed in 1980 at the the entrance to Bidwells Creek. The project cost of $850,000 was funded with the 1977 Beaches and Harbors Bond Act monies.

Some additional relief may be available to the bay communities under the Federal Shoreline Erosion Control Demonstration Act of 1974. Federal funding for low-cost erosion control work may be available for six project sites along Delaware Bay pending action by Congress on the Water Resources Bill in which the projects are contained. The six project sites that have been designated thus far are:

- Fort Elfsborg
- Sea Breeze
- Gandys Beach
- Reeds Beach
- Pierces Point
- Fortescue

The Shoreline Erosion Control Demonstration Act of 1974 (P.L. 93-251 Section 54) was passed by Congress in recognition of a need for low-cost means of protecting inland and sheltered water from wave erosion. The program is developed for demonstration purposes where successful and unsuccessful shore erosion protection means can be documented. The installations are to be low-cost ($50-125/ft. in-place or less) with minimal maintenance charges. The protective works are intended to have an expected useful life of 10-years. Project sites were initially selected to establish at least two demonstration sites on each coast (Atlantic, Gulf, Pacific, Alaska and Great Lakes). Additional sites, including the six sites listed above for the New Jersey coast of Delaware Bay, are included in pending appropriations legislation presently before Congress. Specific protection devices or erosion control measures are to be developed once funding is approved.

TABLE VI.B-15

DAMAGE CENTERS
CUMBERLAND AND CAPE MAY COUNTIES

Location	Shoreline Length (miles)	Homes Affected
Sea Breeze	0.6	45
Money Island	0.5	31
Gandys Beach	0.7	78
Fortescue	1.1	363
Thompson Beach	1.5	56
Reeds Beach	0.8	102
Pierces Beach	0.7	58

Source: USACOE, Philadelphia District (1979).

Project sponsors have obligations under provisions of the Act. These are:

- Sites are to be provided to the Federal Government at no cost;
- Non-Federal sponsors must provide 25 percent of the project cost in cash or in services;
- The sponsor will assume all costs of operation and maintenance after completion of the project; and
- The sponsor will provide and enable access to the demonstration project by the private sector and the Federal Government.

Comparable legislation is contained in Section 32 of the Water Resources Development Act of 1974. This Act authorized a five-year streambank erosion prevention and control demonstration program which consists of (1) evaluation of the extent of erosion on navigable rivers and their tributaries; (2) development of new methods and techniques for bank protection research on soil stability, and identification of the causes of erosion; (3) report on the results of these studies and recommend means to prevent and correct streambank erosion; and (4) demonstration of various methods of streambank erosion control. A demonstration site under this legislation is located on the Delaware River at Paulsboro, New Jersey. Construction at this site was completed in March 1980. Project features include:

- Nylon sand bag groins
- Rubber tire revetments
- Rip-rap revetments
- Longard tube groins
- Rip-rap toe protection for existing bulkhead
- Gabion revetment

A monitoring program is ongoing to assist in the evaluation of performance of these features.

The Corps of Engineers is further considering the erosion of the Delaware River shoreline at Pennsville. Federal funding to correct the situation would be available if these further studies show the damage to be caused by the Pennsville Training Dike, a Federal navigation project.

The Delaware River shore is worthy of consideration for low-cost erosion control methods on a case-by-case basis where they can be demonstrated to be economically feasible. A general location map for the Delaware River and Bay is provided in Figure VI.B-16. Typical engineering projects currently under consideration by the State for the Delaware River shore are listed on Table VI.B-16.

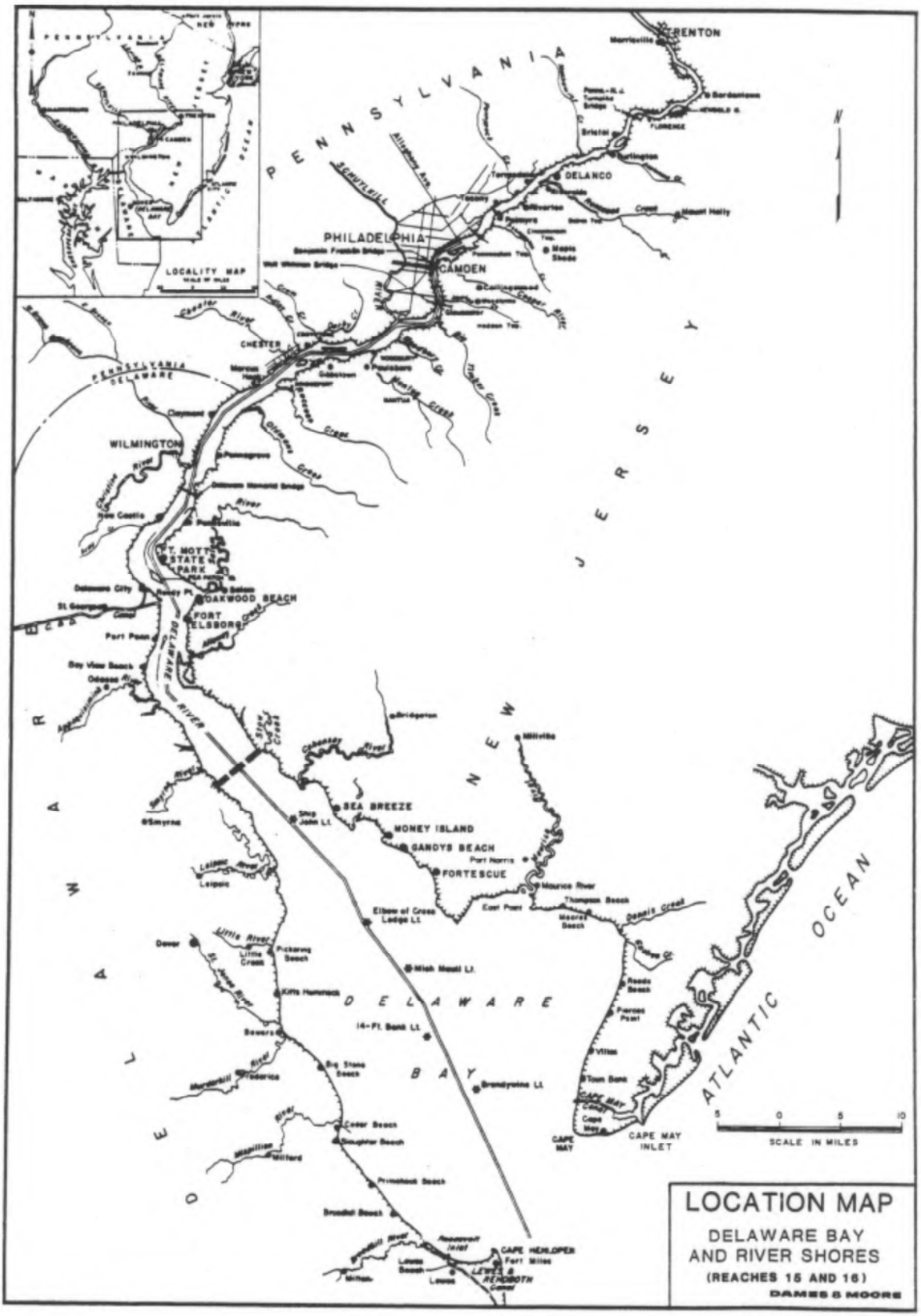


FIGURE VI.B-16

TABLE VI.B-16

DELAWARE RIVER – REACH 16
TYPICAL PROJECTS UNDER CONSIDERATION

County/Municipality	Project Description	Estimated Cost (1980 Dollars)
Salem		
o Pennsville Township	Stone Revetment Construction at Pittsville Street (in progress)	$ 250,000
	Riverview Park Bulkhead Rehabilitation	460,000
o Fort Mott State Park	Revetment Construction	850,000
o City of Burlington	Construction of Steel Bulkhead	2,000,000
o City of Beverly	Bulkhead and Revetment Construction	750,000
o Florence Township	Revetment Construction	300,00
o Carney's Point Township	Steel Bulkhead Construction	475,000

16. Inlet Shores

The dominant erosional processes on inlet shores include tidal current scour, inlet channel migration, and erosion by short period, storm and vessel generated waves. The southern shores of the inlets between the barrier islands south of Barnegat Inlet are especially subject to channel migration effects. The southerly littoral drift generally results in accretion on the northern inlet shore. This filling causes the inlet channels to shift toward the southern shores where they exert their erosional forces.

Historically shore protection methods for New Jersey coastal inlet shores have included the construction of jetties, bulkheads, revetments, groin fields, and beach fill programs. Table VI.B-17 lists the inlet and the stabilization techniques used on each. Fill materials placed to stabilize any inlet shore (e.g., Absecon Inlet – Atlantic City) especially south shores of inlets, have, in most cases, been rapidly lost to swift moving inlet tidal currents. Inlet groin fields (e.g., Hereford Inlet – North Wildwood and Townsend Inlet – Avalon) have generally not been effective in trapping or retaining littoral drift material over prolonged periods. These techniques for building and holding sand beaches on eroding inlet shores are generally ineffective. Other factors such as the occurrence of high velocity currents, steep bottom dropoffs into channels, and vessel traffic reduce the recreational swimming potential of inlet shores to a negligible level at most locations. Therefore, the inability to maintain sand beaches on some of these shores does not represent a significant loss of a recreational resource.

The preference for non-structural approaches to shore stabilization, which generally applies throughout this Master Plan, is not applicable on inlet shores because of the problems noted above. Structural approaches have been reasonably effective in maintaining the position of inlet shores. Projects involving seawall, bulkhead, revetment, and groin stabilization of inlet shores are conditionally in agreement with this Master Plan. Case-by-case review of their expected performance and their economic justification should be completed prior to actual implementation of any such project. Table VI.B-18 lists those inlet projects which are currently under consideration or which have been completed with Beaches and Harbors Bond funds.

Comprehensive inlet plans have been formulated by the Corps of Engineers at various times for the purpose of inlet stabilization and navigational improvements. These plans are summarized in Table VI.B-19. Although evaluation of these inlet stabilization plans is beyond the scope of this Master Plan Study, such projects would be conditionally acceptable if it can be demonstrated that they will not adversely effect shoreline erosion (especially on the downdrift shores) and that they are economically feasible.

TABLE VI.B-17

INLET CONDITION SUMMARY

Inlet	Condition	Responsibility/Recommendations
Shark River	Jetty stabilized	State owned and maintained jetties
Manasquan	Jetty stabilized	Federal project with State participation
Barnegat	Jetty stabilized	Federal project with State participation
Beach Haven	Natural	To be left in a natural state
Little Egg	Natural	To be left in a natural state
Brigantine	Natural	To be left in natural state
Absecon	Jetty stabilized	Federal project, State has maintained responsibility for the north jetty, State and Atlantic City share maintenance responsibility for south jetty.
Great Egg Harbor	Inlet shore armoring on south shore	State and local maintenance
Corsons	Natural	To be left in a natural state
Townsend	Inlet shore armoring on south shore	State and local maintenance
Hereford	Inlet shore armoring on south shore with groins, seawall and bulkhead	State and local maintenance
Cape May	Jetty stabilized	Federal project

TABLE VI.B-18

TYPICAL INLET SHORE PROJECTS UNDER CONSIDERATION

Inlet	Project Description	Estimated Cost (1980 Dollars)
Shark River	Bulkhead replacement on north side of inlet west of Ocean Avenue Bridge (State property)	$ 865,000
	Maintenance of inlet jetties (annual)	6,000
Barnegat	Maintenance of inlet structures on south shore (annual)	22,000
Absecon	Maintenance of north jetty (annual)	28,000
	Rehabilitation of south jetty	800,000
	Maintenance of south jetty (annual)	9,000
	Maintenance of inlet groins, bulkheads and revetments (annual)	6,000
	Revetment extension to connect with Oriental Avenue jetty	320,000
Great Egg Harbor	Emergency beach fill on south shore at foot of Seacliff Road (completed in 1979 with Beaches and Harbors Bond funds)	236,000
	Construction of two timber and stone groins at beach fill site (completed in 1979 with Beaches and Harbors Bond funds)	353,000
	Upgrade stone revetment at south end of Longport	90,000
Townsends	Maintenance of groins and timber bulkhead on south shore (annual)	3,000
Hereford	Extension of stone revetment on south shore at foot of Jersey Avenue, North Wildwood	433,000
	Maintenance of groins, seawall, and bulkheads on south shore of inlet (annual)	9,000
	Construct 1200 linear feet of stone seawall on south shore of inlet plus three stone groins	1,000,000

TABLE VI.B-19

AUTHORIZED FEDERAL INLET STABILIZATION PLANS

Inlet	Project Description	Estimated[1] Initial Cost	Estimated[1] Annual Cost
Barnegat[2]	4200' south jetty, channel dredging, maintenance of jetty and channel, and nourishment of Long Beach Island beaches	$ 31,723,000	$ 724,000
Absecon[3]	2300' offshore weir breakwater with deposition basin maintenance of breakwater dredging of deposition basin for beach nourishment/ bypassing	10,519,000	1,033,000
Great Egg Harbor[4]	3000' north weir jetty, 4200' south jetty, deposition basin, navigation channel maintenance of channel and jetties, dredging of deposition basin for beach nourishement/bypassing	27,231,000	2,297,000
Corson[5]	3225' north weir jetty, 2800' south jetty, deposition basin, navigation channel, maintenance of channel and jetties, dredging of deposition for beach nourishment/bypassing	18,825,000	2,319,000
Townsend[6]	5300' north weir jetty, 1250' south jetty deposition basin, navigation channel, maintenance of channel and jetties, dredging of deposition basin for beach nourishment/bypassing	18,241,000	1,587,000
Hereford[7]	5600' north weir jetty, 1400' south jetty, deposition basin, navigation channel, maintenance of channel and jetties, dredging of deposition for beach nourishment/bypassing	12,646,000	935,000
Cape May[8]	2560' offshore weir breakwater and deposition basin, maintenance of breakwater dredging of deposition basin for beach nourishment/ bypassing	5,357,000	710,000

Notes and Sources:

(1) Updated to 1980 dollar costs
(2) USACOE, Philadelphia District (July 1981)
(3) USACOE, Philadelphia District (September 1974a)
(4) USACOE, Philadelphia District (September 1976b)
(5) USACOE, Philadelphia District (November 1976a)
(6) USACOE, Philadelphia District (1966)
(7) USACOE, Philadelphia District (1972)
(8) USACOE, Philadelphia District (March 1980).

17. Other Shore Areas

The shores of backbays, and tributary waterways are normally not subjected to the high energy open-ocean wave climate which is the major erosional force on the ocean shores. The primary concern in these areas is the treatment of erosion generated by tidal processes or wave action generated by boat traffic. Because of the proximity of these areas to ocean beaches where recreational development is heavily emphasized, beach development (i.e., beach fill) is not normally considered justifiable as a means of shore erosion protection. More commonly, lower cost structural alternatives, such as bulkheading or low profile revetments, are employed to mitigate local erosion problems.

As for Reaches 1, 15 and 16, varying conditions and requirements along the backbay and tributary waterway shores require that the economic feasibility of projects be considered on a case-by-case basis. Various low-cost shore protection methods discussed in Chapter IV, Section B could also be appropriate as local conditions warrent their suitability. Table VI.B-20 provides a list of backbay and tributary waterway shore projects currently under consideration or completed with Beaches and Harbors Bond funds. These types of projects are generally applicable to backbay and tributary waterway shores.

TABLE VI.B-20

BACKBAY AND TRIBUTARY WATERWAYS PROJECTS

County/Municipality	Project Description	Estimated Cost (1980 Dollars)
Atlantic		
o Egg Harbor Township	Bulkhead Repair along Lagoon and Channel Bordering, Brien Drive at Anchorage Point	$ 346,000
o Ventnor City	Bulkhead Rehabilitation at Wellington and Cornwall Avenue	420,000
Cape May		
o Wildwood City	Timber Bulkhead Construction along shorefront of Post Creek	94,000
o North Wildwood City	Construct Bulkhead at 2nd and Delaware Avenue	300,000
Monmouth		
o Spring Lake Borough	Stone Revetment Construction north shore of Wreck Pond	144,000
Ocean		
o Beachwood Borough	Timber Bulkhead Replacement	577,000
o Eagleswood Township	Timber Bulkhead Repair on West Creek	22,000
o Lacey Township	Fill and Rip-rap Placement at Capstian Drive	144,000
o Pine Beach Borough	Fill Placement along Toms River	87,000
o Lavallette Borough	Fill Placement near Vance Avenue on Barnegat Bay	288,000
o Ocean Township	Reconstruct timber breakwater at Waretown Creek	577,000
o Ocean Gate Borough	Beachfill between Monmouth Avenue and Naragansette Avenue	144,000
	Fill placement along Toms River	29,000
o Tuckerton Borough	Bulkhead Repair at Bartlett Avenue	9,000
o Island Heights	Various shore protection repairs (completed in 1980 with Beaches and Harbors Bond funds)	62,000

C. FEDERAL ENGINEERING STUDIES AND AUTHORIZED PROJECTS

The Corps of Engineers, in cooperation with the State, has developed a series of plans for comprehensive shore protection of the ocean beaches and inlets. These plans have received congressional authorization, but most are in the inactive category because of the inability of State and local government units to commit to the initial cost-sharing and maintenance responsibilities. In New Jersey, the general practice with regard to inlet stabilization has been to construct costly master jetties for navigation purposes; however, a few Federal projects which do not involve major inlet stabilization costs have been completed.

A cooperative study on the problems of beach erosion and shore protection along the Atlantic coast of New Jersey was undertaken by the Corps of Engineers and the State of New Jersey pursuant to an application and basic agreement dated September 22, 1952, from the New Jersey Department of Conservation and Economic Development. The agreement was approved by the Chief of Engineers, Department of the Army, on April 1, 1953, in accordance with provisions of the Rivers and Harbors Act (Public Law 71-520).

Sections of the coast were identified with groups of inlets that were closely related both economically and physically. The grouping of the inlets and the order of priority as established by the State of New Jersey was as follows:

- First priority group — Printed as House Document No. 91-160 and authorized by Congress in 1970 under authority of Section 201 of Public Law 89-298:
  - Great Egg Harbor Inlet and Peck Beach
  - Corson Inlet and Ludlam Beach
  - Townsend Inlet and Seven Mile Beach.
- Second priority group — Printed as House Document No. 94-641 and authorized by Congress in 1976 under authority of the Water Resources Development Act of 1976:
  - Hereford Inlet and Five Mile Beach
  - Cape May Inlet to Lower Township
  - Delaware Bay Area.
- Third priority group — Printed as House Document No. 94-631 and authorized by Congress in 1976 under authority of the Water Resources Development Act of 1976:
  - Barnegat Inlet
  - Beach Haven Inlet and Long Beach Island
  - Little Egg Inlet, Brigantine Inlet, and Brigantine Island
  - Absecon Inlet and Absecon Island.
- Fourth priority group — Not printed as a House Document.
  - Shark River Inlet
  - Manasquan Inlet.

This cooperative study has produced a comprehensive long-term beach erosion control, navigation, and storm protection plan for the entire Atlantic coast of New Jersey. A summary of the findings (USACOE, Philadelphia District, 1978) and the status of each group is presented in Table VI.C-1. Figure VI.C-1 shows the location of the planned actions along the coast.

Some Federal plans have been fully implemented on the New Jersey shore. Maintenance of such completed Federal projects must be performed as a requirement of the congressional act under which the project was authorized. State and local governments are required to execute assurances to that effect. Failure to provide for continued maintenance of these projects throughout their economic life (50 years) would violate the contractual agreements with the Federal Government and could result in the forfeiture of Federal funds for future projects.

Three Federal Shore Protection Projects have been completed on the New Jersey Coast — on Long Beach Island, at Atlantic City, and in the Keansburg area of the Raritan Bay shore. These projects and their maintenance commitments are listed in Table VI.C-2.

TABLE VI.C-1

AUTHORIZED FEDERAL PROJECTS
NEW JERSEY COASTAL INLETS AND BEACHES
FIRST PRIORITY GROUP PROJECTS

Project Area and Description	Status
Great Egg Harbor Inlet-Peck Beach: Estimated initial cost of construction at 1977 prices is $12,551,000 Federal and $12,400,000 State of New Jersey. Project would provide for 2 jetties with weir and deposition basin, navigation channel (12' x 300'), 2 groins in Ocean City, and beach fill and periodic nourishment.	Authorized in 1970 under Sec. 201 of the Flood Control Act of 1965. Funds were appropriated in FY 77 for completion of advanced engineering and design plans. However, the project has been suspended and placed in the inactive category due to the inability of the State to provide the required local assurances.
Corson Inlet-Ludlam Beach: Estimated initial cost of construction at 1977 prices is $11,356,000 Federal and $12,000,000 State of New Jersey. Project would provide for 2 jetties with weir and deposition basin, navigation channel (12' x 300'), 10 groins, and beach fill and periodic nourishment.	Inlet channel was initially dredged by the Corps in 1967 under the emergency authority provided by the Rivers and Harbors Act of 1945. Last maintenance dredging was done by the Corps in 1969 with reimbursement by the State. The combined inlet and beach project was authorized in 1970 under Sec. 201 of the Flood Control Act of 1965. Funds were appropriated in FY 77 for completion of advanced engineering and design. However, the project has been suspended and placed in the inactive category due to the inability of the State to provide the required local assurances.
Townsend Inlet-Seven Mile Beach: Estimated initial cost of construction at 1977 prices is $8,692,000 Federal and $7,720,000 State of New Jersey. Project would provide for 2 jetties with weir and deposition basin, navigation channel (12' x 300'), 7 groins along inlet, and beach fill and periodic nourishment.	Inlet channel was initially dredged by the Corps in 1967 under the emergency authority provided by the Rivers and Harbors Act of 1945. Last maintenance dredging was performed during July 1976 under a Corps' permit issued to State. The combined inlet and beach project was authorized in 1970 under Sec. 201 of the Flood Control Act of 1965.

TABLE VI.C-1 (Continued)

SECOND PRIORITY GROUP PROJECTS

Project Area and Description	Status
Hereford Inlet-Five Mile Beach: Estimated initial cost of construction at 1977 prices is $11,908,000 Federal and $7,170,000 State of New Jersey. Project would provide for 2 jetties with weir and deposition basin, dredging and maintenance of navigation channel (12' x 300'), 4 groins and bulkhead along inlet and ocean frontage of North Wildwood, and dunes with sand fence and dune grass.	Inlet channel was initially dredged by the Corps in 1967 under the emergency authority provided by the Rivers and Harbors Act of 1945. Last maintenance dredging was done by the State in 1975 under Corps permit. The combined inlet and beach project was authorized in 1967 by the Water Resources Development Act of 1976. Phase I pre-construction planning authorized by the 1976 legislation.
Cape May Inlet to Lower Township Authorized Feasibility Study Plan (1976): Estimated initial cost of construction at 1979 prices is $24,100,000 Federal and $4,200,000 State of New Jersey. Project would provide for a breakwater updrift of north jetty with weir and deposition basin, 9 groins, rehabilitation of a portion of Cape May seawall, beach fill and periodic nourishment, and dunes with sand fence and dune grass.	Authorized by the Water Resources Development Act of 1976. Section III of the Rivers and Harbors Act of 1968 is applicable to this project. Phase I pre-construction planning initiated in October 1977.
Cape May Inlet to Lower Township Tentatively Selected Plan (1980): Estimated initial costs of construction at July 1979 prices are $6,769,000 initial cost and $5,357,000 deferred cost (10 years). Annual maintenance and nourishment costs are $739,000. Project provides a reduced weir-breakwater (recommended in a deferred status), 9 groins in Cape May City, a reduced beach fill volume and the deletion of the seawall rehabilitation, and dune construction and groins in Lower Township.	A Phase I General Design Memorandum presenting a tentatively selected plan for this area was released in 1980 (USCOE, Philadelphia District, March 1980). The Federal Government is accepting full funding responsibility for the tentatively selected plan since erosion damage is related to the construction of the Federal navigation project at Cape May Inlet.
Cape May Point: Estimated initial cost of construction at 1977 prices is $3,290,000 Federal and $1,760,000 State of New Jersey. Project would provide for 5 groins and 3 groin extensions, 2 dikes, beach fill and periodic nourishment, and dunes with sand fence and dune grass.	Authorized in 1976 by the Water Resources Development Act of 1976. Phase I pre-construction planning authorized by the 1976 legislation.

TABLE VI.C-1 (Continued)

THIRD PRIORITY GROUP PROJECTS

Project Area and Description	Status
Barnegat Inlet: Estimated initial cost of construction at 1980 prices is $20,001,500 Federal and $11,721,500 State of New Jersey. Project would provide for a new south jetty, dredging and maintenance of a navigation channel (10' x 300'), nourishment of Long Beach Island beaches and jetty sport fishing facilities.	Inlet channel periodically dredged by the Corps as related to previous authorized project. Current project authorized by the Water Resource Development Act of 1976.
Long Beach Island: Estimated initial cost of construction at 1977 prices is $9,610,000 Federal and $9,400,000 State of New Jersey. Project would provide for 1 new groin, reimbursement for 14 groins, modification of 7 groins, maintenance of existing and new groins, maintenance of existing south jetty at Barnegat Inlet as a weir breakwater creating a deposition basin, and beach fill and periodic nourishment.	Authorized by the Water Resources Development Act of 1976. Project is presently inactive.
Brigantine Island: Estimated initial cost of construction at 1977 prices is $5,700,000 Federal and $2,800,000 State of New Jersey. Project would provide for 1 new groin and 1 extension, reimbursement for 6 groins and 1 extension, maintenance of existing and new groins, beach fill and periodic nourishment, dunes with sand fence and dune grass, and removal of timber piling from beach.	Authorized by the Water Resources Development Act of 1976. Project is presently inactive.
Absecon Island: Estimated initial cost of construction at 1977 prices is $8,618,000 Federal and $8,800,000 State of New Jersey. Project would provide for breakwater updrift of existing north jetty at Absecon Inlet with weir and deposition basin, relocation of existing navigation channel, and beach fill and periodic nourishment.	Inlet channel periodically dredged by the Corps as related to previous authorized project. Current project authorized by the Water Resources Development Act of 1976. Project is presently inactive.

TABLE VI.C-1 (Continued)

FOURTH PRIORITY GROUP PROJECTS

Project Area and Description	Status
Sandy Hook to Shark River Inlet: Estimated initial cost of construction at 1978 prices is $53,084,000. Project would provide for placement of beach fill to a berm width of 100 ft, construction of 23 new groins, the extension of 14 existing groins, and periodic nourishment.	Authorized by the Rivers and Harbors Act of 1958. Project is presently inactive.
Belmar to Manasquan Inlet: Estimated initial cost of construction at 1978 prices is $15,671,000. Project would pro vide for placement of beach fill to a berm width of 100 ft and periodic nourishment.	Authorized by the Rivers and Harbors Act of 1958. Project is presently inactive.
Point Pleasant Beach to Seaside Park: Estimated initial cost of construction at 1978 prices is $18,259,000. Project would provide for placement of beach fill to a berm width of 100 ft and periodic nourishment.	Authorized by the Rivers and Harbors Act of 1958. Project is presently inactive.

Source: USACOE, Philadelphia District (1978); USACOE, Philadelphia District (1980).

1998 pri

53
15.4
18.2
86.8 / 50.50
43.4
Total

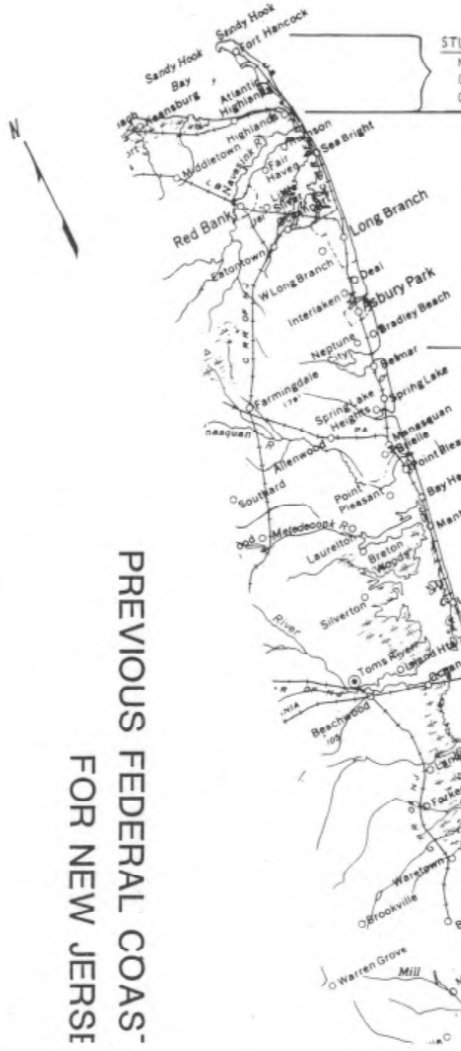
TABLE VI.C-2

COMPLETED FEDERAL SHORE PROTECTION PROJECTS

Location	Features
Borough of Keansburg[a] Unincorporated muncipality of East Keansburg (Waycake Creek to Pews Creek)	14,700 ft of hurricane beach protection consisting of a 25-ft minimum width berm at elevation +15 ft MSL, beach grass planting, sand fences, 3 stone groins, and 11 drainage structures.
Long Beach Island[b]	Beach protection consisting of a 50 ft. minimum-width berm at an elevation of +10 ft MLW and 6 new groins, reconstruction and extension of one stone groin, and construction of 180 ft of stone revetment and 90 ft of timber bulkhead.
Atlantic City, Absecon Island[b]	Placement of beachfill along 6000 ft of oceanfront beach, construction or modification 14 groins, stone revetment at toe of bulkhead, extension of Oriental Avenue jetty.

Sources:
[a] USACOE, New York District (1976)
[b] USACOE, Philadelphia District (1974).

PREVIOUS FEDERAL COAS
FOR NEW JERSE



STUDIES AT SANDY HOOK
NATIONAL PARK SERVICE HAS FORMULATED MASTER PLAN FOR GATEWAY NATIONAL RECREATION AREA. LONG RANGE BEACH EROSION CONTROL IMPROVEMENTS WERE INVESTIGATED

AUTHORIZED FOR SEA BRIGHT TO SHARK RIVER INLET
BEACH FILL & PERIODIC NOURISHMENT
23 ADDITIONAL GROINS
14 GROIN EXTENSIONS

AUTHORIZED FOR SHARK RIVER INLET TO ISLAND BEACH STATE PARK
BEACH FILL & PERIODIC NOURISHMENT

UNDER STUDY FROM SEA BRIGHT TO ISLAND BEACH STATE PARK
SAND BYPASSING SYSTEMS AT THE INLETS SHARK RIVER AND MANASQUAN INLETS

AUTHORIZED MODIFICATIONS FOR BARNEGAT INLET
NEW PARALLEL SOUTH JETTY
DREDGE AND MAINTAIN NAVIGATION CHANNEL (10' x 300')
REMOVAL OF SHOAL ADJACENT TO ISLAND BEACH
FILL ERODED PORTIONS OF ISLAND BEACH SHORELINE

AUTHORIZED FOR LONG BEACH ISLAND
BEACH FILL & PERIODIC NOURISHMENT, 1 ADDITIONAL GROIN UTILIZING EXISTING SOUTH JETTY AT BARNEGAT INLET AS WEIR-TYPE

'AL INLET AND BEACH PLANS
:Y OCEAN SHORE



BREAKWATER TO DEVELOP DEPOSITION BASIN

AUTHORIZED FOR BRIGANTINE ISLAND
BEACH FILL & PERIODIC NOURISHMENT
DUNE WITH SAND FENCE & DUNE GRASS
1 ADDITIONAL GROIN AND 1 GROIN EXTENSION

AUTHORIZED MODIFICATION FOR ABSECON ISLAND
AUTHORIZED PROJECT FOR ABSECON INLET FRONTAGE OF ATLANTIC CITY IS ADEQUATE AND SHOULD BE COMPLETED
BEACH FILL & PERIODIC NOURISHMENT ALONG OCEAN-FRONT BEACHES
WEIR-TYPE OFFSHORE BREAKWATER UPDRIFT OF BRIGANTINE JETTY TO FORM DEPOSITION BASIN

AUTHORIZED FOR GREAT EGG HARBOR-PECK BEACH
2 JETTIES WITH WEIR AND DEPOSITION BASIN
DREDGE AND MAINTAIN NAVIGATION CHANNEL (12' x 300')
2 GROINS IN OCEAN CITY, BEACH FILL & PERIODIC NOURISHMENT

AUTHORIZED FOR CORSON INLET-LUDLAM BEACH
2 JETTIES WITH WEIR AND DEPOSITION BASIN
DREDGE AND MAINTAIN NAVIGATION CHANNEL (12' x 300')
10 GROINS, BEACH FILL & PERIODIC NOURISHMENT

AUTHORIZED FOR TOWNSEND INLET-SEVEN MILE BEACH
2 JETTIES WITH WEIR AND DEPOSITION BASIN
DREDGE AND MAINTAIN NAVIGATION CHANNEL (12' x 300')
7 GROINS ALONG INLET, BEACH FILL & PERIODIC NOURISHMENT

AUTHORIZED FOR HEREFORD INLET-FIVE MILE BEACH
2 JETTIES WITH WEIR AND DEPOSITION BASIN
DREDGE AND MAINTAIN NAVIGATION CHANNEL (12' x 300')
4 GROINS AND BULKHEAD ALONG INLET FRONTAGE OF NORTH WILDWOOD
BEACH FILL & PERIODIC NOURISHMENT ALONG INLET FRONTAGE OF NORTH WILDWOOD AND OCEAN FRONTAGE
DUNES WITH SAND FENCE & DUNE GRASS

AUTHORIZED FOR CAPE MAY INLET TO LOWER TOWNSHIP
BREAKWATER UPDRIFT OF NORTH JETTY WITH WEIR AND DEPOSITION BASIN(DEFERRED), 9 GROINS
BEACH FILL & PERIODIC NOURISHMENT

AUTHORIZED FOR CAPE MAY POINT
5 GROINS AND 3 GROIN EXTENSION
2 DIKES, BEACH FILL & PERIODIC NOURISHMENT
DUNES WITH SAND FENCE & DUNE GRASS

SOURCES:
USACOE, PHILADELPHIA DISTRICT, 1978 & 1980
NATIONAL PARK SERVICE, 1978

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FIGURE VI.C-1

CHAPTER VII

THE COST/BENEFIT ANALYSIS FOR ALTERNATIVE ENGINEERING PLAN EVALUATION

A. INTRODUCTION

As part of the priority analysis for alternative reach engineering projects the benefit-to-cost ratio was derived from four input parameters —engineering costs, public service costs, recreational benefits, and property protection benefits. For each of the oceanfront reaches, this ratio was computed for the five engineering plans presented in Chapter VI, Section B. Figure VII.A-1 illustrates the procedures involved in calculating the non-incremental benefit-to-cost ratio. An explanation of the four input parameters is presented in Section B below. The component costs and benefits for each oceanfront reach alternatives evaluated are summarized in Table VII.A-1.

The cost-benefit analysis required that the various costs and benefits be expressed in comparable terms. All costs and benefits on Table VII.A-1 are expressed in present worth values with a rate of return of 9 percent for the 50-year planning period. A present worth value accounts for the effect of time on a future economic activity. The time value of money (opportunity to use funds during the intervening period in an alternative manner) is recognized in this way. The future benefits or costs are converted to equivalent present day dollars by discounting at a given rate of return. In the Master Plan analysis, the net present worth approach was used as opposed to an average annualized value approach. It was felt that the net present worth approach was more applicable to the uneven temporal distribution of the benefits and costs observed in this analysis (i.e., low annual benefits occur early in the planning period, and large annual benefits occur later in the planning period).

To illustrate the present worth approach, Table VII.A-2 shows four different cost schedules. The assumed interest rate is 6%.

TABLE VII.A-2

EXAMPLE COST SCHEDULES

Year	A	B	C	D
0	-	-	-	-
1	$ 600	$ 1600	$ 1359	-
2	600	1540	1359	-
3	600	1480	1359	-
4	600	1420	1359	
5	600	1360	1359	-
6	600	1300	1359	-
7	600	1240	1359	-
8	600	1180	1359	-
9	600	1120	1359	-
10	10,600	1060	1359	17,910
Totals	$16,000	$13,300	$13,590	$17,910

PROCEDURES FOR COST-BENEFIT ANALYSIS

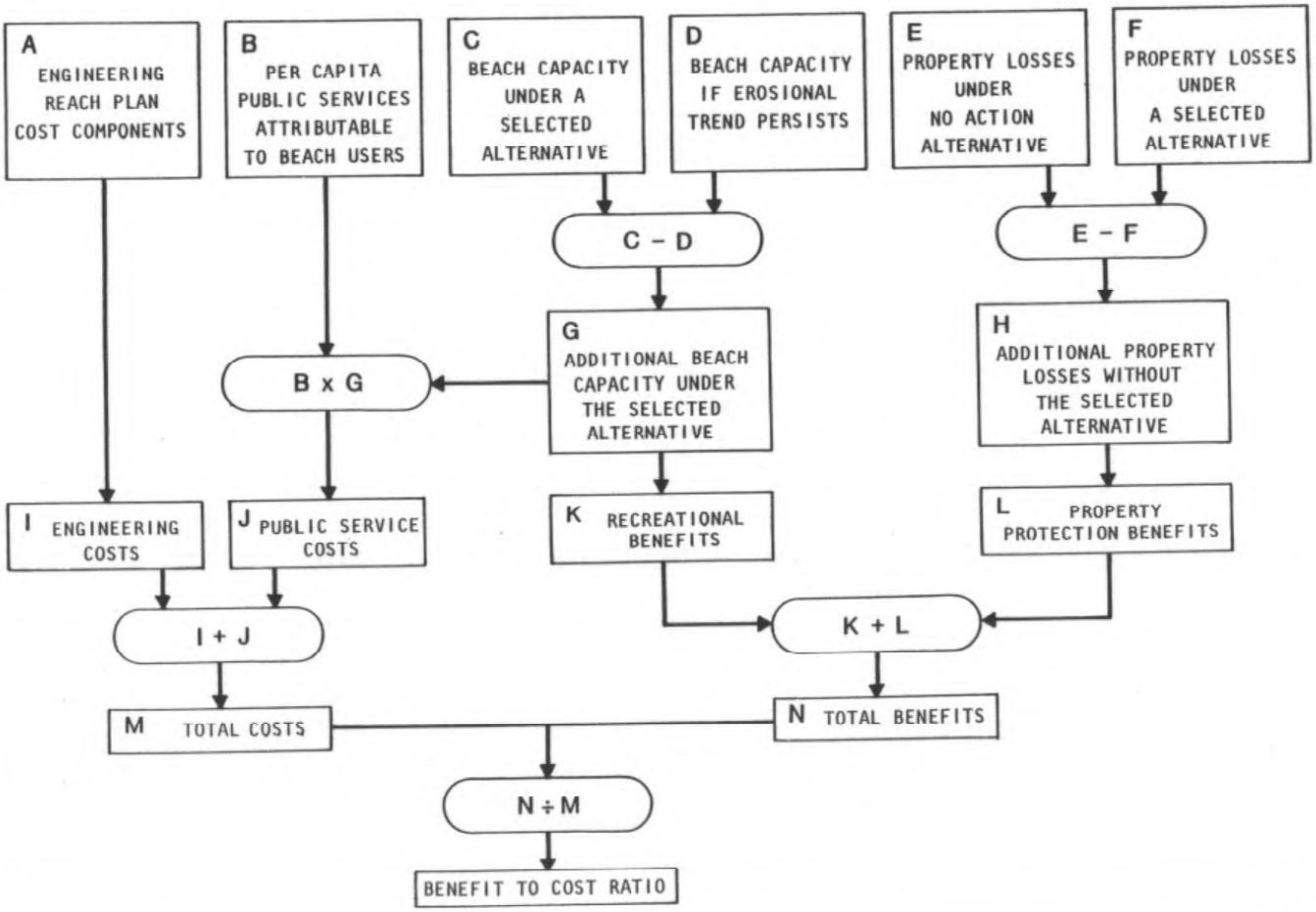

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FIGURE VII.A-1

TABLE VII.A-1

COST-BENEFIT ANALYSIS FOR OCEANFRONT REACHES (2-14)[a]

Reach No.	Reach Name	Erosion Control Alternatives[b]	Engineering Cost (in million dollars)	Public Service Cost (in million dollars)	Recreational Benefits (in million dollars)	Property Protection (in million dollars)	Benefit/ Cost Ratio
2	Sandy Hook to Long Branch	(1)	10.402	5.081	10.163	7.280	1.13
		(2)	23.689	9.709	19.418	7.209	0.80
		(3)	26.187	9.709	19.418	7.280	0.74
		(4)	8.578	5.081	10.163	7.209	1.27
		(5)	4.482	0	0	6.755	1.51
3	Long Branch to Shark River Inlet	(1)	41.272	10.384	20.769	4.383	0.49
		(2)	21.495	4.140	8.280	4.360	0.49
		(3)	40.232	10.477	20.954	4.383	0.50
		(4)	28.837	6.932	13.864	4.383	0.51
		(5)	11.883	0	0	1.579	0.13
4	Shark River Inlet to Manasquan Inlet	(1)	29.876	7.502	15.004	2.481	0.47
		(2)	13.164	5.234	10.468	2.479	0.70
		(3)	29.876	7.502	15.004	2.487	0.47
		(4)	29.876	7.502	15.004	2.487	0.47
		(5)	3.598	0	0	0.566	0.16
5	Manasquan Inlet to Mantoloking	(1)	12.401	0.374	0.749	2.161	0.23
		(2)	4.271	0.374	0.749	2.161	0.63
		(3)	12.401	0.374	0.749	2.161	0.23
		(4)	7.357	0.374	0.749	2.161	0.38
		(5)	0.602	0	0	0.050	0.08
6	Mantoloking to Barnegat Inlet	(1)	21.750	0.203	0.406	2.704	0.14
		(2)	7.870	0.203	0.406	2.697	0.38
		(3)	21.750	0.203	0.406	2.704	0.14
		(4)	12.725	0.203	0.406	2.697	0.24
		(5)	0.944	0	0	0.100	0.10
7	Long Beach Island	(1)	28.496	4.306	8.612	6.894	0.47
		(2)	11.321	3.905	7.810	6.894	0.96
		(3)	28.496	4.306	8.612	6.894	0.47
		(4)	14.153	4.047	8.094	6.894	0.82
		(5)	5.149	0	0	1.183	0.23
8	Brigantine Island	(1)	13.297	0.257	0.515	0.352	0.06
		(2)	4.649	0.257	0.515	0.352	0.17
		(3)	13.297	0.257	0.515	0.352	0.06
		(4)	12.308	0.257	0.515	0.352	0.07
		(5)	0.980	0	0	0.035	0.04
9	Absecon Island	(1)	25.279	50.456	100.911	2.328	1.36
		(2)	28.741	71.165	142.330	2.328	1.45
		(3)	28.741	71.165	142.330	2.328	1.45
		(4)	23.018	26.698	53.397	2.328	1.12
		(5)	3.487	0	0	0	0
10	Peck Beach	(1)	30.708	43.898	87.696	17.925	1.41
		(2)	17.573	42.431	84.861	17.198	1.70
		(3)	30.504	43.867	87.734	17.925	1.42
		(4)	21.617	43.184	86.367	17.193	1.60
		(5)	1.007	0	0	1.187	1.18
11	Ludlam Island	(1)	42.409	8.460	16.921	8.584	0.50
		(2)	20.687	8.460	16.921	8.584	0.88
		(3)	42.409	8.460	16.921	8.584	0.50
		(4)	28.511	8.460	16.921	8.584	0.69
		(5)	0.795	0	0	0.349	0.44
12	Seven Mile Beach	(1)	18.724	24.448	48.896	0.514	1.14
		(2)	7.711	16.097	32.193	0.402	1.37
		(3)	18.724	24.448	48.896	0.514	1.14
		(4)	12.963	21.974	43.949	0.402	1.27
		(5)	0.959	0	0	0.092	0.10
13	Five Mile Beach	(1)	4.150	0.052	0.103	0	0.02
		(2)	0.973	0.052	0.103	0	0.10
		(3)	4.150	0.052	0.103	0	0.02
		(4)	3.244	0.052	0.103	0	0.03
		(5)	0.911	0	0	0	0
14	Cape May Inlet to Cape May Point	(1)	35.837	22.196	44.393	0.754	0.78
		(2)	31.740	20.324	40.648	0.754	0.80
		(3)	35.837	22.196	44.393	0.754	0.78
		(4)	34.263	22.196	44.393	0.754	0.80
		(5)	1.497	0	0	0.571	0.38

Note: See text for cost-benefit methodology discussion.

(a) All estimated costs and benefits are expressed in present worth values.

(b) Alternative engineering plans are: (1) Storm Erosion Protection; (2) Recreational Development; (3) Combination of Storm Protection and Recreational Development; (4) Limited Restoration; and (5) Maintenance Program

The cost schedules are completely different as are the total disbursements over the 10-year period. Schedule A represents the payment of interest (6% on $10,000) annually with a final payment of interest and principal. Schedule B represents a uniform payment of principal ($1000/year) plus the interest payment on the remaining balance. Schedule C represents a uniform annual payment of interest and principal. Schedule D represents a repayment of the principal and all accumulated interest in a lump sum. At first glance, one might be tempted to identify Schedule B as being the lowest cost schedule. However, all schedules are, in fact, economically equivalent. This is because they simply represent four ways of repaying a $10,000 loan at 6%. Since they are all based on the same $10,000 value in year 0, at the same interest rate, the plans are equivalent.

The present worth of each of the four schedules is $10,000. Therefore, comparisons can be made directly; they are all equal in value. Likewise, they can be combined simply; the present worth of the four schedules combined is $40,000. Attempts at comparing or combining the schedules directly, without proper economic analysis, is confusing and misleading as is shown in comparing the total disbursements row. Therefore, expression of costs and benefits in present worth terms allows their direct comparison even though they occur in vastly different patterns and amounts throughout the planning period.

B. COMPONENTS OF THE COST-BENEFIT ANALYSIS

1. Engineering Costs

Engineering costs include component costs pertaining to each alternative plan. Typical items include initial beach fills, periodic beach width expansions, beach nourishment, and structural maintenance required to achieve a specific level of protection throughout the project design life. The basis for engineering costs estimates for each reach is provided in Chapter VI, Section B of this volume.

2. Public Service Costs

The influx of daily and seasonal beach users creates demands for public services. The typical local municipal budget used to support the demands of beach users consists of two components – direct expenditures, including beach maintenance, lifeguards, first aid and emergency services, restrooms, etc; and that portion of local infrastructure and utility capacities that must be in place to accommodate the higher seasonal and peak demands, including the transportation system (parking lots, access routes with sufficient carrying capacity), and sewage, water, and solid waste disposal systems.

In estimating these costs, the average per capita local, noneducational public services expenditures for all New Jersey municipalities with a population of less than 50,000 were estimated for 1977 and 1978. The larger municipalities were omitted to avoid biasing the sample because of economics of scale (i.e., welfare costs) found in older urban centers that often translate into high per capita service costs. The estimates of local expenditures were taken from the Abstract of Ratables and Exemptions for each county for 2 years (New Jersey Department of the Treasury, Division of Taxation, (1978, 1979).

A second estimate of the same per capita public services costs was made for the 53 shore communities in the four coastal counties. This analysis showed that the average annual noneducational per capita service costs for coastal municipalities were 50 percent higher than in non-coastal municipalities. The 1978 figures were $378

per capita for the municipalities and $250 per capita for the non-coastal municipalities. This difference of $128 per capita can be attributed largely to the need to provide services and infrastructure for seasonal visitors and to the geographic characteristics of coastal locations (limited land areas, high population densities, etc.).

The exact proportion of this per capita cost differential that is attributable to providing local public services for shore visitors is difficult to determine. For the purposes of this analysis, it was assumed that the total differential is used for provision of extra tourist-demanded public services. The cost differential was multiplied by the total estimated 1978 population of the 53 coastal municipalities to arrive at an estimated total local municipal expenditure attributable to tourism. This total was, in turn, divided by the estimated 1978 beach user totals as interpolated from the New Jersey Statewide Comprehensive Outdoor Recreation Plan (SCORP), (NJDEP, 1977) to yield a figure of approximately $1 ($0.976); this $1 per capita rate was viewed as a reasonable upper bound figure for public service cost attributable to beach users. It was recognized that attributing all of the estimated tourism public service costs solely to beach users may be an over-estimate; however, as indicated in New Jerseyan's Vacations – A Statewide Survey (Eagleton Institute of Politics, 1979), going to the beach and swimming are the two most popular activities of visitors to the New Jersey shore. Thus, it seems that a significant proportion of total public service costs required to accommodate tourists can be attributed to people who use the beach.

3. Recreational Benefits

Recreational benefits from alternative engineering plans were determined by estimating the increases in beach user capacity with each plan. Typical design curves that were used in estimating recreational benefits for Recreational Development alternatives are illustrated on Chapter VI, Figure VI.A-3. The increase in beach capacity was determined for Recreational Development alternatives by comparing the average day or peak day user demand to the existing beach capacity. For other alternatives, such as the Storm Erosion Protection and Limited Restoration programs, initial beach fills are considered for the increase in beach capacity. It was assumed that this capacity would be maintained throughout the project life. Since the Maintenance Program alternative would only maintain the erosional status quo, it would not offer any additional beach capacity. By definition, there are no recreational benefits under the Maintenance Program alternative. Further, the Storm Erosion Protection or Recreational Development alternatives control the initial beach fill for the Combination scheme; therefore, the recreational benefits for the Combination scheme would at least equal the benefits credited to the controlling alternative. Higher benefits would be obtained if the resulting available beach area is greater than that of the controlling alternative – this is a condition of satisfying the level of protection required by the Storm Erosion Protection alternative and meeting the projected recreational demand for the project life.

For determining recreational benefits, the peak day demand curve forms the upper boundary constraint of the beach capacity. Once the added beach area exceeds the capacity determined by the peak day demand, there are no additional benefits credited. In other words, providing recreational beach areas in excess of what is required by demand is, in fact, less cost beneficial.

In the analysis of recreational benefits, a total of 66 recreational days per year was assumed; 44 are average days and 22 are peak days. A beach fill resulting in an increase in beach capacity not exceeding the average day demand was allowed to satisfy the 66 recreational days. A beach fill resulting in an increase in beach

capacity exceeding the average day demand was assumed to satisfy the 22 peak day demand. In this case, beach capacity for the 44-average day demand and the 22-peak-day demand was summed to yield the total increase in beach capacity for a particular year. The average day demand curve was used to determine the number of beach users for the 44 average days.

A 100 square foot beach area for each beach user and a daily turnover rate of two persons per day were assumed in estimating beach capacity. These estimating factors are taken from the Statewide Comprehensive Outdoor Recreation Plan (NJDEP, 1977). The area criterion differs from the 75 square feet per person value which is used by the Corps of Engineers (USACOE, CERC, 1977). A comparison of the benefit-cost ratios using the two criteria was done for the Reach 10 (Peck Beach — Ocean City) Recreational Alternative. The results of this comparison are presented in Table VII.B-1.

TABLE VII.B-1

COMPARISON OF THE REACH 10 (PECK BEACH)
RECREATIONAL DEVELOPMENT ALTERNATIVE
UNDER DIFFERENT DESIGN CRITERIA
(in million dollars)*

Area Criterion (sq ft/person)	Engineering Cost	Public Service Cost	Recreational Benefit	Property Protection Benefit	Benefit/ Cost Ratio
100	$17.573	$42.431	$84.862	$17.193	$ 1.70
75	$12.168	$25.387	$50.774	$17.193	$ 1.81

*All dollar values are expressed in total present worth values.

The use of the 75 square feet per person results in a reduction in the quantity and therefore the cost of sand required for beach fills. This is because each unit area of both the existing and added beach can accommodate more bathers as compared to the 100 square feet per person design case. For this reason, less added beach area is required to accommodate the estimated additional demand. Therefore, the recreation benefit and the public service cost both decrease proportionately. The property protection benefit is not a function of the area criterion and remains unchanged in this case. The net result in this case is an increase in the benefit-cost ratio of about 10 percent when the Corps criterion is used. Similar results are expected in the cases of Reach 9 (Absecon Island) and Reach 12 (Seven Mile Beach) Recreational Development alternatives. In the case of the Reach 4 (Shark River Inlet to Manasquan Inlet), Reach 5 (Manasquan Inlet to Mantoloking), Reach 6 (Mantoloking to Barnegat Inlet), Reach 7 (Long Beach Island), Reach 8 (Brigantine Island), and Reach 13 (Five Mile Beach) Recreational Development alternatives, no beach expansions are required to meet the present and future recreational demands. Therefore, engineering costs remain unchanged but the recreational benefits would decrease if the 75 square foot criteria is used. The net result would be a decrease in benefit-cost ratio. In the case of the Maintenance Program alternatives, the benefit-cost ratio is not a function of the area criterion since there are no recreation benefits associated with these plans.

Table VII.B-2 presents the estimated number of additional beach users that would be accommodated under each alternative plan using the 100 square feet per person criterion. The total number of additional beach users throughout the project life was obtained by summing the yearly beach capacities. The recreational benefits under each alternative plan were then estimated using the present worth value approach.

A daily opportunity cost of $2 per beach user was used in assessing recreational benefits. This amount was based on the daily fees charged by the various beaches located along New Jersey's Atlantic coast during the summer of 1979. The primary source of beach fee information was A Guide to New Jersey Beaches (NJDEP, 1979).

4. Property Protection Benefits

Property protection benefits for any of the five alternative plans are equivalent to the estimated losses in property which would occur if the alternative plan was not undertaken. Assumptions made in estimating these losses include:

- If no action is taken (including no maintenance), the erosional rates as published by Nordstrom and others (1977) and CCES (1979) will persist throughout the project life. In addition, the occurrence of a 100-foot storm event berm encroachment after the long term erosional losses was considered.
- A 75-foot storm event berm encroachment was considered for the groin-protected areas where the functional groins will be maintained under all alternative engineering plans.
- For applicable alternatives, the program of periodic renourishment within a reach will maintain the natural and designed beach widths throughout the project life.
- In the presence of a maintained seawall, erosion will stop at the seawall location, which forms the inland limit of the damage zone for all alternative plans. Therefore, property protection benefits inland of the seawall included losses that would otherwise occur under the no-action case.

The shore erosion rates used in this analysis were taken from Nordstrom and others (1977) and CCES (1979). These rates were based on analyses of shoreline change from 1952 to 1971 and thus are taken as reasonably representative of present erosional conditions, including the influence of shore protection structures. Since this was the only uniform data base available for the entire study area, uncertainties involved in using erosion rates from different time periods for different shoreline areas were minimized. However, it is recognized that future temporal erosion trends may vary considerably from those occurring from 1952 to 1971. Nordstrom and others (1977) discuss the numerous difficulties in quantitatively predicting long-term erosional trends which result from the interactions between short- and long-term variation in littoral forces and shoreline conditions.

For the analysis of property protection benefits, the long-term and storm erosion damage zone for each alternative engineering plan was delineated from 1977 air photographs for each reach. The high-water line was used as the starting line. This line was identified on the air photos by the change in color tones on the beach (wetted sand line). Table VII.B-3 summarizes the methods of delineating the erosion

TABLE VII.B-2

ESTIMATED ADDITIONAL BEACH USERS ACCOMMODATED UNDER ALTERNATIVE ENGINEERING PLANS

Reach Number	Reach Name	Alternatives*	Total Additional Beach User Days During Project Life (in millions)
2	Sandy Hook to Monmouth	(1)	41.628
		(2)	113.304
		(3)	113.304
		(4)	41.628
		(5)	—
3	Long Branch to Shark River Inlet	(1)	79.820
		(2)	60.111
		(3)	84.217
		(4)	6.129
		(5)	—
4	Shark River Inlet to Manasquan Inlet	(1)	84.890
		(2)	74.505
		(3)	84.890
		(4)	84.890
		(5)	—
5	Manasquan Inlet to Mantoloking	(1)	7.524
		(2)	7.524
		(3)	7.524
		(4)	7.524
		(5)	—
6	Mantoloking to Barnegat Inlet	(1)	9.367
		(2)	9.367
		(3)	9.367
		(4)	9.367
		(5)	—
7	Long Beach Island	(1)	99.983
		(2)	83.123
		(3)	99.983
		(4)	88.045
		(5)	—
8	Brigantine Island	(1)	11.190
		(2)	11.190
		(3)	11.190
		(4)	11.190
		(5)	—
9	Absecon Island	(1)	335.759
		(2)	408.000
		(3)	408.000
		(4)	225.354
		(5)	—
10	Peck Beach	(1)	325.343
		(2)	318.179
		(3)	325.589
		(4)	314.403
		(5)	—
11	Ludlam Island	(1)	78.759
		(2)	78.759
		(3)	78.759
		(4)	78.759
		(5)	—
12	Seven Mile Beach	(1)	277.035
		(2)	238.190
		(3)	277.035
		(4)	248.598
		(5)	—
13	Five Mile Beach	(1)	3.846
		(2)	3.846
		(3)	3.846
		(4)	3.846
		(5)	—
14	Cape May Inlet to Cape May Point	(1)	139.012
		(2)	135.219
		(3)	139.012
		(4)	139.012
		(5)	—

Notes:
*Engineering alternatives are:

(1) Storm Erosion Protection
(2) Recreational Development
(3) Combination of Storm Protection and Recreational Development
(4) Limited Restoration
(5) Maintenance Program.

TABLE VII.B-3

DELINEATION OF LONG-TERM AND STORM EROSION DAMAGE ZONES FOR ASSESSMENT OF PROPERTY PROTECTION BENEFITS

Alternative	Methodology
No Action	50-year erosional rate loss plus 100' storm event berm encroachment.
Storm Erosion Protection	In beach fill areas, the maximum level of storm protection is achieved and no property damages occur. Without beach fills, storm event berm encroachment* was used.
Recreational Development	In beach fill areas, the maximum level of storm protection is achieved if initial beach fill exceeds that required for the storm erosion protection. Otherwise, storm event berm encroachments* were used.
Combination Scheme	Maximum level of protection achieved in combining storm erosion protection and recreational development alternatives. No property losses would occur.
Limited Restoration	In beach fill areas with storm protection berm widths, the maximum level of storm protection is achieved with no property damages. Without beachfills, storm event berm encroachment* was used.
Maintenance Program	50-year erosional rate plus 75' storm event berm encroachment in groin-protected areas and 100' encroachment elsewhere.

*A 100' encroachment is used for unprotected areas, and a 75' encroachment is used for groin-protected areas.

and storm erosion damage zone for each of the five alternative engineering plans. Within the various damage zones, total property losses were estimated by evaluating the non-beach acreage, structures, and roadways likely to be affected.

Property values within the erosion damage zone were estimated using the present worth value approach. The natural beach area inside this zone which tends to protect properties by forming a buffer against the sea, was not counted as a component for property loss. The average number of years required for the beach to erode to the non-beach property areas was estimated from the air photos using erosion rates for the segments within each reach. The total loss in property was then averaged throughout the remaining years of the planning period, assuming that these losses would be equally distributed in each year. With this average, the present worth values of the losses was estimated.

The calculation of the value of real property affected by erosion was based on consideration of the following items:

- o Upland or developable land
- o Commerical structures
- o Residential structures
- o Roads and Utilities
- o Boardwalks

It was assumed that the unit monetary values developed in the following paragraphs represent the replacement costs of the above infrastructure (in 1980 dollars).

o Upland or Developable Land

Estimates of the current market value of shorefront land were obtained by contacting realtors active in New Jersey's coastal area. Information was obtained on the estimated market value or current selling price of vacant, developable shorefront land with all necessary public services and utilities. Realtors were also asked to estimate the relative proportions of land and structure costs of recent real estate transactions where information on the cost of vacant land was not available. The emphasis was on the cost of shorefront parcels. This involved contacts with 20 real estate agencies and local planning officials. The per acre land costs for each of the reaches are summarized in Table VII.B-4.

o Commercial Structures

Average structures were estimated at $225,000 each, ($200,000 for building, $25,000 for contents). For large structures or unique structures, building costs were estimated on square foot basis utilizing construction cost indices from Dodge Construction Systems Costs (McGraw Hill, 1980). For example, high-rise apartments were calculated at $35 per square foot and hotels at $42.00 per square foot. It was assumed that the value of interior furnishings were 20% of the construction cost.

o Residential Structures

The estimated average residential structure cost was estimated at $60,000 per structure plus $15,000 for contents. This was based on a 1200 square foot home at $50 per square foot construction costs.

TABLE VII.B-4

SHOREFRONT LAND COST ESTIMATES

Reach No.	Reach Name	Estimated Average Cost Per Acre
2	Sandy Hook to Long Branch	$ 450,000
3	Long Branch to Shark River Inlet	$ 450,000
4	Shark River to Manasquan Inlet	$ 900,000
5	Manasquan Inlet to Mantoloking	$ 900,000
6	Mantoloking to Barnegat Inlet	$ 650,000
7	Long Beach Island	$ 650,000
8	Brigantine Island	$ 650,000
9	Absecon Island	$ 1,500,000
10	Peck Beach	$ 1,100,000
11	Ludlam Island	$ 900,000
12	Seven Mile Beach	$ 900,000
13	Five Mile Beach	$ 900,000
14	Cape May Inlet to Cape May Point	$ 650,000

o Roads and Utilities

Roads, including storm and sanitary sewers, gas lines, and water pipes were estimated to cost $240 per linear foot. Table VII.B-5 provides the cost components of this estimate.

o Boardwalks

Average boardwalk replacement costs were estimated at $275 per linear foot. This estimate is based on a sampling of recent repair and replacement costs experienced by New Jersey coastal communities.

TABLE VII.B-5

INFRASTRUCTURE UNIT COST ESTIMATE
ROADS AND UTILITIES

Sanitary Sewers (15" vitrified clay)	$100/ft
Storm sewers (29" asbestos cement)	50/ft
Water (6" ductile iron)	10/ft
Gas (3" steel)	10/ft
Roadway (2 lane, 24' width, bituminous concrete with curbs and sidewalk)	70/ft
Total cost per unit length of road	$240/ft

Sources: McGraw Hill, 1980; USEPA, May, 1978; NJDEP, September 1979

Table VII.B-6 lists the total estimated value of existing real property that would be protected by the various engineering alternatives. The Storm Protection and Combination alternatives (Nos. 1 and 3) were designed to protect the entire area of the shorefront that would be affected by erosion over the next 50 years under the no-action alternative. Thus, the benefit for these alternatives is the total amount of real property currently found in the erosion hazard area. Differences in property protection benefits under the remaining alternatives (Nos. 2, 4 and 5) arise from the fact that even with the implementation of these alternatives, some real property in the erosion hazard area would be lost in most reaches.

The total amount of property protected under each alternative was transformed into a present worth value estimate so that it would be compatible with the other benefits and costs used in the analysis. This was done in several steps.

1) A determination was made for each reach as to when erosion losses would begin to affect existing real property under the no action alternative.

2) It was assumed that property protection benefits would begin to accrue at this point (i.e., property begins to be protected at this point that would be otherwise lost under the no action alternative).

3) It was assumed that the property protection benefit is equally spread out over the period from the beginning of the accrual of the benefits until the end of the 50-year planning period.

4) The present value of this future stream of benefits was then calculated.

C. EXAMPLE CALCULATIONS

In order to illustrate the elements of the cost-benefit evaluation, in the following sections a summary of computations is provided for Reach 10 (Peck Beach – Ocean City). The development of costs and benefits parallels the discussion in Section B of this chapter. All computations are for the Recreational Development alternative for Reach 10.

1. Engineering Costs

The example engineering plan consists of a program of phased beach development, structural maintenance, and dune maintenance. A summary of the components of the plan and the estimate of engineering costs is provided in Table VII.C-1. The components of the estimate are discussed in more detail below.

- Beach Fill

An initial fill of 314,000 yards would provide a 35 ft. expansion along 13,800 ft. of beach for a total average beach width of 170 ft. Periodic expansions of the beach would be done in uniform increments at 10-year intervals to keep pace with the projected recreational demand. About 585,000 cubic yards of sand would be required to provide a 48 ft. width increment during each of the expansions for a total beach width of 360 ft. at year 2010. In addition, replenishment of the beach would be required to compensate for the erosion rate of 180,000 cubic yards per year. The renourishment would be done on a 5-year cycle for a total volume of 1,170,000 cubic yards with 1.3 overfill factor. The assumptions and the cost components for the Peck Beach beachfill cost estimate are summarized in Table VII.C-2.

TABLE VII.B-6

ESTIMATED GROSS VALUE OF REAL PROPERTY PROTECTION FOR OCEANFRONT REACH ALTERNATIVES EVALUATED

Reach No.	Reach Name	Alternatives*	Estimate of Real Property Value Protected	Year Property Protection Benefits Will Begin To Occur
2	Sandy Hook to Monmouth	(1)	$ 64,089,000	1990
		(2)	63,459,000	
		(3)	64,089,000	
		(4)	63,459,000	
		(5)	59,467,000	
3	Long Branch to Shark River Inlet	(1)	83,835,000	2004
		(2)	83,395,000	
		(3)	83,835,000	
		(4)	83,395,000	
		(5)	58,702,000	
4	Shark River Inlet to Manasquan Inlet	(1)	121,552,000	2021
		(2)	121,327,600	
		(3)	121,552,000	
		(4)	121,327,000	
		(5)	27,728,000	
5	Manasquan Inlet to Mantoloking	(1)	77,898,000	2015
		(2)	77,898,000	
		(3)	77,898,000	
		(4)	77,898,000	
		(5)	1,800,000	
6	Mantoloking to Barnegat Inlet	(1)	160,340,000	2025
		(2)	159,936,000	
		(3)	160,340,000	
		(4)	159,936,000	
		(5)	5,930,100	
7	Long Beach Island	(1)	321,138,000	2020
		(2)	321,138,000	
		(3)	321,138,000	
		(4)	321,138,000	
		(5)	55,102,400	
8	Brigantine Island	(1)	18,981,000	2023
		(2)	18,981,000	
		(3)	18,981,000	
		(4)	18,981,000	
		(5)	2,046,000	
9	Absecon Island	(1)	119,664,000	2022
		(2)	119,664,000	
		(3)	119,664,000	
		(4)	119,664,000	
		(5)	0	
10	Peck Beach	(1)	393,311,000	2006
		(2)	377,336,300	
		(3)	393,311,000	
		(4)	377,336,000	
		(5)	26,004,000	
11	Ludlam Island	(1)	140,517,000	2001
		(2)	140,517,000	
		(2)	140,517,000	
		(3)	140,517,000	
		(4)	140,517,000	
		(5)	5,709,000	
12	Seven Mile Beach	(1)	25,228,000	2021
		(2)	19,732,000	
		(3)	25,228,000	
		(4)	19,732,000	
		(5)	9,501,000	
13	Five Mile Beach	(1)	0	—
		(2)	0	
		(3)	0	
		(4)	0	
		(5)	0	
14	Cape May Inlet to Cape May Point	(1)	36,976,000	2021
		(2)	36,976,000	
		(3)	36,976,000	
		(4)	36,976,000	
		(5)	28,004,000	

Notes:
*Engineering alternatives are:

(1) Storm Erosion Protection
(2) Recreational Development
(3) Combination of Storm Protection and Recreational Development
(4) Limited Restoration
(5) Maintenance Program.

TABLE VII.C-1

ENGINEERING COST ESTIMATE SUMMARY
RECREATIONAL DEVELOPMENT ALTERNATIVE
REACH 10 – PECK BEACH

Cost Components	Estimated Present Worth Initial Costs	Estimated Present Worth Periodic Operation Costs
Beach Fill		
o Initial fill at the northern end of island for a beach width of 170' (berm width approximately 8' at +10' MLW. In-place fill volume: 314,000 cu. yd.	$ 2,794,000	
o Periodic expansion in berm width in 10-year intervals (585,000 cu. yd. each expansion to year 2010) for a total width of 360' (berm width 180' at +10' MLW)		$ 2,877,000
Beach Nourishment		
o 1,170,000 cu. yd. at 5-year intervals		10,895,000
Initial Structural Maintenance		
o Initial repairs to 3 groins and 1000 L.F. of timber bulkhead	433,000	
Maintenance of Dune and Existing Structures		
o 20 groins		120,000
o 12,000 L.F. of timber bulkhead		64,000
o Placement of about 32 acres of dune grass, 18,500 L.F. of sand fence and replacement of sand fence at 3-year intervals	220,000	170,000
SUBTOTALS	$ 3,447,000	$ 14,126,000

ESTIMATED PRESENT WORTH COST TOTAL $3,447,000 + $14,126,000 = $ 17,573,000

TABLE VII.C-2

BEACH FILL COST ESTIMATES
REACH 10 – PECK BEACH
(in million dollars)

	Initial Fill	Periodic Expansion (10-year intervals)	Periodic Nourishment (5-year intervals)
In-place fill volume[1] x 10^6 cu. yds.	0.314	0.585	0.900
Quantity with fill factor[2] x 10^6 cu. yds.	0.408	0.761	1.170
Fill Cost @ $3.00/cu. yd.	$ 1.225	$ 2.282	$ 3.510
Mobilization and Demobilization	0.800	0.800	0.800
Subtotal	$ 2.025	$ 3.082	$ 4.310
Subtotal with 15% contingency	$ 2.328	$ 3.544	$ 4.957
Total with 20% Engineering Design and Administration & Supervision	$ 2.794	$ 4.253	$ 5.948
Annualized Cost		0.280[3]	0.994[4]
Present Worth Cost Total	$ 2.794	$ 2.877	$ 10.895

Notes:

(1) Conventional beach filling at $3.00/cubic yard
(2) Overfilling factor = 1.3
(3) Uniform Series, sinking fund factor at a 9% interest rate and a 10-year period (0.0658).
(4) Uniform Series, sinking fund factor at a 9% interest rate and a 5-year period (0.1671).

The present worth costs of the initial fill program are equivalent to the total costs since all construction is assumed to take place in less than one year. The present worth costs of the periodic programs (nourishment and beach expansions) are estimated in a two step process. First the cost of an individual operation is annualized over the operation cycle period (5 years for nourishment and 10 years for beach expansion). For example in the case of the periodic expansion:

Annual Cost Of Beach Expansion =
(Cost of one beach increment of expansion) (A/F, 9% 10 years)
($4,253,000) (0.0658) = $280,000 (rounded)

Where (A/F, 9%, 10 years) is the uniform series, a sinking fund factor at a 9% interest rate and a 10-year period.

Next the annualized cost is converted into present worth terms as shown below.

Present Worth Cost of Berm Expansion =
(Annual Cost) (P/A, 9%, 30 years)
($280,000) (10.2737) = $2,877,000 (rounded)

Where (P/A, 9%, 30 years) is the uniform series present worth factor at a 9% interest rate and a 30-year period (berm expansions are periodic up to 2010 when the upper bound on recreational demand is met.)

A similar calculation for beach nourishment to mitigate against erosion losses yields an annualized operation cost of $994,000 using a 5-year cycle. The equivalent present worth cost for a 50-year planning period would be $10,895,000.

o Initial Structural Maintenance

A program of initial structural repair is proposed for Peck Beach to restore the existing functional structures to a uniform level of integrity. Estimates of required initial structural maintenance for each reach were taken from a survey report entitled Shore Protection Structures, Public Access, and Evaluation (NJDEP, Office of Shore Protection, January 1977). The cost estimate in that study were upgraded to 1980 dollars for inclusion in the Master Plan analysis. The estimate of required initial maintenance is summarized in Table VII.C-3.

TABLE VII.C-3

ESTIMATED COST OF INITIAL STRUCTURAL MAINTENANCE
REACH 10 – PECK BEACH

	1977 Cost Estimate	1980 Value* Estimate
Groins		
Equivalent of 3 groins	$ 150,000	$ 216,500
Bulkheads		
Approximately 1,000 L.F.	150,000	216,500
Totals	$ 300,000	$ 433,000

*Construction cost factor of 1.443 was used for conversion of cost from 1977 to 1980 dollars.

o Structural Maintenance Costs

After the initial structural repair discussed above, periodic maintenance of existing functional structure is proposed to insure their integrity throughout the planning period. The cost of maintenance of structures is estimated by assuming that expenditures would be limited to periodic amounts, which in total, would be equivalent to the cost of replacement of the structure at the end of the planning period. For example, 20 groins are to be maintained. They have an estimated average replacement cost of $463,000 per groin or a total replacement cost of about $9 million. The groin maintenance cost is therefore:

Present Worth Maintenance Cost of 20 Groins =
(Replacement Cost) (P/F, 9%, 50 years)
($9 x 10^6) (0.0134) = $120,000 (rounded)

Where (P/F, 9%, 50 years) is the single payment present worth factor at a 9% interest rate and a 50-year maintenance period.

A similar calculation for the maintenance of 12,000 linear feet of timber bulkhead, with an estimated replacement cost of $400 per linear foot, yields a present worth bulkhead maintenance cost of $64,000. Thus, the total present worth cost of structural maintenance is:

$120,000 (for 20 groins) + $64,000 (for bulkhead) = $184,000.

o Dune Maintenance

Dune maintenance, including placement of sand fencing and dune grass planting, is also included under the Recreational Development alternative for Peck Beach. The cost estimate are derived as indicated in Table VII.C-4.

2. Public Service Cost

Public service costs are estimated at $1.00 per additional beach user as described in Section VII.B.2. The conversion of those costs to present worth terms is directly analogous to the computation of the present worth of recreational benefits which are described in the next section. The estimated total present worth cost of public service from that analysis was $42,431,000.

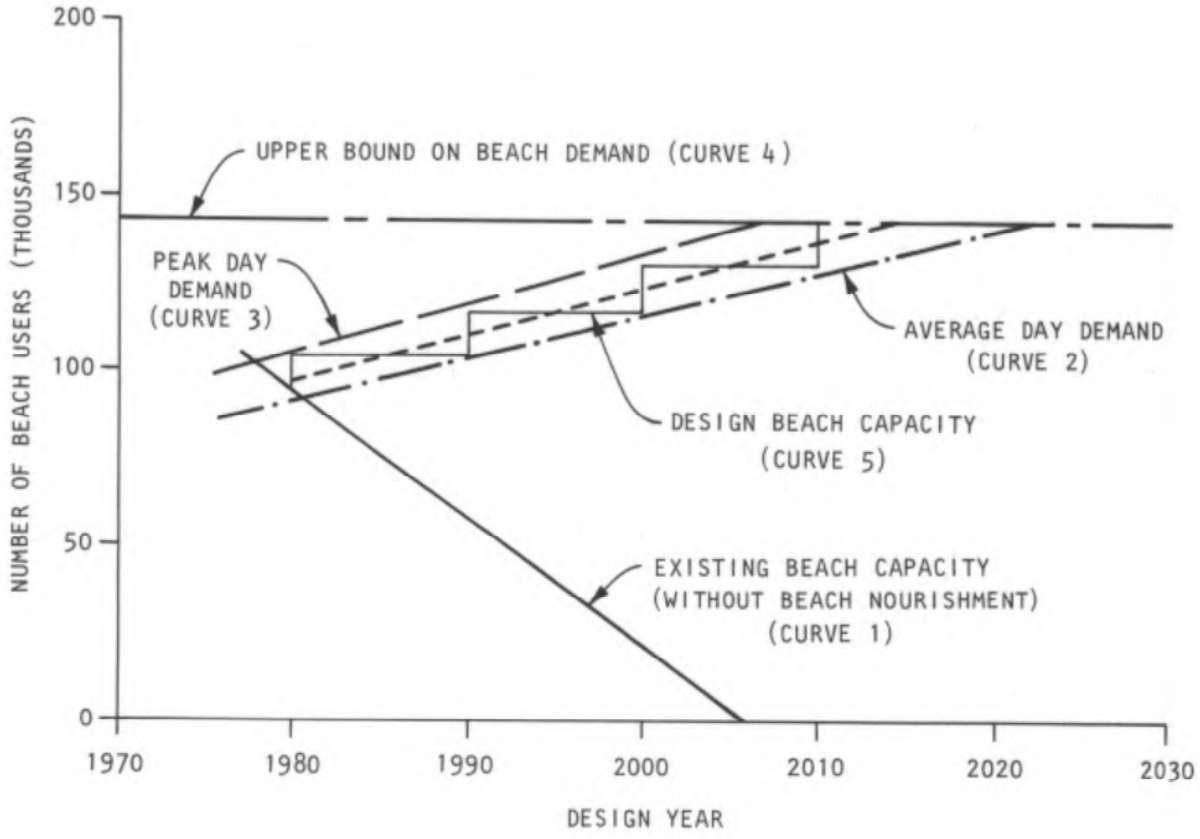
3. Recreational Benefits

Figure VII.C-1 shows the proposed recreational development design for Peck Beach. The existing beach capacity (Curve 1 on Figure VII.C-1) shows a progressive loss of beach capacity to erosion until the existing beach is depleted by about year 2006. Curves 2 and 3 represent the average day demand and the peak day demand respectively. Estimated limitations on transportation links to Peck Beach place an upper limit on the number of beach users which can realistically be expected to serve. This upper bound limit is shown by Curve 4. The stepped line (Curve 5) represents the recommended beach design capacity considering capacity losses due to erosion between fill increments. The dashed line intersecting the midpoints of the line segments of Curve 5 represent an approximation of Curve 5 for computational purposes. Selected values of the demand curves and the design beach are shown below.

TABLE VII.C-4

COST ESTIMATE SUMMARY
PECK BEACH DUNE MAINTENANCE

	Estimated Cost	
Dune Grass Planting		
32 acres @ $3800/acre	$ 122,000	
Sand Fence Placement		
18,500 L.F. @ $2.00/ft	37,000	
Subtotal (rounded)	159,000	
Contingency @ 15%	24,000	
Subtotal (rounded)	183,000	
Engineering & Design and Supervision & Administration (E&D and S&A) @ 20%	37,000	
Total First Cost		220,000
Replacement of sand fence @ 3-yr intervals	37,000	
Contingency @ 15%	5,500	
Subtotal	42,500	
E&D and S&A @ 20%	8,500	
Cost of replacement 3 yr period	51,000	
Annualized Cost (Replacement Cost) (A/F, 9%, 3 yrs) (51,000) (0.3051) =	15,500	
Present Worth Cost (Annualized Cost) (P/A, 9%, 50 yrs) (15,500) (10.9617) =		170,000
Cost Summary		
Initial Dune Maintenance Cost		220,000
Present Worth of Recurring Cost		170,000
Total Present Worth Cost		$ 390,000



RECREATIONAL DESIGN FOR PECK BEACH
BEACH USERS VS TIME

DAMES & MOORE

FIGURE VII.C-1

	1980	2010	2030
Average Day Demand	89,900	127,000	151,800
Peak Day Demand	103,400	146,100	174,000
Design Capacity (Daily)	103,400	143,300	143,300

The year 2010 is when it is estimated that the design capacity (daily) would meet the estimated maximum carrying capacity of the beach estimated from traffic flow and highway capacity considerations.

The additional number of beach users served by the proposed design for each year is estimated by summing the net increase in average day usage (Curve 2 minus Curve 1 values) for 44 average days and the net increase in peak day usage (Curve 5 minus Curve 1) for 22 peak days. The total additional beach user days for the project is obtained by summing up all the annual contributions for the 50-year planning period. For the Peck Beach Recreational Development alternative, an estimated 318,179,000 additional beach user days would be provided. Table VII.B-3 lists the estimated additional beach users accomodated under all the reach engineering plans evaluated.

The total value of the recreational benefits of an alternative is simply the product of the total number of additional beach users accomodated times a daily opportunity cost of $2 per beach user. For the Peck Beach example:

Gross Recreational Benefit Over 50 years =
($318,179,000 additional beach users) ($2/user) = $636,358,000

This figure is deceiving because it gives equal importance to a $2 contribution made 50 years from now and a $2 contribution made now. Present worth analysis is used here, as it is throughout the economic analysis, to properly discount or weight the value of future benefits (or costs) to yield an equivalent investment value (or cost) at the present time. The general present value computation procedure is similar to those presented earlier with the additional use of a gradient method to calculate the annualized value of a linearly increasing stream of benefits or costs. Presentation of the method or the decomposition of the data in Figure VII.C-1 required to apply the method is too complex to include in this chapter. For details of the gradient method as well as other elements of analysis used here, the reader is referred to Grant et al. (1976). For the Peck Beach example, the present worth value of the recreational benefits amounts to $84,861,000 or less than one-eight of the gross value of the benefits calculated earlier.

4. Property Protection Benefits

The estimated gross values of existing real property that would be protected under the Recreational Development alternatives from Table VII.B-6 is $377,336,300. It was estimated that erosion would begin to effect existing real property by 2006, or about 25 years into the 50-year planning period. It was then assumed (for the Recreational Development design alternative) that the $377,336,300 of real property protected would occur evenly throughout the remaining 25 years of the planning period. Thus:

$377,336,300 for 25 years = $15,093,452 of property protection benefits per year

The calculation of the present value of the property protection benefits in this case is a two step procedure. First the present value of the uniform series of benefits is calculated at the year that the benefits begin to accrue, which is 2006.

Present Worth of Benefits in 2006 =
(Annual Benefits) (P/A, 9%, 25 years)
($15,093,452) (9.8226) = $148,256,942

Where (P/A, 9%, 25 years) is the uniform series present worth factor with a 9% interest rate for a period of 25 years (2006 through 2030).

Next, the property protection value at 2006 must be discounted to reflect the present worth in 1980.

Present Worth of Benefits In 1980 =
(Value of Benefits in 2006) (P/F, 9%, 25 years)
($148,256,942) (0.1160) = $17,198,000 (rounded)

Where (P/F, 9%, 25 years) is the single payment present worth factor with a 9% interest rate for a period of 25 years (1980 through 2006).

The calculated present worth values of the property protection benefits for the remaining alternatives for Reach 10, as well as for the other reaches, are provided in Table VII.A-1.

5. Benefit-Cost Ratio

The benefit-to-cost ratio is calculated by summing all the benefits and dividing by the total project costs as shown in Figure VII.A-1. For the Peck Beach Recreational Development alternative example:

Costs		Benefits	
Engineering	$17,573,000	Recreational	$84,861,000
Public Service	42,431,000	Property Protection	17,198,000
Total Costs	$60,004,000	Total Benefits	$102,059,000

$$\frac{\text{Benefit}}{\text{Cost}} \qquad \frac{\$102,059,000}{60,004,000} = 1.70$$

Since the ratio exceeds 1, the benefits exceed the cost and the alternative is shown to be more attractive than doing nothing. The benefit-cost figures for all reach alternatives are provided in Table VII.A-1.

CHAPTER VIII

COST COMPARISON FOR ALTERNATIVE BEACH NOURISHMENT SCHEMES

A. INTRODUCTION

Preliminary estimates have been prepared to compare the cost effectiveness of beach nourishment schemes which have possible application on the New Jersey coast. The schemes include conventional nourishment using offshore sand sources, sand bypassing across inlets with supplemental nourishment, sand recycling by pipeline, and sand recycling by dredge/barge. All schemes are designed to supply a sand volume comparable to the estimated erosion losses. Reach 4 (Shark River Inlet to Manasquan Inlet) is used to illustrate the computation procedure.

B. ALTERNATIVE COST ESTIMATES

1. General Assumptions

Estimated annual erosion losses from Reach 4 beaches amount to 150,000 cubic yards. The Manasquan Inlet, at the southern end of the reach, forms a littoral barrier for the northward transport of sand. Estimates place the net littoral transport south of the inlet at 74,000 cubic yards; this is the quantity of sand which could be bypassed around the inlet without increasing the erosion rate on the beaches south of the inlet. Supplemental nourishment of 76,000 cubic yards per year would be required, with bypassing to balance the annual erosion losses.

The following assumptions apply to the four beach nourishment schemes evaluated:

- Nine percent interest rate in present worth cost computations.
- 50-year project life.
- Annual erosional loss of 150,000 cubic yards.
- Similar beach nourishment schemes are installed on updrift and downdrift beaches.
- An approximate 30-percent loss of fine sand during handling.

2. Conventional Nourishment

Conventional nourishment assumes that suitable nourishment sands are available in sufficient quantities in offshore sources to satisfy project needs. Some losses of fines would be associated with the use of borrow areas. An overpumpage of 1.3 times the required in-place volume is estimated to be sufficient to compensate for these losses. The analysis also assumes that the project would prove to be attractive enough to result in competitive bidding by dredging contractors. Estimated costs for conventional nourishment are shown in Table VIII.B-1. Nourishment would be accomplished every 5 years to balance the mobilization cost penalties against the losses of beach area between nourishment intervals.

TABLE VIII.B-1

ESTIMATED COSTS FOR CONVENTIONAL NOURISHMENT

REACH 4

In-place nourishment volume at 5-yr intervals (150,000 cu yd/year)	750,000 yd^3
Fill volume with 1.3 overpumpage	975,000 yd^3
Cost to place @ \$3/yd^3	\$ 2,925,000
Mobilization and Demobilization	800,000
SUBTOTAL	\$ 3,725,000
Contingency allowance @ 15%	559,000
SUBTOTAL	\$ 4,284,000
Engineering, Design, Supervision, and Administration @ 20%	857,000
Nourishment cost per interval	5,141,000
Total annual cost = \$5,141,000 (0.1671)*	859,000
Total present worth cost = \$859,000 (10.9617)**	\$ 9,416,000

*Sinking fund factor, uniform series, 9 percent, 5 years.

**Present worth factor, uniform series, 9 percent, 50 years.

3. Sand Bypassing With Supplemental Nourishment

It is assumed that sand can be bypassed at an annual rate of 74,000 cubic yards from Point Pleasant to Manasquan across the Manasquan Inlet by means of a pipeline system. An additional 76,000 cubic yards of sand from offshore sources would be required to satisfy the 150,000 cubic yard annual erosion rate. Use of offshore borrow areas (or other sand sources) would result in some loss of fines. The analysis also assumes that the nourishment project would prove to be attractive enough to result in competitive bidding by dredging contractors. Nourishment would be accomplished at 10-year intervals to balance mobilization cost penalties against the losses of beach area between nourishment intervals. Shorter nourishment intervals may be possible if this project can be coupled with an adjacent project so as to result in sufficient sand volumes to attract dredgers' bids.

Pipeline bypass system costs were developed from data provided by Souder and others (1978). Cost estimates for pipe sizes ranging from 8 to 18 inches were

evaluated; estimates for the most economical system (i.e., 8-inch pipe) are listed in Table VIII.B-2. A facility life of 20 years for bypassing equipment is assumed. Three replacement cycles with provisions for terminal value accounting after 10 years of the third cycle are used in the computations in Table VIII.B-2.

4. Sand Recycling By Pipeline System

Sand recycling by means of a permanent pipeline consists of a deposition basin protected by an offshore breakwater, a permanent base pumping plant, a pipeline system running the length of the reach (31,000 feet), and booster pumping stations. System costs were developed from data provided by Souder and others (1978). Cost estimates for pipe sizes from 8 to 18 inches were evaluated; estimates for the most economical system (i.e., 12-inch pipe) are shown in Table VIII.B-3. A facility life of 20 years for pipe and pumping equipment is assumed. Three replacement cycles, with provisions for terminal value accounting after 10 years of the third cycle, are used in the computations.

The estimate assumes that a recycling system is also in operation in Reach 5 (Manasquan Inlet to Mantoloking) which is updrift of Reach 4. The breakwater-protected deposition basin together with the Manasquan Inlet jetties would act as a littoral barrier. It is conservatively assumed that no sand would be transported beyond that littoral barrier. It is further assumed that erosion losses would increase as a result of the blockage of the littoral transport. The erosion losses with a recycling scheme in Reach 4 are estimated to increase to 224,000 cubic yards per year.

5. Sand Recycling With A Dredge/Barge System

Sand recycling with a dredge/barge system consists of a deposition basin protected by an offshore breakwater, a small hydraulic dredge (approximately 12-inch pipe), and two self-propelled shallow draft hopper barges with a capacity of 300 cubic yards each. The hydraulic dredge would load the barges from behind the breakwater. The barges would then transport the sand to updrift beaches (to the south in Reach 4) and deposit the sand in the surf zone (6- to 8-foot water depth) where it could be driven onto the beach by long period wave action.

The estimates given in Table VIII.B-4 assume that a recycling system is also in operation in Reach 5 (Manasquan Inlet to Mantoloking) which is updrift of Reach 4. The operation of the breakwater-protected deposition basin together with the Manasquan Inlet jetties would result in an increase in erosion rates to about 224,000 cubic yards per year.

Project costs are based on updated costs reported by Sanderson (1976) from experience with Corps operations in the Wilmington District, North Carolina. Twenty-five year life is assumed for the dredge and barge components.

TABLE VIII.B-2

ESTIMATED COST FOR SAND BYPASSING WITH SUPPLEMENTAL NOURISHMENT
(8-INCH PIPE)
REACH 4

Bypassing Operations Costs	
Annual pipeline cost	$ 3,000
Annual energy cost	8,600
Base pumping plant operational costs	169,200
Base pumping plant fixed costs	406,000
Total annual cost (1976 dollars)	$ 587,000
Total annual cost (1980 dollars)	846,000
Present worth cost = ($846,000) (10.9617)*	$ 9,274,000
Terminal Value of Bypass Equipment	
Annual pipeline cost	$ 3,000
Based pumping plant fixed costs	406,000
Total annual cost	409,000
Present worth of plant = ($409,000) (6.4177)** (end of 50-yr project life)	2,625,000
Present worth of plant = ($2,625,000) (0.0134)*** (terminal value)	35,000
Net present worth cost of bypassing system ($9,274,000 - 35,000)	$ 9,239,000
Supplemental Nourishment Costs	
In-place nourishment volumes at 10-yr interval (76,000 cu yd/year)	760,000 yd^3
Fill volume with 1.3 Overpumpage	988,000 yd^3
Cost to place @ $3/$yd^3$	$ 2,964,000
Mobilization and Demobilization	800,000
SUBTOTAL	$ 3,764,000
Contingency Allowance @ 15%	565,000
SUBTOTAL	$ 4,329,000
Engineering, Design, Supervision and Administration @ 20%	866,000
Total nourishment cost per interval	$ 5,195,000
Total Annual cost = $5,195,000 (0.0658)+	342,000
Present worth cost of nourishment = $342,000 (10.9617)*	$ 3,749,000
Cost Totals	
Present worth cost of inlet bypassing	$ 9,239,000
Present worth cost of supplemental nourishment	3,749,000
Total present worth cost	$ 12,988,000

*Present worth factor, uniform series, 9 percent, 50 years.
**Present worth factor, uniform series, 9 percent, 10 years.
***Present worth factor, single payment, 9 percent, 50 years.
+Sinking fund factor, uniform series, 9 percent, 10 years.

TABLE VIII.B-3

ESTIMATED COSTS FOR SAND RECYCLING BY PIPELINE (12-INCH PIPE)
REACH 4

Recycling Plant Costs	
Booster pump station annual cost (3 stations)	$ 118,000
Annual pipeline cost	65,000
Annual energy cost	116,000
Base pumping plant operations cost	194,000
Base pumping plant fixed cost	580,000
Booster station labor costs	17,000
Total annual cost (1976 dollars)	$ 1,090,000
Total annual cost (1980 dollars)	$ 1,571,000
Present worth cost of recycling plant = ($1,571,000) (10.9617)*	$ 17,221,000
Terminal Value of Equipment	
Booster station annual cost	$ 118,000
Annual pipeline cost	65,000
Based pumping plant fixed costs	580,000
Total annual cost	$ 763,000
Present worth of capital items at the end of the 50-yr project life = ($763,000) (6.4177)**	4,897,000
Present worth of terminal value = ($4,898,000) (0.0134)***	66,000
Net present worth cost of recycling system = $17,221,000 - 66,000	$ 17,155,000
Offshore Breakwater	
Present worth cost of 1000-ft breakwater	$ 4,560,000
Present worth cost of breakwater maintenance	61,000
	$ 4,621,000
Total Cost	
Present worth cost of recycling system	$ 17,155,000
Present worth cost of breakwater	4,621,000
	$ 21,776,000

*Present worth factor, uniform series, 9 percent, 50 years.
**Present worth factor, uniform series, 9 percent, 10 years.
***Present worth factor, single payment, 9 percent, 50 years.

TABLE VIII.B-4

ESTIMATED COSTS OF SAND RECYCLING WITH A BARGE/DREDGE SYSTEM
REACH 4

Nourishment Costs	
Annual nourishment required (in-place)	224,000 yd^3
Fill volume with 1.3 overpumpage	291,000 yd^3
Cost to place @ \$2.50/yd^3	\$ 728,000
Mobilization and Demobilization	30,000
SUBTOTAL	\$ 758,000
Contingency allowance @ 15%	114,000
SUBTOTAL	\$ 872,000
Engineering and design and supervision and administration @ 20%	174,000
Total annual nourishment cost	1,046,000
Total present worth cost = (\$1,046,000) (10.9617)*	\$ 11,466,000
Structural Costs	
1000-ft offshore breakwater	\$ 4,560,000
Breakwater maintenance	61,000
	\$ 4,621,000
Total present worth cost	\$ 16,087,000

*Present worth factor, uniform series, 9 percent, 50 years

C. ALTERNATIVE COST COMPARISON

Table VIII.C-1 summarizes the present worth costs of the four beach nourishment systems evaluated for Reach 4. Conventional beach nourishment has the lowest total cost, making it the prime system for recommended use. In recent years conventional nourishment costs have escalated rapidly, and this trend is likely to continue. Therefore, project costs using conventional nourishment can also be expected to grow over time. Additionally, it was assumed that the projects would be attractive enough to result in competitive bidding by dredging contractors. Because of the relatively small quantities involved in nourishment of individual reaches (less than 1 million cubic yards), grouping of projects for several reaches may be required to gain contractor interest. Minor adjustment of schedule and volumes of periodic nourishment can also be made so that nourishment and berm expansion operations for the recreational alternative occur coincidentally. Such a combination of fill operations generally results in an adequate sized project.

The detailed cost comparison of beach nourishment schemes was only performed in entirety for Reach 4 (Shark River Inlet to Manasquan Inlet). Since other reaches have comparable or longer ocean frontage, the pipeline recycling system would have higher total costs due to the requirement for additional booster stations, pipe, and other equipment. Likewise the dredge/barge recycling scheme would also experience higher unit costs due to longer transport distances. Sand bypassing at Shark River Inlet is a possible partial nourishment scheme for Reach 3 (Long Branch to Shark River Inlet). The costs for this system also appears to be higher than conventional nourishment as in the Reach 4 example. A cost comparison of the conventional nourishment scheme and the sand recycling by dredge/barge system was done for all of the oceanfront reaches. That comparison is summarized in Table VIII.C-2.

In short, conventional nourishment appears to be the most economical scheme for all oceanfront reaches.

TABLE VIII.C-1

COST COMPARISON OF BEACH NOURISHMENT SCHEMES
REACH 4

System	Cost
Conventional nourishment from offshore sources	$ 9,416,000
Sand bypassing with supplemental nourishment	$ 12,988,000
Sand recycling by pipeline	$ 21,776,000
Sand recycling by dredge/barge system	$ 16,087,000

TABLE VIII.C-2

SUMMARY OF COST COMPARISON FOR CONVENTIONAL AND DREDGE/BARGE NOURISHMENT SCHEMES
ALL OCEANFRONT REACHES

Reach No.	Reach Name	Cost (Present Worth Dollars) Conventional Renourishment	Dredge/Barge Recycling
2	Sandy Hook to Long Branch	$4,096,000 (85,000 cu yd/year @ 10-year intervals)	$35,899,000 (439,000 cu yd/year)
3	Long Branch to Shark River Inlet	$8,430,000 (130,000 cu yd/year @ 5-year intervals)	$27,099,000 (354,000 cu yd/year)
4	Shark River Inlet to Manasquan Inlet	$9,416,000 (150,000 cu yd/year @ 5-year intervals)	$16,087,000 (224,000 cu yd/year)
5	Manasquan Inlet to Mantoloking	$3,669,000 (74,000 cu yd/year @ 10-year intervals)	$6,410,000 (74,000 cu yd/year)
6	Mantoloking to Barnegat Inlet	$6,926,000 (125,000 cu yd/year @ 7-year intervals)	$11,247,000 (125,000 cu yd/year)
7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)	$6,172,000 (98,000 cu yd/year @ 8-year intervals)	$7,282,000 (98,000 cu yd/year)
8	Little Egg Inlet to Absecon Island (Brigantine Island)	$3,669,000 (74,000 cu yd/year @ 10-year intervals)	$8,765,000 (75,000 cu yd/year)
9	Absecon Inlet to Great Egg Inlet (Absecon Island)	$17,192,000 (250,000 cu yd/year @ 3-year intervals)	$21,987,000 (250,000 cu yd/year)
10	Great Egg Inlet to Corson Inlet (Peck Beach)	$10,895,000 (180,000 cu yd/year @ 5-year intervals)	$13,927,000 (180,000 cu yd/year)
11	Corson Inlet to Townsends Inlet (Ludlam Island)	$19,892,000 (300,000 cu yd/year @ 3-year intervals)	$24,445,000 (300,000 cu yd/year)
12	Townsends Inlet to Hereford Inlet (Seven Mile Island)	$4,135,000 (86,000 cu yd/year @ 10-year intervals)	$14,907,000 (200,000 cu yd/year)
13	Hereford Inlet to Cape May Inlet (Seven Mile Beach)	$62,000 (130,000 cu yd/year @ 5-year intervals)	$18,442,000 (225,000 cu yd/year)
14	Cape May Inlet to Cape May Point	$19,730,000 (297,000 cu yd/year @ 3-year intervals)	$21,983,000 (297,000 cu yd/year)

Note: All fill volumes are in-place quantities without overpumpage factor.

CHAPTER IX

RESPONSE TO EROSION EMERGENCIES

A. INTRODUCTION

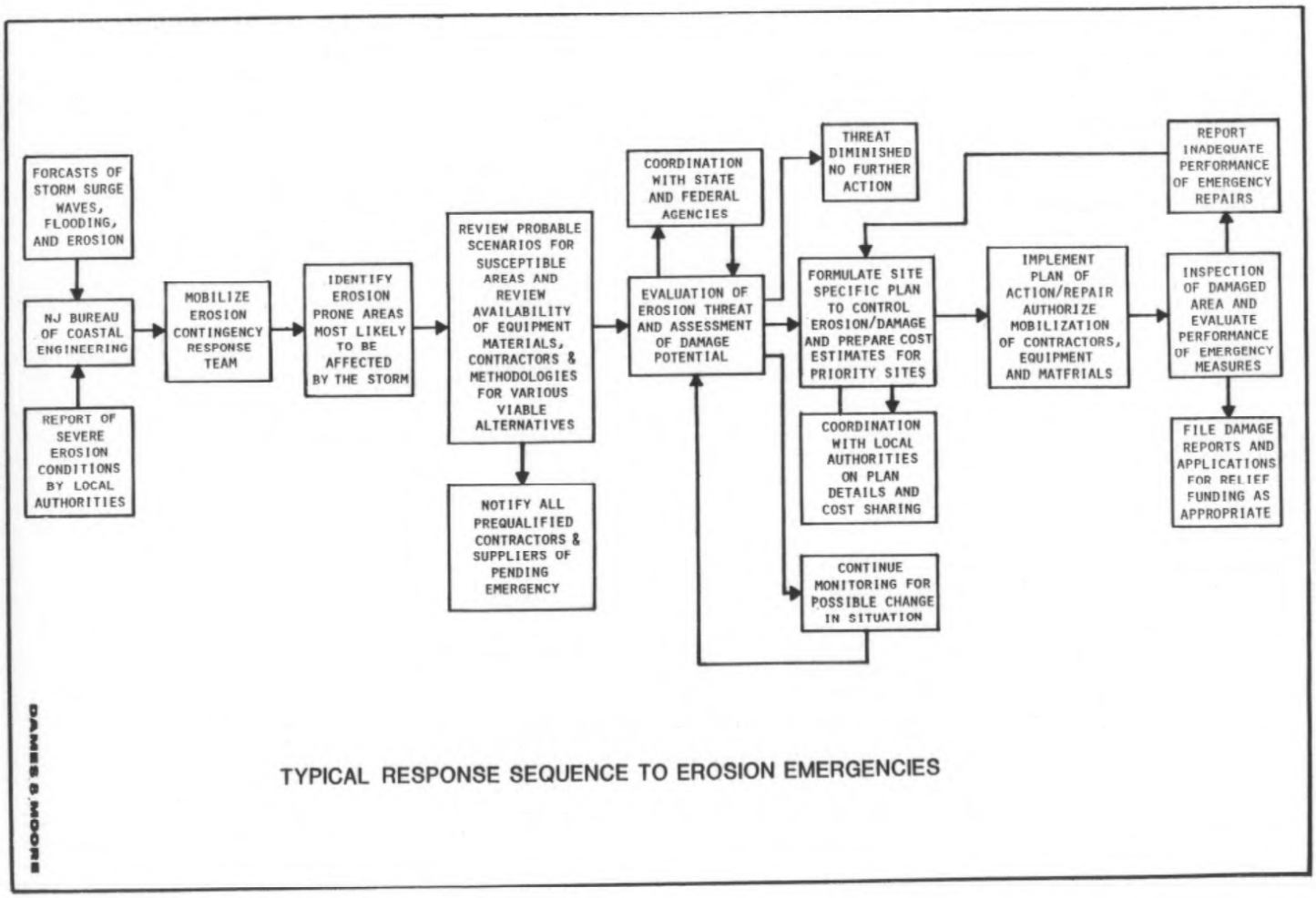
The goal of contingency planning is preparedness on a regional scale to allow for the control of a severe erosion event which would be likely to threaten property or infrastructure. The intent of contingency planning is to limit damage to the natural beach features or manmade structures that were designed to absorb the principal force of the erosive activity. In so doing, more serious damage to property and infrastructure behind the initial line of defense is prevented. A well-designed contingency plan enables rapid organized response to a storm erosion emergency. The no-plan condition promotes delay and failure to meet the crisis at hand.

The effective response to an emergency is dependent on the availability of materials such as large stone, fill, treated timber, hardware, and equipment for construction and transit purposes. Furthermore, logistics of materials and equipment access and availability to the site must be considered. If materials are not readily available or if transit times to reach a particular emergency area are excessive, consideration must be given to making resources available at or in proximity to the affected areas. Even where provisions can be made for adequate access, equipment and materials, unskilled manpower, and insufficient funds usually prove to be the limiting factors in contingency plan implementation, especially where storm erosion damage is severe and widespread. For this reason, state and local governments must develop priority goals and objectives so that the best use of available resources can be made in minimizing damage during erosion emergencies.

Methodologies for dealing with an emergency erosion event must be commensurate with the type and intensity of the damage. For example, regional wave scour of a dune field differs significantly from the situation where storm waves are breaking directly on a damaged seawall. In most situations, stone is the most reliable material for use in an emergency. It is more stable, easier to install, and more functionally reliable than other materials. The length of beach that can be protected is directly proportional to the amount of onsite equipment and the volume of stone delivered. As a practical guideline, emergency mitigation requires as much equipment and material as can be mobilized.

An important aspect of contingency planning is implementation. A system must be established by which an erosion emergency can be anticipated, monitored, and quickly assessed for a response/no response decision. A schematic representation of a typical decision process required for contingency plan implementation is provided in Figure IX.A-1. A major drawback in handling erosion emergencies has been delays in implementing mitigation due to confusion regarding the severity of the situation, cost sharing arrangements, permit problems, and other miscellaneous legal and contractual technicalities. The question of who must pay for emergency protection of private property should be answered prior to any emergency work. It is imperative that such issues as payment, permits, liability, and responsibility be addressed beforehand or waived so as not to delay implementation of the erosion contingency plan.

Proper planning for an erosion emergency involves consideration of the probable damage scenarios, equipment and materials logistics, and the emergency protection methodology mentioned above. General policy procedures can be estab-



TYPICAL RESPONSE SEQUENCE TO EROSION EMERGENCIES

FIGURE IX.A-1

lished for typical implementation problems, but mitigation methodology must be addressed on a geographic basis. To establish mitigation methodologies for New Jersey, the shoreline was divided into preparedness regions according to similarities in beach characteristics, existing erosion protection features, access, and most probable damage scenario. In this manner, seven regions were delineated as follows:

- Region I - Raritan Bay
- Region II - Sandy Hook to Manasquan Inlet
- Region III - Manasquan Inlet to Barnegat Inlet
- Region IV - Long Beach Island and Brigantine Island
- Region V - Absecon Inlet to Cape May Inlet
- Region VI - Cape May Inlet to Cape May Point
- Region VII - Delaware Bay and Delaware River.

The locations of these regions are shown on Figure IX.A-2 and listed in Table IX.A-1.

B. CONTINGENCY CONSIDERATIONS BY REGION

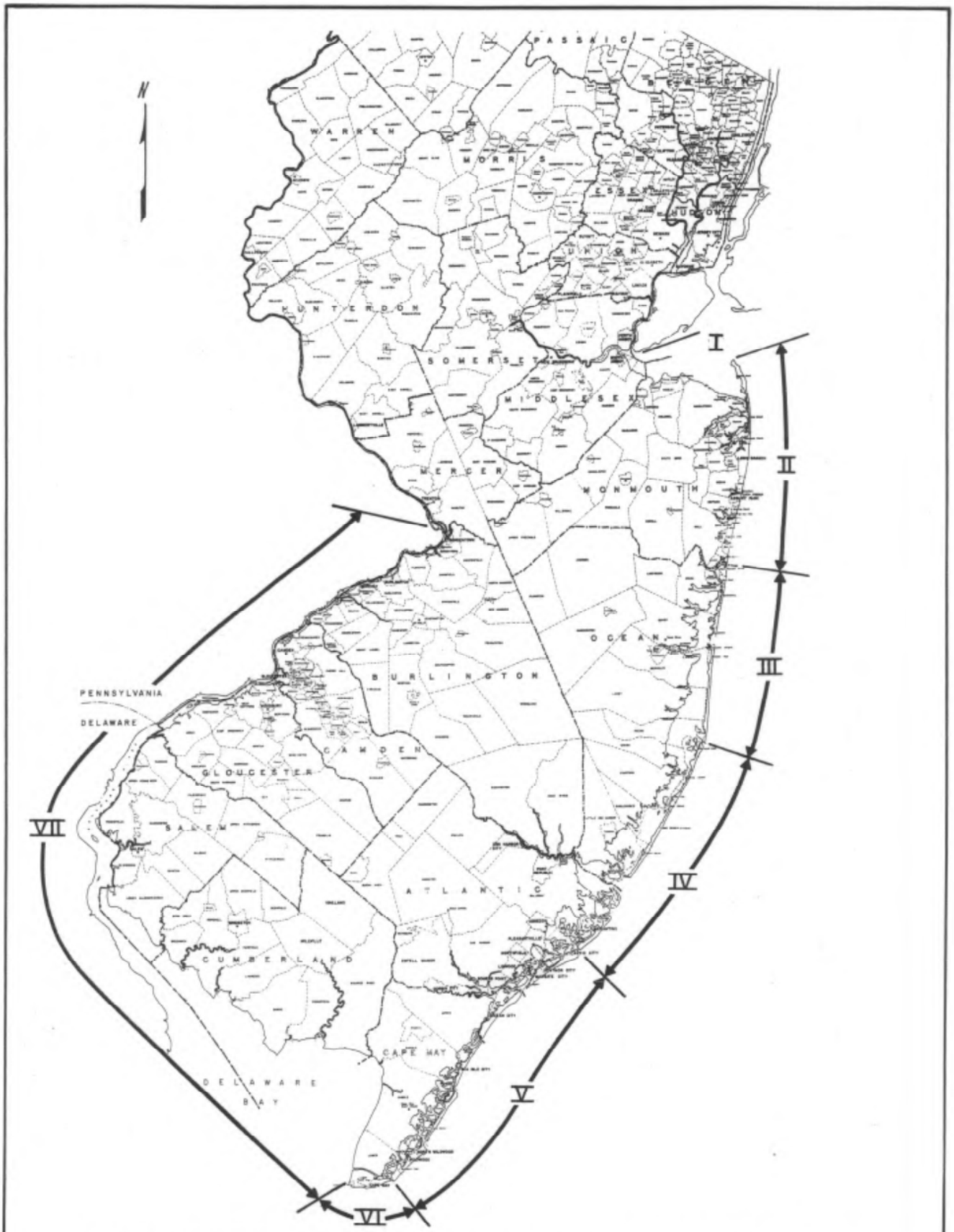
Included in each regional discussion below is a probable damage scenario, the projected equipment and material logistics required, and the probable mitigating measures that could be implemented in the event of an erosion emergency. Pertinent considerations are summarized in matrix form on Figure IX.B-1.

1. Region I - Raritan Bay

This area consists of small clusters of private dwellings which are exposed primarily to short-period storm wave action due to their proximity to the bay-shore. Probable damage in this region also includes bluff erosion and sloughing. These effects can threaten buildings near the face of the bay-shore bluffs. High water with accompanying wave action may impinge directly on revetments or bulkhead structures at low-lying private property.

Typical emergency measures that could be implemented in this region include placement of stone riprap to repair revetments and bulkheads damaged or threatened with failure and emergency repairs to arrest bluff erosion and undermining. Commercially available shore protection methods such as Longard tubing, which would form temporary barriers to high water level and wave action, are a possibility for this region because of its lower intensity storm exposure. However, these methods become more labor intensive and demand closer construction tolerances and experienced contractors. In addition, a large supply of sand is required for effective application of Longard tubing.

Stone, sand, and equipment are readily available within this region. Consequently, once a problem is identified, stone riprap to patch breached or damaged bulkheads and sand for emergency backfilling could be easily obtained. Approximately three loads of stone per delivery truck (20 tons per load) could be dispatched from the northern New Jersey quarry stockpiles on the first day of mobilization. Furthermore, about 10 delivery trucks from the local area could be used. With these assumptions, approximately 600 tons of rock could be delivered within 24 hours to any point in Region I. This translates to about 300 feet of toe protection provided that enough equipment is on hand to place the delivered stone. Thus, without more construction equipment and stone, the amount of Region I shoreline that could be protected on an emergency basis is relatively small.



PROPOSED CONTINGENCY PLANNING REGIONS

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FIGURE IX.A-2

TABLE IX.A-1

CONTINGENCY PLANNING REGIONS

Contingency Planning Region	Reach Number	Reach Description
I	1	Raritan Bay
II	2	Sandy Hook to Long Branch
	3	Long Branch to Shark River Inlet
	4	Shark River Inlet to Manasquan Inlet
III	5	Manasquan Inlet to Mantoloking
	6	Mantoloking to Barnegat Inlet
IV	7	Barnegat Inlet to Little Egg Inlet (Long Beach Island)
	8	Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island)
V	9	Absecon Inlet to Great Egg Harbor Inlet (Absecon Island)
	10	Great Egg Harbor Inlet to Corson Inlet (Pecks Beach)
	11	Corsons Inlet to Townsends Inlet (Ludlam Island)
	12	Townsends Inlet to Hereford Inlet (Seven Mile Beach)
	13	Hereford Inlet to Cape May Inlet (Five Mile Beach)
VI	14	Cape May Inlet to Cape May Point
VIII	15	Delaware Bay – Cape May Point to Stow Creek
	16	Delaware River – Stow Creek to Crosswicks Creek

FIGURE IX.B-1

CONTINGENCY PLAN MATRIX

PLANNING REGIONS	PROBABLE EROSION DAMAGE SCENARIO						PRACTICAL CONTINGENCY MEASURES				OTHER CONSIDERATIONS		
	SHORELINE RETREAT OR DUNE SCARPING	BLUFF EROSION AND UNDERMINING	BULKHEAD OR REVETMENT DAMAGE	SEAWALL DAMAGE OR COLLAPSE	BREACHING OF DUNES OR STRUCTURES AND OVERWASH	UNDERMINING AND DAMAGE TO BUILDINGS ALONG SHOREFRONT	STONE OR RIP RAP PLACEMENT	SAND OR RUBBLE FILL	REPAIR OF BULKHEADING	APPLICATION OF LOW-COST ALTERNATIVE METHODS	ACCESS LIMITATIONS	STOCK PILE MATERIALS	HEAVY EQUIPMENT REQUIRED
I - RARITAN BAY SHORE	●	●	●	●		●	●	●	●	●			
II - SANDY HOOK TO MANASQUAN INLET	●	●	●	●	●	●	●	●		●	●	●	●
III - MANASQUAN INLET TO BARNEGAT INLET	●				●	●	●	●		●			●
IV - BARNEGAT INLET TO ABSECON INLET	●		●		●	●		●	●		●	●	
V - ABSECON INLET TO CAPE MAY INLET	●		●	●	●	●	●	●	●	●			●
VI - CAPE MAY INLET TO CAPE MAY POINT	●		●	●		●	●		●	●		●	●
VII - DELAWARE BAY AND RIVER	●	●	●			●	●	●	●	●	●	●	●

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2. Region II - Sandy Hook to Manasquan Inlet

This region is dominated by the seawall at Sea Bright and Monmouth Beach and the headland bluffs with stone revetments and timber bulkheads which extend south to Deal. The bluffs and seawall areas are exposed to direct storm wave attack. Between Shark River Inlet and Manasquan Inlet, the narrow beaches are steeply sloped and backed by low dunes that are susceptible to erosion scarping and recession. The shore protection structures are susceptible to damage of varying degree. Leaching of bluff material through the toe protection structures could lead to spontaneous failures of local bluff areas. Stone displacement or revetment damage could lead to a progressive and more serious failure unless quickly repaired. This is particularly acute along the northern seawall area where toe scour and slope steepening could cause serious problems.

Emergency protection measures for this region would consist mainly of stone riprap. The seawall at Sea Bright and southward, including individual revetments in the Manasquan to Shark River Inlet area, could be temporarily repaired by placement of adequate stone sizes to further arrest seawall deterioration or revetment failure. Larger stone sizes will be required for the Sea Bright-Monmouth Beach seawall since it is subject to higher waves. Consequently, the contingency plan must allow for acquisition of stones in sizes which are compatible with those already in place; reliance on quarry mining by demand would not permit response under emergency conditions.

From Monmouth Beach to Manasquan, provision for emergency fill should be made to repair areas washed out behind damaged revetment and bulkheads. This program would be in conjunction with emergency structural repairs. For less severe events, commercially available, low-cost shore protection methods could be used to arrest a toe scour problem if low water tide conditions permit.

Region II is also within ready access of northern New Jersey equipment and material suppliers. However, in the Sea Bright-Monmouth Beach area, consideration should be given to the limited access to and vulnerability of Ocean Avenue. If a serious breach or flooding occurs, contingency access should be planned to ensure uninterrupted transit to the site. As discussed for Region I, approximately 600 tons of stone could also be delivered on the first day to any point in Region II. This quantity translates to about 40 feet of seawall repair at Sea Bright and 300 feet for the area between Shark River Inlet and Manasquan Inlet. Implementation of seawall repairs at Sea Bright will require cranes for stone placement. Front-end loaders could be used to place smaller stone between Shark River Inlet and Manasquan Inlet.

3. Region III - Manasquan Inlet to Barnegat Inlet

This region is characterized by moderate-to-narrow beach widths, steeply sloped beaches, and very low, narrow dunes. Probable storm erosion damage in this area would consist of high water wave action impinging on the backshore and creating erosion scarps, landward retreat of shoreline, and possible undermining of buildings. Multiple-road access to this region permits importation of equipment and materials on an as-needed basis from distant sources. However, the southern portions of Region III may be susceptible to breaching and overwashing during more severe storm events. This condition would pose access problems in downcoast locations.

The principal emergency protection measure requirement of this region would consist of arresting the local erosion scarping that will occur with the high water levels and storm wave action. This can best be handled by placing plastic filter cloth and stone riprap to reduce loss of the sandy material. Consequently, an adequate quantity and size of stone would be required. Four hundred to 600 tons of stone can be delivered to the region on the first day of mobilization; thus, 200 to 300 feet of shoreline could be protected if front-end loaders were available onsite. Grading of steep scarps to a flatter slope prior to revetment placement, if possible, would greatly hinder the erosion mechanism. Emergency trucking of sand to fill gaps left by irregular losses of backshore areas should be accomplished prior to placement of emergency stone. This would provide for a more uniform backshore line and prevent concentrations of wave energy and flanking of existing shore protection structures.

Alternative measures, such as commercially available shore erosion control methods, could be used for temporary repair of storm damage. The limitations of such temporary measures have been previously mentioned.

4. Region IV - Long Beach Island and Brigantine Island

Long Beach Island and Brigantine Island are characterized by moderate-to-narrow beach widths and very low-to-moderate dune elevations. A probable damage scenario for these islands would include erosion scarping at the dune toe, with resultant shoreline retreat and possible undermining of buildings. Dune breaching and overwashing is probable at both islands for more severe storm occurrences. Contingency planning is important in this region to recognize and close a potential dune breach before it can develop into a serious condition.

Emergency mitigation would consist of placement of stone riprap over plastic filter cloth and emergency sand or rubble filling to plug gaps in the dune. These measures would lessen upland flooding and dune breaching.

Both Long Beach and Brigantine Islands have only one road to the mainland. If either of these roads is flooded, washed out during a storm, or blocked by evacuation congestion, any remote mobilization of equipment and materials would be prohibited. Contingency planning for Region IV must recognize this possibility, and onsite storage of equipment and materials is highly recommended. Approximately 400 tons of stone from the northern quarries could be delivered to any point in Region IV during the first day of dispatch. This corresponds to only about 200 feet of shoreline repair that could be implemented using front-end loaders.

5. Region V - Absecon Inlet to Cape May Inlet

This region consists of Absecon Island, Peck Beach, Ludlam Beach, Seven Mile Beach, and Five Mile Beach. These individual islands are moderately to heavily developed and have beaches ranging from very narrow to very wide. For the most part, the islands are flat with dunes of varying elevations. Bulkhead structures fronting private development are used extensively for storm protection. A range of probable damage scenarios for this area includes erosion scarping, potential undermining of buildings adjacent to the beach, and inundation damage resulting from breaches in dunes or bulkheading.

Emergency protection measures for Region V would consist mainly of stone riprap placed over filter cloth to arrest dune scarping and erosion, to mitigate damage to bulkhead breaches or failure, and to plug overwash areas. Planning for this region

should emphasize maintaining the integrity of the existing shore protection structures. Consequently, emergency sand fill, stone riprap toe protection, and timber replacement would provide the main components of emergency repairs. If conditions permit, commercially available methods could be used to provide temporary toe protection and to maintain bulkhead stability.

The individual islands have mulitple access, with roads connecting to the mainland and to adjacent islands. Weight limitations on bridges connecting the adjacent islands may constrain some material transport. In general, however, alternative routes for importation of emergency equipment and materials should be available in the event of flooding or wash out of some roads.

Since southern New Jersey shore points are distant from the northern quarry sites, truck transit directly from the quarry to the emergency area is not efficient. Individual truck deliveries to Atlantic City would require two trips for the first day – decreasing to one trip at the southern portions of the region. An assumed limited availability of 10 trucks for emergency response implies deliverable tonnages ranging from 200 to 400; this translates to shore protection lengths of only 100 to 200 feet. Any emergency response plan for this region would be limited by the material supply rate unless regional stockpiling centers were established.

6. Region VI - Cape May Inlet to Cape May Point

This region contains population centers at Cape May City and Cape May Point. Cape May City is protected by a stone seawall at the northern end and a bulkhead structure along the southern portion. Cape May Point is a small development of private dwellings fronted by a narrow beach. A probable damage scenario for this region would include stone displacement, undermining, and failure of the seawall and timber bulkhead at Cape May City. Undermining of buildings due to scour of the beach and dune is likely at Cape May Point.

Emergency protection measures for these two areas would involve placement of stone to arrest undermining and damage to the seawall or timber bulkhead. Emergency sand fill may also be required at Cape May Point to stabilize seriously washed out landward areas or dune areas prior to placement of stone riprap. The use of low-cost shore protection methodology would be limited within this region. Proprietary products such as Longard tubes could be used to plug gaps in dunes or provide toe erosion protection. However, this would be restricted to small lot application and low intensity storm conditions and would depend on the availability of sand and experienced labor.

Although access to Region VI is adequate and would normally permit equipment and materials importation during erosion emergencies, the region is quite distant from the northern New Jersey stone quarries. Individual trucks dispatched for emergency response would be limited to one trip for the first day. Assuming that 10 trucks could be obtained from different haul companies, only 200 tons of stone would be available for the first 24 hours of the emergency. This is equivalent to repair of approximately 20 feet of seawall at Cape May City or 100 feet of toe protection at Cape May Point. A regional stockpiling center for stone is recommended to improve response time and increase emergency coverage.

7. Region VII - Delaware Bay and Delaware River

The Delaware Bay and the Delaware River south of Pennsville are characterized by isolated developments with little or no beaches. North of Pennsville, private and industrial riverfront development increases appreciably but beaches remain scarce and small. Typical damage scenarios for the developed bay-shore areas include toe erosion of dunes and bluffs resulting in shoreline recession and undermining of buildings. Direct surge and wave impingment on existing bulkheads fronting private dwellings may also occur.

Emergency repairs for the bay-shore areas would consist of placing stone riprap to arrest further shoreline retreat or providing temporary bulkhead repair. Sand fill would be needed to restore severely washed out areas prior to stone placement.

Access varies along the Delaware Bay shore from very good in the southerly more populated areas to poor in the smaller isolated northern villages. Consequently, equipment and material importation is viable at the southern portion and less probable for the individual low-lying northern villages. This must be understood by the local residents who could provide their own low-cost shore protection measures. Stone delivery rates to southern portions of Region VII are the same as described for Region VI. First-day deliveries could only accommodate about 100 feet of emergency shore protection. Therefore, if more coverage is desired, regional stockpiling centers or additional delivery trucks would be needed.

Typical damage scenarios for the developed riverfront areas in Region VII include bank erosion and damage or failure of individual timber on sheet pile bulkheads during high river stage periods. Emergency filling or bulkhead repairs may be implemented to arrest further erosion and damage and to protect threatened property or infrastructure. In severe cases, stone can be used to stabilize the riverbank. If stone is required, delivery from quarries in northern New Jersey to northern river areas would be comparable with that in Regions I and II. For more southerly stretches of the river, delivery would be comparable with that in Regions III and IV. Use of stone quarries in Pennsylvania could reduce travel time and increase daily deliverable quantities along the Delaware River.

Because access to developed riverfront areas is generally good and adequate materials and equipment can be obtained for most emergency situations, stockpiling of materials is not an important contingency consideration for the Delaware River portion of Region VII.

Low-cost emergency shore protection measures, which could be implemented to protect very localized sites, are most appropriate for Region VII. Commercially available methods could be considered on a case-by-case basis for areas along both the bay and river shores.

C. SUMMARY AND RECOMMENDATIONS

Contingency planning regions have been identified on the basis of probable damage scenario, projected equipment and material logistics, and probable protection measures that could be implemented in the event of an erosion emergency. Areas along the Raritan Bay, the Atlantic Coast from Sandy Hook to Barnegat Inlet, and the Delaware River are within reasonable distances of material supplies. Multiple access for delivery of these materials to the shore is also available; therefore, the storage of emergency repair materials in areas with ready access to the shoreline is not essential.

However, onsite storage of materials appears appropriate for Long Beach and Brigantine Islands due to the vulnerability of access routes. For the remaining coastal areas, from Absecon Island to Cape May Point and the Delaware Bay shore, emergency repair materials stockpiled at regional storage centers would be appropriate. Long hauling distances for riprap and the resulting impact on response time are the primary factors behind this conclusion.

The contingency plan for each planning region will be further analyzed and refined during the Detailed Design Phase of the Shore Protection Facilities Construction Program. The following tasks will be considered during that phase and updated periodically:

- Prepare detailed plans and specifications to implement the shoreline protection schemes which are presented in the Master Plan.
- Refine contingency plans with respect to materials and equipment logistics and material stockpiling schemes.
- Develop priority goals, objectives, and related policies to be followed in allocating limited funds or manpower in emergency situations.
- Formulate and adopt a policy with respect to legal, financial, environmental, and contractual considerations and arrangements for contingency plan implementation.
- Develop communication links with the National Weather Service through which forecasts of storm surges (Pore et al., 1974) and beach erosion (Richardson, 1977) can be obtained.

CHAPTER X

COASTAL EROSION HAZARD AREA DELINEATION METHODOLOGY REVIEW

A. INTRODUCTION

This chapter provides a summary discussion of the methodology for delineation of coastal erosion hazard areas. The coastal erosion hazard area is used by various coastal states as a management zone (e.g., setback zone) where construction or excavation may be restricted or regulated to aid in minimizing unreasonable danger to life and property. The designation of a hazard zone is an attempt to achieve a balance between social and economic factors that are involved in erosion hazard area development.

The coastal erosion hazard area concept presented herein is not synonymous with a coastal flood inundation area or coastal high hazard area ("V" zone), as delineated by the Federal Emergency Management Agency (FEMA) on flood insurance maps published under the National Flood Insurance Program. Although the erosion hazard area and "V" zone overlap to some degree, damages and long-term effects associated with each are substantially different — for example, secular variations due to shoreline change are characteristic of coastal erosion hazard areas, while storm inundation damages relate primarily to flooding (water damages to property) but topographically the area may remain unchanged. Temporary or permanent topographic alteration occurs in zones subjected to short- or long-term erosion.

The erosion hazard area as discussed herein is synonymous by definition with the area identified by the North Carolina Department of Coastal Resources (Tayfun et al., 1979) as the "ocean erodible area." This area includes beaches, frontal dunes, inlet lands, and other coastal areas in which there is a substantial possibility of excessive erosion and significant permanent or temporary shoreline fluctuation during a designated period.

Development in areas landward of a designated erosion hazard area may be assumed to be relatively safe from erosion, but the uncertainties inherent in zone delineation are due to:

- Irregularities of shoreline change over short periods of time and distance.
- The influence of unpredictable migrating inlets.
- Storm overwash occurrences.
- Formation of new inlets.
- The variety of methods used for erosion hazard zone delineation.

The major problem facing coastal managers is the general lack of a uniform approach for erosion hazard area delineation — from state to Federal, state to state, and location to location.

There are two major elements in the concept of shoreline erosion — a short-term erosion event component, with rapid erosion losses associated with the wave and surge activity accompanying a storm event; and the long-term erosion trend component responding to littoral processes. Empirical methodologies for assessing each of these components are discussed separately below. The application of appropriate methodologies for the delineation of erosion setback zones for New Jersey is also discussed, including a nonquantitative delineation methodology involving assessment of the geomorphic character of shore areas.

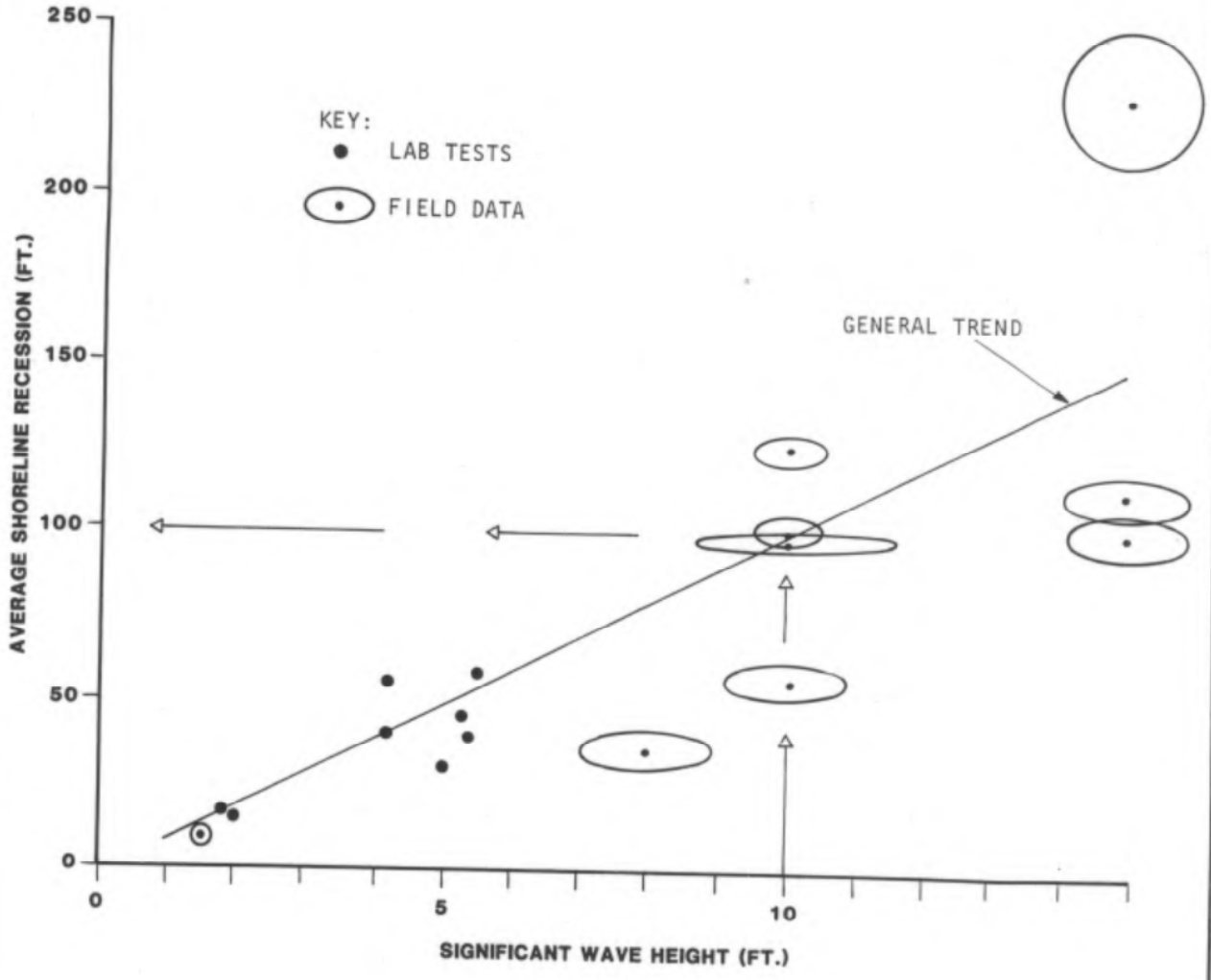
B. SHORT-TERM EROSION EVENT (STORM ACTION)

Many factors affect the degree of shoreline erosion in a storm, including shoreline configuration, shoreline material characteristics, water level, wave conditions, and storm duration. The extent to which erosion is individually dependent on any of these factors is not clearly known, since experimentally precise storm erosion data are not readily available. Consequently, there are no established analytical relationships that describe the effect of erosion on shoreline and dune configurations and soil properties. For these reasons, available case studies must be used in conjunction with conservative engineering judgement to develop an erosion component methodology based on storm events.

Shoreline profile data recorded both before and after a storm can be used to determine either the volumetric amount of shoreline erosion or the distance that the shoreline receded at a certain elevation. Every sandy (noncohesive) shoreline has an associated vertical equilibrium profile that is determined by shoreline properties and prevailing water levels and wave conditions. In the event of a hurricane or other severe storm, high wind waves can cause rapid erosion. The maximum possible wave height at the coast can be significantly higher when associated with a surge or increased sea level. Much of the eroded material initially from the shore is deposited in the offshore zone and tends to inhibit further erosion. Thus, with storms of a relatively long duration, the rate of erosion decreases as the storm proceeds, and the shoreline configuration approaches a flattened storm equilibrium profile. Results from a series of erosion tests showed that almost 50 percent of the erosion, expressed as eroded volume, occurred within the first 1/8 of the time required to reach dynamic equilibirum (Van der Meulen and Gourlay, 1968). In tests performed by the Beach Erosion Board (Caldwell, 1959), 50 percent of the erosion occurred in the first 25 percent of the duration of the test. Both investigations involved tests using beach type sand. Naturally, the results of laboratory tests must be analyzed with caution, since all of the mechanisms for removing eroded material from the offshore zone may not be fully represented in laboratory flumes. However, these tests establish physical evidence supporting the storm equilibrium profile concept.

The oceanographic characteristics that control erosion during a storm are storm duration, surge height, and wave properties. As discussed previously, the rates of erosion are related to storm duration. The surge, or water elevation rise associated with the storm, influences the level of attack of the wind-generated waves and also increases the maximum wave height that can be supported at the coast where the waves are the primary source of energy driving the erosion and transport processes. In most storm erosion cases in oceans, bays, and estuaries, water current stresses from other than wave-induced currents are insignificant compared to wave forces.

The wave tank test of Caldwell (1959) indicates that wave height is the controlling factor for shoreline recession associated with storms. This relationship also applies to the trend of results from the analysis of shoreline recession associated with major coastal storms and hurricanes. Figure X.B-1 presents the results of the plot of significant wave height and average shoreline recession for the test tank data and for actual storm occurrences. The data and sources are tabulated in Table X.B-1. The test tank data (Caldwell, 1959) show the results of a 20-hour test for various wave heights. Maximum erosion among all the elevations within the profile is used. For the actual field data, erosional retreat for the upper portions of the profile is used where available. For cases in which the wave height at the coast was not available, a range of wave heights is estimated from considerations of the storm surge, beach profile, and deep water wave height. Where only maximum recessional distance is available,



AVERAGE SHORELINE RECESSION VS. SIGNIFICANT WAVE HEIGHT FOR FIELD CASES AND LAB TESTS

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FIGURE X.B-1

TABLE X.B-1

STORM RECESSION AND LAB TESTS RESULTS

Storm or Lab Test	Approximate Maximum Wave Height at Coast (ft)	Average Shoreline Recession (ft)	Reference
Northeaster - Nov. 6-7, 1953 New Jersey Coast	10	98 (at +10-ft elevation)	(a, b)
Stalled Hurricane - 1950 Florida Gulf Coast	8	35 (at MHW)	(a)
Northeaster - Oct. 4-5, 1948 Virginia Beach, Va.	10	100 (at +10-ft elevation)	(a)
Hurricane - Sept. 1938 Jones Beach, Long Island, N.Y.	15	100 (at +10-ft elevation)	(a)
Hurricane Audrey - June 27, 1957 Louisiana Coast	10	125 (at +3-ft elevation)	(a)
Hurricane Carla - Sept. 11, 1961 Mustang-Island, Texas	15	230 (estimated) (maximum 300)	(c)
Hurricane Betsy - Sept. 8-10, 1965 Alligator Spit, Fla. (Low Energy Environment)	1.5	12	(d, e)
Hurricane - Sept. 1919 Corpus Christi, Texas	15	110 (estimated) (150 maximum)	(f)
Hurricane Eloise - Sept. 23, 1975 Florida Panhandle	10	55	(g)
Beach Erosion Board Wave Tank Erosion Tests	4.2 (11.3 sec)* 4.2 (11.3 sec) 1.8 (11.3 sec) 5.5 (11.3 sec) 5.3 (5.6 sec) 5.0 (3.8 sec) 2.0 (16.0 sec) 5.3 (16.0 sec)	57 40 18 59 46 30 14 39	(a)

*Wave periods of Beach Erosion Board wave tank tests.

References:
(a)Caldwell (1959)
(b)USACOE, North Atlantic Division (March 1954).
(c)Hayes (1967).
(d)Warnke et al. (1966).
(e)Perkins and Enor (1968).
(f)Price (1956).
(g)Morton (1976).

the average recession distance is estimated based on the relationship between other storm maximum and average values of recession.

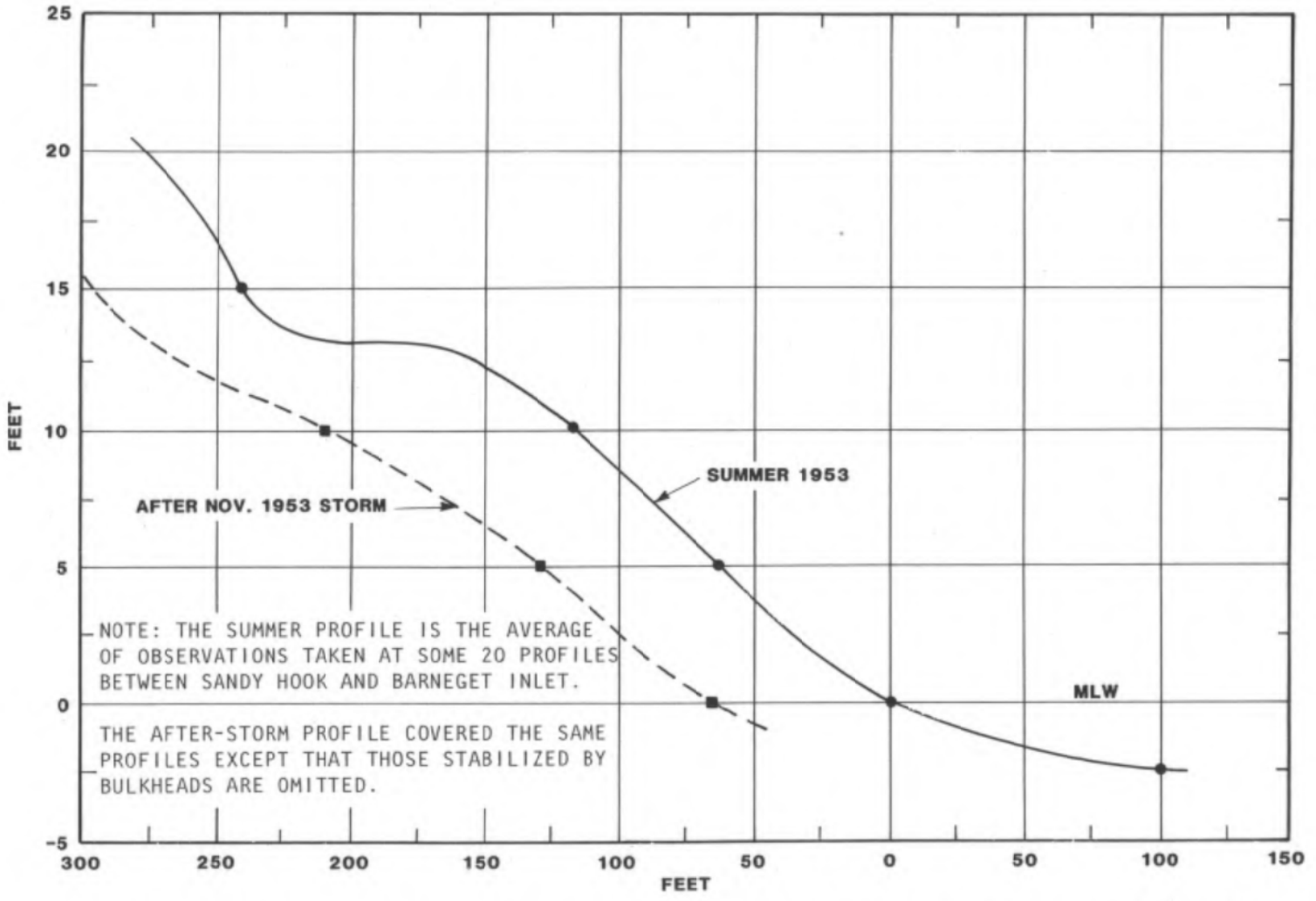
As discussed in Volume 1, Section II.B.1, on design assumptions for the alternative engineering plans, a 100-foot design beach width has been used where groins are absent. The initial recommendation for the use of this width came from Corps erosion control plans for the area from Sandy Hook to Barnegat Inlet (USACOE, North Atlantic Division, March 1954). This was based on a review of the erosion losses associated with the November 1953 northeaster which struck the New Jersey shore. The extreme tidal conditions, together with severe wave action, resulted in excessive damage to beaches, beach protection structures, homes, roads, and other public and private property adjacent to the ocean shore. Storm tides reached their maximum historical record (9.1 feet above mean sea level (MSL) at Sandy Hook). Maximum sustained wind velocity at LaGuardia Airport was recorded at 55 mph, with gusts up to 74 mph. At Atlantic City, the maximum 5-minute average velocity was recorded at 65 mph. Comparison of beach profiles taken after the storm with similar profiles measured in the summer of 1953 indicated that the recession of unprotected shoreline for this 40-mile stretch averaged 70 feet (Figure X.B-2). The average recession at the 10-foot elevation was 98 feet, with a maximum of 180 feet. Since wave data are not available for the 1953 storm, the significant wave height is estimated.

Although considerable scatter in the data is apparent on Figure X.B-1, and no quantitative relationships can be derived, the trend of increased recession with increasing significant wave height (as shown) can be used to evaluate the general magnitude of an event associated with a particular recession distance. The selection of a 100-foot recession distance can be associated with storm activity characterized by significant wave heights of about 10 feet. However, due to the scatter of the data, the recession distance for a significant wave height of 10 feet could range from 70 to 130 feet. Also, the significant wave height for a 100-foot recession could range from 8.5 to 14 feet. These significant wave heights would be associated with recurrence intervals ranging from 70 to 500 years, respectively. The recurrence intervals are based on wave data from Atlantic City (USACOE, Philadelphia District, 1976a; and Thompson, 1977; as presented in CCES, December 1979, Figure 2-6).

The recession distance associated with the general trend of Figure X.B-1 for a significant wave height of 10 feet (recurrence interval of 100 years) is 100 feet. One hundred feet was thus chosen as the short-term component of the recession setback distance and represents the average recession distance at +10 feet elevation associated with the November 1953 storm. The 100-foot recession distance represents the minimum distance; areas with erosion rates lower than 2 ft/yr (for 50-year planning period) would be governed by the short-term storm recession of 100 feet. Areas with erosion rates greater than 2 ft/yr would have setbacks as determined by the long-term erosion rates discussed below.

Another method for estimating short-term storm-induced erosion is a semi-empirical procedure based on a technique originally developed by Edelman (1968) and later modified by Vallianos (1974) and Knowles (1973). The method generally involves a balance of the areas of upland erosion ($A_{erosion}$) and offshore deposition ($A_{deposition}$), as schematically illustrated on Figure X.B-3. The basic assumption is that all sand transport is in an onshore-offshore direction, with no net contribution coming from the alongshore direction. Other assumptions inherent in the method can be summarized as follows:

FIGURE X.B-2



STORM EROSION OF NORTHERN NEW JERSEY BEACHES

(STORM OF NOV. 6-7, 1953)

SOURCE: CALDWELL, 1959

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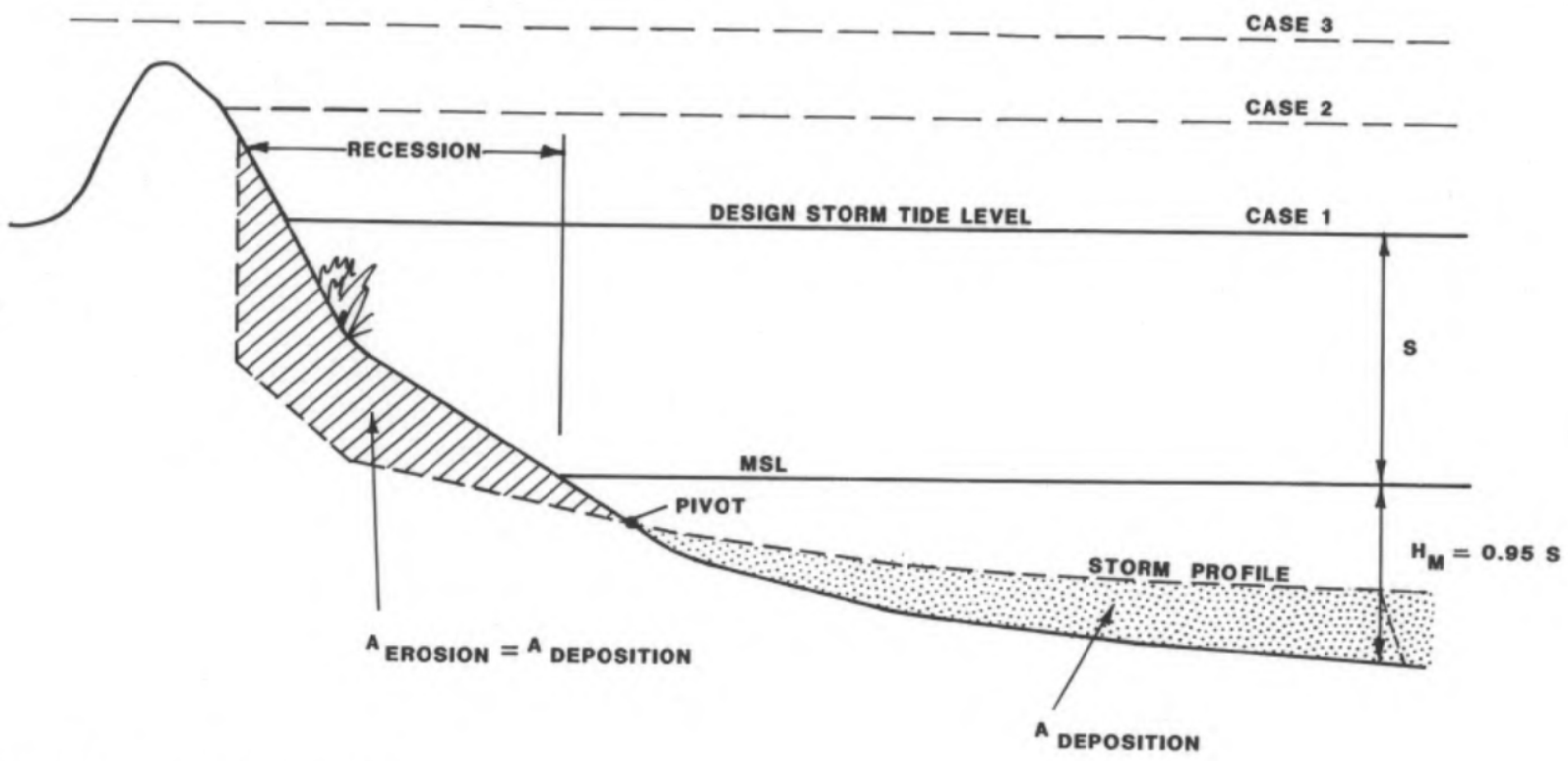

REFERENCE: TAYFUN ET AL, 1979.

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FIGURE X.B-3

SCHEMATIC OF SEMI-EMPIRICAL METHOD OF ASSESSING STORM EROSION RECESSION

- The offshore profile flattens by a factor of about two from its pre-storm slope, with the sand required for this flattening coming from the beach and dunes.

- The outer limit of sand deposition occurs at a depth approximately equal to the breaking depth of the storm wave.

- The foreshore limit of offshore bottom slope or breakpoint in the pre-storm profile occurs at a mean depth of approximately -2 feet with respect to MSL. This is referred to as "pivot" on Figure X.B-3.

Based on these partly empirical, partly idealized assumptions, the pre-storm profile and a line representing the design 100-year storm tide level (S) are plotted with respect to MSL.

The breaking wave depth (Hm) relative to MSL, which determines the approximate offshore limit of sand deposition, corresponds to about 95 percent of the local design storm tide level. This is also shown schematically on Figure X.B-3. Except at the two extreme ends of the storm profile, the beach and offshore profiles are then flattened by a ratio of 2:1 relative to the original profile starting from the pivot point. Finally, with the area of offshore deposition so determined, a planimeter is used to measure and match the area of erosion with the offshore area of deposition. The recession line relative to MSL immediately follows, as shown on Figure X.B-3.

In the first case, shown on Figure X.B-3 by a solid line design storm tide level (e.g., 50- or 100-year storm), the dune is sufficiently high and wide to remain above the storm tide level during the erosion process, presumably providing sufficient protection against overwash or overland flooding. The second and third cases, shown by dashed lines on Figure X.B-3, correspond to higher storm tide levels relative to the dune height and width. In the second case, the top of the dune is initially above the storm tide. However, due to its insufficient height and width, the dune is likely to erode below the tide level, with an accompanying overwash or overtopping of the dune line which can result in partial overland flooding. In the third case, the dune is initially below the storm tide level so that it will be overtopped throughout the entire erosion process.

The first case seems to be characteristic of profiles ideally suited for a valid application of the method since the storm profile intersects the storm tide level — which allows for calculation of an area of upland erosion. The second case, where the storm profile does not intersect the storm tide level, represents profiles for which the technique provides an estimate of the area of erosion, with no consideration of overwash or overtopping effects; the recession lines estimated for such cases are only rough guidelines. The third case and subsequent cases characterize profiles for which no recession line can be estimated with the method shown.

C. LONG-TERM EROSION RATE

Methods used to delineate the zone influenced by long-term coastal erosion trends involve the projection of historic rates of shoreline erosion for some set planning period (e.g., 10, 50, or 100 years). As concluded at the Conference on Coastal Erosion in Cape May, New Jersey (FIA, 1977), no universally acceptable methodology for determining historic erosion rates is currently available. Nordstrom

and others (1977) have reviewed the problems associated with a number of approaches and point out the difficulties in measuring long-term erosion rates for New Jersey. These difficulties include:

- Inadequate beach profile or aerial photographic data coverage.
- Insufficient period of coverage of data.
- Long-term erosion trends often disguised by cyclic trends of shorter duration.
- Structural modifications of shoreline over the data period.
- Problems with data generated from aerial photographs.

The disadvantages and limitations associated with the use of aerial photographs to measure beach characteristics and determine long-term erosion rates, considered by Nordstrom and others (1977), include:

- Error in identifying the reference lines for measurement.
- Measurement errors.
- Spacing of measurement sections along coastal segments.
- Relief distortions in photographs due to parallax.
- Photo scale variations due to altitude variations and tilt of the airplane.
- Lens distortions.
- Photographic film and paper shrinkage.
- Tidal, wave height, beach slope, and other physical variations affecting shoreline characteristics between photographic overflights.

A more extensive review of the literature concerning application of aerial photographs in investigating coastal phenomena is included in Stafford (1971).

Despite the problems discussed above, aerial photographs are often the only practical data base for evaluating beach behavior. As is the case for New Jersey, repeated aerial photographic coverage of shoreline areas is the only cost-effective means of evaluating historic trends statewide and establishing erosion hazard zones along the coast.

The use of aerial photographs to determine erosion-prone areas has been investigated by Dolan and others (1977). Dolan considers the most meaningful method of establishing erosion hazard management zones to include the average of mean erosion rates and the variances (standard deviation) of change in the shoreline and storm surge penetration line along the New Jersey coast as a measure of the variability of the erosion recession rate over time. Similarly, Nordstrom and others (1977) and CCES (1979) have assessed erosion rates for the New Jersey ocean and bay shores from aerial photographs taken from 1952 to 1971. These are the only erosion rate measurements which have been uniformly analyzed for the entire State. The aerial measurements were selected over the long-term rates obtained from using older historical charts since the aerial measurements show changes which have occurred within the last decade and thus reflect the influence of the various protective structures which characterize the shoreline. Both Nordstrom's study and Dolan's study used too few years of data to make proper use of the standard deviation methodology proposed by Dolan.

For the Master Plan analysis, a 50-year erosional setback was evaluated for New Jersey using the erosion rates from Nordstrom and others (1977). For bay-shore areas, additions to these rates were obtained from the Dune District Management study prepared by CCES (1979) for the NJDEP. The Nordstrom annual rates were

multiplied by 50 years to determine the distance that the shoreline is expected to retreat if the historical rates should continue. The most frequently occurring 50-year recession setback distances are in the 175- to 325-foot range — with a maximum of about 600 feet. If the recent rate of sea level rise continues (see Volume 1, Section I.C.3.6.(7)) over the next 50 years, a retreat of the shoreline over the average beach slope due to submergence alone would amount to about 175 feet (Yasso and Hartman, 1975), suggesting that the 50-year erosional retreat values are not unrealistic. Continued monitoring of shoreline position would be required in any setback scheme so that improved methodologies could be incorporated and rates updated to periodically determine new setback lines (i.e., perhaps every 5 years).

D. NONQUANTITATIVE COASTAL EROSION HAZARD AREA DELINEATION METHOD

This approach would involve any method whereby coastal geomorphic characteristics are combined in a nonquantitative fashion to delineate shore zones where the degree of safety for development (e.g., Danger, Caution, or Safe) can be evaluated with respect to the probability of future erosion damage, inlet migration, or inlet formation.

Pilkey and others (1978) used this type of methodology in identifying degrees of safety for development along North Carolina barrier islands. Key characteristics used in this evaluation included:

- Barrier island elevations.
- Barrier island width.
- Former inlet locations.
- Presence or absence of dunes.
- Beach and dune vegetation.
- Dune stability.
- Historic overwash or damage areas.
- Historic transitory areas (e.g., inlet shores).
- Historic erosion/recession rates.
- Protective backbay wetlands.
- Storm surge flood potential
- Soil type.
- Shore protection structures.

Although this type of methodology is useful for a cursory evaluation of erosion hazard areas along sparsely developed coastal areas, it is probably not rigorous enough to provide the quantitative or semiquantitative analysis that is normally required for delineation of the heavily developed coastal areas such as those along the New Jersey shore.

CHAPTER XI

SHORE PROTECTION LEGISLATION

A. INTRODUCTION

Since 1940, the Department of Environmental Protection has the explicit authority to engage in shore protection. NJSA 12:6A-1, which was passed in that year, authorized the Department to:

> ...repair, reconstruct, or construct bulkheads, seawalls, breakwaters, groins, jetties, beachfills, dunes and any or all appurtenant structures and work, on any and every shore front along the Atlantic Ocean, in the State of New Jersey, or any shore front along the Delaware Bay and Delaware River, Raritan Bay, Barnegat Bay, Sandy Hook Bay, Shrewsbury River including Navesink River, Shark River, and the coastal inland waterways extending southerly from Manasquan Inlet to Cape May Harbor, or at any inlet, estuary or tributary waterway along the shores of the State of New Jersey, to prevent or repair damage caused by erosion and storm, or to prevent erosion of the shores and to stabilize the inlets or estuaries and to undertake any and all actions and work essential to the execution of this authorization and the powers granted hereby.

This chapter of the Shore Protection Master Plan describes the Beaches and Harbor Bond Act of 1977 and the first appropriation bill passed thereunder. The 1977 Act made available $20,000,000 for shore protection, and the 1978 appropriations bill assigned certain planning responsibilities to the Department. The chapter also describes several recent legislative proposals for an act to protect and manage the shorefront environment. Copies of each piece of legislation are reproduced at the end of this chapter.

B. THE BEACHES AND HARBORS BOND ACT OF 1977

As recently as the mid-1970's, New Jersey was spending an average of $1 million on shore protection annually. The Capital Needs Commission recognized the inadequacy of this amount, and recommended the creation of an expanded program using bond financed funds. The Legislature acted on this recommendation by passing P.L. 1977, c.208, the Beaches and Harbors Bond Act. As stated in the preamble, its purpose was:

> ..to authorize the creation of a debt of the State of New Jersey by the issuance of bonds of the State in the aggregate principal amount of $30,000,000.00 for the purposes of researching, planning, acquiring, developing, constructing, and maintaining beach and harbor restoration, maintenance and protection facilities, projects and programs; providing the ways and means to pay the interest of such debt and also to pay and discharge the principal thereof; and providing for the submission of this act to the people at a general election; and providing an appropriation thereof.

The Bond issue was approved by the voters of the State in November 1977 (see Table XI-1), and one year later the first appropriations bill was passed. P.L. 1978, c.157 allocated $20 million of the $30 million from the Beaches and Harbors fund for:

> State matching grants to municipalities for the research, planning, acquiring, developing, constructing, and maintaining of beach restoration, maintenance and protection facilities, projects and programs, which grants shall be made in accordance with the provisions of this act.

The Act appropriated $4 million for these purposes, with State grants to equal a minimum of 50% of project costs. In addition, the Act required the Department to develop and report to the Legislature on a funding formula for State matching grants, and placed a cap of 75% on the State's share of a project. The formula developed by the Department was submitted to the legislature in July 1981, and is described in Volume 1, Section II.B.3 of the Shore Protection Master Plan.

Finally, the Act directed the Department to prepare a comprehensive five year capital beach protection program, to serve as the basis for the spending of bond funds. This Master Plan has been prepared in compliance with that directive.

C. PROPOSED SHORE PROTECTION ACTS

Three bills to create a shorefront regulatory program have been introduced in recent years; one in June of 1980 (A-1825), one in November 1980 (A-2228), and one in December 1980 (A-2262). All three proposed a regulatory program directed at the protection of dune and shorefront areas, although they differed somewhat in their approach. They all recognized the limitations of the Coastal Area Facility Review Act (CAFRA) of 1973 (N.J.S.A. 13:19-1 et seq.) which requires a permit from the DEP only for major development projects including housing developments of 25 or more units.

1. Assembly Bill 1825 (June 1980)

This bill, entitled the Dune and Shorefront Protection Act, would have established a regulatory program, administered by DEP, for most activities in a dune and shorefront area lying between the ocean and the first paved public road parallel to the water. The construction, reconstruction, or expansion of most structures, the excavation or deposition of materials, and large scale planting of vegetation within the area would have required a permit from DEP. In addition, the reconstruction of buildings in this area more than 50 percent damaged by a coastal storm, would have been prohibited.

Dune and dune/shorefront areas were to be delineated, mapped, and periodically redelineated by DEP, so that dynamic shoreline changes could be incorporated. Dunes were defined as including overwash fans, which greatly expanded the post-storm significance of the regulatory program.

DEP's regulatory authority could have been delegated to local governments, and the bill directed all affected municipalities to adopt, within two years of the Act's effective date, an ordinance which met the goals of the Act, subject to DEP approval. DEP would have continued to regulate construction in those communities which failed to adopt an ordinance or to enforce an approved ordinance. Following a vociferous public debate, the bill was withdrawn by its sponsor in August 1980.

TABLE XI-1

1977 BEACHES AND HARBORS BOND ISSUE REFERENDUM
VOTE BY COUNTY

County	Yes	No	Total	% Yes
Atlantic	23,927	14,165	38,092	62.8
Bergen	130,271	84,240	214,511	60.7
Burlington	40,930	28,648	69,578	58.8
Camden	56,322	43,121	99,443	56.6
Cape May	13,057	8,405	21,462	60.8
Cumberland	10,263	11,005	21,268	48.3
Essex	81,017	52,074	133,091	60.9
Gloucester	25,060	25,996	51,056	49.1
Hudson	85,002	35,772	120,774	70.4
Hunterdon	9,378	10,572	19,950	47.0
Mercer	48,453	26,816	75,269	64.4
Middlesex	72,409	47,028	119,437	60.6
Monmouth	77,671	43,260	120,931	64.4
Morris	57,483	46,558	104,041	55.3
Ocean	43,719	29,312	73,031	59.9
Passaic	33,981	32,133	66,114	51.4
Salem	6,668	8,770	15,438	43.2
Somerset	32,317	22,509	54,826	58.9
Sussex	12,239	14,014	26,253	46.6
Union	66,481	45,040	111,521	59.6
Warren	8,256	10,591	18,847	43.8
TOTALS:	907,904	640,029	1,547,933	58.65

Source: Provided by NJDEP, Division of Coastal Resources.

2. Assembly Bill 2228 (November 1980)

This bill, entitled the Beach and Dune Protection Act, is a modified version of A-1825, and would regulate construction in an area extending from the mean high water line landward to (1) the vegetation line, (2) a man-made feature parallel to the water, or (3) the landward foot of a dune. Overwash fans are not included in the definition of dunes.

The bill requires DEP to prepare a model ordinance defining prohibited, conditional, and permitted uses on beaches and dunes, within six months of the Act's passage. Municipalities would then be required to submit their own beach and dune protection ordinances within six months of the date on which DEP adopted its ordinance. Only if a municipality failed to adopt an ordinance would DEP have the authority to step in and undertake direct regulation.

3. Assembly Bill 2262 (December 1980)

This Act, entitled the New Jersey Shorefront Protection Act of 1981, resembles A-2228. There are differences however. The bill's findings section (Section 2) explicitly recognizes the developed character of New Jersey's barrier islands by stating:

> The developed coastal areas of New Jersey, including developed barrier islands and adjacent shorefront areas, represent in their developed state, a unique and invaluable social, economic, recreational and aesthetic resource. These areas differ dramatically in purpose, nature and protection requirement from the 68 undeveloped barrier islands lying off the Atlantic and Gulf waters of the United States.
>
> Given the present degree of commerical and residential development in these areas, given the measurable and intangible benefits that accrue to the residents of the State of New Jersey and the public at large from the beach, boating, fishing, and vocation facilities that this diversely developed coastal area offers, and given the present extensive knowledge of the protective and restorative nature of beach nourishment and other selected coastal engineering programs, it is hereby declared that it is appropriate, essential, feasible and in the public interest to preserve, protect, and enhance these coastal regions in their developed state.

A-1825 and A-2228 have no comparable language.

Municipalities would have one year from the effective date of the Act in which to adopt an ordinance. DEP would have the authority to regulate construction in any community which failed to adopt an ordinance or which had its ordinance revoked for a failure to enforce. The actual regulatory requirements and minimum standards of the bill are identical to those in A-2228. There is, however, no authorization for a model ordinance to be prepared by DEP.

As of the final writing of this Plan (September 1981) both A-2228 and A-2262 were still under consideration by the State Assembly.

D. COPIES OF EXISTING AND PROPOSED SHORE PROTECTION LEGISLATION

Copies of the following legislation are included below:

1. Beaches and Harbors Bond Act of 1977
2. 1979 Appropriation Bill (P.L. 1978, c.157)
3. 1981 Appropriation Bill (P.L. 1981, c.89)

The following proposed legislation are also included below:

4. Dune and Shorefront Protection Act
   Assembly Bill 1825 (June, 1980)
   Withdrawn August, 1980
5. Beach and Dune Protection Act
   Assembly Bill 2228 (November, 1980)
6. New Jersey Shorefront Protection Act
   Assembly Bill 2262 (December, 1980)

*

1. BEACHES AND HARBORS BOND ACT OF 1977.

P. L. 1977, CHAPTER 208, *approved September 3, 1977*

1977 Assembly No. 3419

AN ACT to authorize the creation of a debt of the State of New Jersey by the issuance of bonds of the State in the aggregate principal amount of $30,000,000.00 for the purposes of researching, planning, acquiring, developing, constructing and maintaining beach and harbor restoration, maintenance and protection facilities, projects and programs; providing the ways and means to pay the interest of such debt and also to pay and discharge the principal thereof; and providing for the submission of this act to the people at a general election; and providing an appropriation therefor.

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BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. This act shall be known and may be cited as the "Beaches and Harbors Bond Act of 1977."

2. The Legislature finds and determines that:

a. The restoration, maintenance and protection of our beaches and harbors are essential to the welfare, commerce and prosperity of the people of the State.

b. The State's growing population, expanding commercial development and tourist industry all require and should have a clean, adequate and accessible shoreline.

c. The restoration of our harbors will be a significant aid to navigation and commerce and will benefit the economy and the general safety and welfare of our citizens.

3. As used in this act unless the context indicates a different meaning or intent:

a. "Bonds" means the bonds authorized to be issued, or issued, under this act;

b. "Commissioner" means the Commissioner of Environmental Protection;

c. "Construct" and "construction" mean, in addition to the usual meaning thereof, acts of construction, reconstruction, replacement, extension, improvement and betterment;

"Department" means the Department of Environmental Protection;

"Project" means any work relating to beach or harbor restoration, maintenance or protection;

"Commission" means the New Jersey Commission on Capital Budgeting and Planning.

4. Bonds of the State of New Jersey are hereby authorized to be issued in the aggregate principal amount of $30,000,000.00 for the purposes of researching, planning, acquiring, developing, constructing and maintaining beach and harbor restoration, maintenance and protection facilities, projects and programs.

5. Said bonds shall be serial bonds and known as "Beaches and Harbors Bonds" and as to each series, the last annual installment thereof (subject to redemption prior to maturity) shall mature and be paid not later than 35 years from the date of its issuance but may be issued in whole or in part for a shorter term.

Said bonds shall be issued from time to time as the issuing officials herein named shall determine.

6. When the bonds are issued from time to time the bonds of each issue shall constitute a separate series to be designated by the issuing officials. Each series of bonds shall bear such rate or rates of interest as may be determined by the issuing officials, which interest shall be payable semiannually; provided, that the first and last interest periods may be longer or shorter, in order that intervening semiannual payments may be at convenient dates.

7. Said bonds shall be issued and sold at such price not less than the par value thereof and accrued interest thereon, and under such terms, conditions and regulations, as the issuing officials may prescribe, after notice of said sale, published at least once in at least three newspapers published in the State of New Jersey, and at least once in a publication carrying municipal bond notices and devoted primarily to financial news, published in the city of New York or in New Jersey, the first notice to be at least 5 days prior to the day of bidding. The said notice of sale may contain a provision to the effect that any or all bids in pursuance thereof may

be rejected. In the event of such rejection or of failure to receive any acceptable bid, the issuing officials, at any time within 60 days from the date of such advertised sale, may sell such bonds at private sale at such price not less than the par value thereof and accrued interest thereon and under such terms and conditions as the issuing officials may prescribe. The issuing officials may sell all or part of the bonds of any series as issued to any State fund or to the Federal Government or any agency thereof, at private sale, without advertisement.

8. Until permanent bonds can be prepared, the issuing officials may, in their discretion, issue in lieu of such permanent bonds temporary bonds in such form and with such privileges as to registration and exchange for permanent bonds as may be determined by the issuing officials.

9. The proceeds from the sale of the bonds shall be paid to the State Treasurer and be held by him in a separate fund, and be deposited in such depositories as may be selected by him to the credit of the fund, which fund shall be known as the "Beaches and Harbor Fund."

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10. a. The moneys in said "Beaches and Harbor Fund" are hereby specifically dedicated and shall be applied to the cost of the purposes set forth in section 4 of this act, and all such moneys are hereby appropriated for such purposes, and no such moneys shall be expended for such purpose (except as otherwise hereinbelow authorized) without the specific appropriation thereof by the Legislature, but bonds may be issued as herein provided notwithstanding that the Legislature shall not have then adopted an act making specific appropriation of any of said moneys.

b. At any time prior to the issuance and sale of bonds under this act, the State Treasurer is hereby authorized to transfer from any available money in the treasury of the State to the credit of the "Beaches and Harbors Fund" such sum as he may deem necessary. Said sum so transferred shall be returned to the treasury of this State by the treasurer thereof from the proceeds of the sale of the first issue of bonds.

c. Pending their application to the purpose provided in this act, moneys in the "Beaches and Harbors Fund" may be invested and reinvested as other trust funds in the custody of the State Treasurer in the manner provided by law. Net earnings received from the investment or deposit of such fund shall be paid into the General State Fund.

11. In case any coupon bonds or coupons thereunto appertaining or any registered bond shall become lost, mutilated or destroyed, a new bond shall be executed and delivered of like tenor, in substitution for the lost, mutilated or destroyed bonds or coupons, upon the owner furnishing to the issuing officials evidence satisfactory to them of such loss, mutilation or destruction, proof of ownership and such security and indemnity and reimbursement for expenses as the issuing officials may require.

12. Accrued interest received upon the sale of said bonds shall be applied to the discharge of a like amount of interest upon said bonds when due. Any expense incurred by the issuing officials for advertising, engraving, printing, clerical, legal or other services necessary to carry out the duties imposed upon them by the provisions of this act shall be paid from the proceeds of the sale of said bonds, by the State Treasurer upon warrant of the Comptroller of the Treasury, in the same manner as other obligations of the State are paid.

13. Bonds of each series issued hereunder shall mature in annual installments commencing not later than the tenth year and ending not later than the thirty-fifth year from the date of issue of such series, and in such amounts as shall be determined by the issuing officials, and the issuing officials may reserve to the State by appropriate provision in the bonds of any series the power to redeem all or any of such bonds prior to maturity at such price or prices and upon such terms and conditions as may be provided in such bonds.

14. The issuing officials may at any time and from time to time issue refunding bonds for the purpose of refunding in whole or in part an equal principal amount of the bonds of any series issued and outstanding hereunder, which by their terms are subject to redemption prior to maturity, provided such refunding bonds shall mature at any time or times not later than the latest maturity date of such series, and the aggregate amount of interest to be paid on the refunding bonds, plus the premium, if any, to be paid on the bonds refunded, shall not exceed the aggregate amount of interest which would be paid on the bonds refunded if such bonds were not so refunded. Refunding bonds shall constitute direct obligations of the State of New Jersey, and the faith and credit of the State are pledged for the payment of the principal thereof and the interest thereon. The proceeds received from the sale of refunding bonds shall be held in trust and applied to the payment of the bonds refunded thereby. Refunding bonds shall be entitled to all the benefits of this act and subject to all its limitations except as to the

maturities thereof and to the extent herein otherwise expressly provided.

15. To provide funds to meet the interest and principal payment requirements for the bonds issued under this act and outstanding, there is hereby appropriated in the order following:

a. Revenue derived from the collection of taxes as provided by the "Sales and Use Tax Act" (P. L. 1966, c. 30) as amended and supplemented, or so much thereof as may be required; and

b. If in any year or at any time funds, as hereinabove appropriated, necessary to meet interest and principal payments upon outstanding bonds issued under this act, be insufficient or not available then and in that case there shall be assessed, levied and collected annually in each of the municipalities of the counties of this State a tax on real and personal property upon which municipal taxes are or shall be assessed, levied and collected, sufficient to meet the interest on all outstanding bonds issued hereunder and on such bonds as it is proposed to issue under this act in the calendar year in which such tax is to be raised and for the payment of bonds falling due in the year following the year for which the tax is levied. The tax thus imposed shall be assessed, levied and collected in the same manner and at the same time as other taxes upon real and personal property are assessed, levied and collected. The governing body of each municipality shall cause to be paid to the county treasurer of the county in which such municipality is located, on or before December 15 in each year, the amount of tax herein directed to be assessed and levied, and the county treasurer shall pay the amount of said tax to the State Treasurer on or before December 20 in each year.

If on or before December 31 in any year the issuing officials shall determine that there are moneys in the General State Fund beyond the needs of the State, sufficient to meet the principal of bonds falling due and all interest payable in the ensuing calendar year, then and in the event such issuing officials shall by resolution so find and shall file the same in the office of the State Treasurer, whereupon the State Treasurer shall transfer such moneys to a separate fund to be designated by him, and shall pay the principal and interest out of said fund as the same shall become due and payable, and the other sources of payment of said principal and interest provided for in this section shall not then be available, and the receipts for said year from the tax specified in subsection a. of this section shall thereon be considered and treated as part of the General State Fund, available for general purposes.

16. Should the State Treasurer, by December 31 of any year, deem it necessary, because of insufficiency of funds to be collected from the sources of revenues as hereinabove provided, to meet the interest and principal payments for the year after the ensuing year, then the treasurer shall certify to the Comptroller of the Treasury the amount necessary to be raised by taxation for such purposes, the same to be assessed, levied and collected for and in the ensuing calendar year. In such case the Comptroller of the Treasury shall, on or before March 1 following, calculate the amount in dollars to be assessed, levied and collected as herein set forth in each county. Such calculation shall be based upon the corrected assessed valuation of such county for the year preceding the year in which such tax is to be assessed, but such tax shall be assessed, levied and collected upon the assessed valuation of the year in which the tax is assessed and levied. The Comptroller of the Treasury shall certify said amount to the county board of taxation and the county treasurer of each county. The said county board of taxation shall include the proper amount in the current tax levy of the several taxing districts of the county in proportion to the ratables as ascertained for the current year.

17. The Governor, State Treasurer and Comptroller of the Treasury or any two of such officials (hereinafter referred to as "the issuing officials") are hereby authorized to carry out the provisions of this act relating to the issuance of said bonds, and shall determine all matters in connection therewith subject to provisions hereof. In case any of said officials shall be absent from the State or incapable of acting for any reason, his powers and duties shall be exercised and performed by such person as shall be authorized by law to act in his place as a State official.

18. Bonds issued in accordance with the provisions of this act shall be a direct obligation of the State of New Jersey and the faith and credit of the State are pledged for the payment of the interest thereon as same shall become due and the payment of the principal at maturity. The principal and interest of such bonds shall be exempt from taxation by the State or by any county, municipality or other taxing district of the State.

19. Said bonds shall be signed in the name of the State by the Governor or by his facsimile signature, under the Great Seal of the State, and attested by the Secretary of State, or an assistant Secretary of State, and shall be countersigned by the facsimile signature of the Comptroller of the Treasury. Interest coupons attached to said bonds shall be signed by the facsimile signature

of the Comptroller of the Treasury. Such bonds may be issued notwithstanding that any of the officials signing them or whose facsimile signatures appear on the bonds or coupons shall cease to hold office at the time of such issue or at the time of the delivery of such bonds to the purchaser.

20. a. Such bonds shall recite that they are issued for the purposes set forth in section 4 of this act and that they are issued in pursuance of this act and that this act was submitted to the people of the State at the general election held in the month of November, 1977 and that it received the approval of the majority of votes cast for and against it at such election. Such recital in said bonds shall be conclusive evidence of the authority of the State to issue said bonds and of their validity. Any bonds containing such recital shall in any suit, action or proceeding involving their validity be conclusively deemed to be fully authorized by this act and to have been issued, sold, executed and delivered in conformity herewith and with all other provisions of statutes applicable thereto, and shall be incontestable for any cause.

b. Such bonds shall be issued in such denominations and in such form or forms, whether coupon or registered as to both principal and interest, and with or without such provisions for interchangeability thereof, as may be determined by the issuing officials.

21. For the purpose of complying with the provisions of the State Constitution this act shall, at the general election to be held in the month of November, 1977 be submitted to the people. In order to inform the people of the contents of this act it shall be the duty of the Secretary of State, after this section shall take effect, and at least 15 days prior to the said election, to cause this act to be published in at least 10 newspapers published in the State and to notify the clerk of each county of this State of the passage of this act, and the said clerks respectively, in accordance with the instructions of the Secretary of State, shall cause to be printed on each of the said ballots, the following:

If you approve the act entitled below, make a cross (×), plus (+), or check (√) mark in the square opposite the word "Yes."

If you disapprove the act entitled below, make a cross (×), plus (+), or check (√) mark in the square opposite the word "No."

If voting machines are used, a vote of "Yes" or "No" shall be equivalent to such markings respectively.

	Yes.	BEACHES AND HARBORS BOND ISSUE Should the "Beaches and Harbors Bond Act of 1977" which authorizes the State to issue bonds in the amount of $30,000,000.00 for the purposes of researching, planning, acquiring, developing, constructing and maintaining beach and harbor restoration, maintenance and protection facilities, projects and programs, providing the ways and means to pay the interest of such debt and also to pay and discharge the principal thereof, be approved?
	No.	INTERPRETIVE STATEMENT Approval of this act would authorize the sale of $30,000,000.00 in bonds to be used for the development, construction, and maintenance of beach and harbor restoration, maintenance and protection facilities.

The fact and date of the approval or passage of this act, as the case may be, may be inserted in the appropriate place after the title in said ballot. No other requirements of law of any kind or character as to notice or procedure except as herein provided need be adhered to.

The said votes so cast for and against the approval of this act, by ballot or voting machine, shall be counted and the result thereof returned by the election officer, and a canvass of such election had in the same manner as is provided for by law in the case of the election of a Governor, and the approval or disapproval of this act so determined shall be declared in the same manner as the result of an election for a Governor, and if there shall be a majority of all the votes cast for and against it at such election in favor of the approval of this act, then all the provisions of this act not made effective theretofore shall take effect forthwith.

There is hereby appropriated the sum of $5,000.00 to the Department of State for expenses in connection with the publication of notice pursuant to this section.

The commissioner shall submit to the State Treasurer and the commission with the department's annual budget request a plan for the expenditure of funds from the Beaches and Harbors Fund for the upcoming fiscal year. This plan shall include the following information: a performance evaluation of the expenditures made from the fund to date; a description of programs planned during the upcoming fiscal year; a copy of the regulations in force governing the operation of programs that are financed, in part or in whole, by funds from the "Beaches and Harbors Fund"; and an estimate of expenditures for the upcoming fiscal year.

22. Immediately following the submission to the Legislature of the Governor's Annual Budget Message the commissioner shall submit to the special joint legislative committe created pursuant to Assembly Concurrent Resolution No. 66 of the 1968 Legislature, as reconstituted and continued by the Legislature from time to time, a copy of the plan called for under section 21 of this act, together with such changes therein as may have been required by the Governor's budget message.

23. Not less than 30 days prior to the commissioner entering into any contract, lease, obligation, or agreement to effectuate the purposes of this act the commissioner shall report to and consult with the special joint legislative committee created pursuant to Assembly Concurrent Resolution No. 66 of the 1968 Legislature as reconstituted and continued from time to time by the Legislature.

24. This section and sections 21 of this act shall take effect immediately and the remainder of the act shall take effect as and when provided in section 21.

2. 1979 APPROPRIATION BILL (P.L.1978, C.157)

P. L. 1978, CHAPTER 157, *approved November 24, 1978*

1978 Assembly No. 1578 (*Official Copy Reprint*)

AN ACT appropriating $4,000,000.00 from the *[State]* Beaches and Harbor Fund for State matching grants to **municipalities to** research, plan, acquire, develop, construct and maintain beach restoration, maintenance and protection facilities, projects and programs; directing the Department of Environmental Protection to prepare a comprehensive beach protection plan and to research a funding formula for such facilities and to report to the Legislature on such funding formula; and providing for possible reimbursement to certain municipalities based on such formula.

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BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. The Legislature finds and determines that:

a. The voters of New Jersey on November 8, 1977 approved the Beaches and Harbors Bond Act of 1977 authorizing $30,000,000.00 for the purposes of researching, planning, acquiring, developing, constructing and maintaining beach and harbor restoration, maintenance and protection facilities, projects and programs.

b. It is the intent of the Legislature that $20,000,000.00 from the Beaches and Harbors Bond Act of 1977 be allocated toward the research, planning, acquiring, developing, constructing and maintaining beach restoration maintenance and protection facilities, projects and programs as recommended by the New Jersey Commission on Capital Budgeting and Planning and the Department of Environmental Protection.

c. To achieve the purposes of the Beaches and Harbors Bond Act of 1977 a comprehensive beach protection plan for a 5-year capital program should be developed by the Department of Environmental Protection.

2. *Of the $30,000,000.00 authorized by the "Beaches and Harbors Bond Act of 1977," the sum of $20,000,000.00 is hereby allocated for State matching grants to municipalities for the researching, planning, acquiring, developing, constructing and maintaining of beach restoration, maintenance and protection facilities, projects and programs, which grants shall be made in accordance with the provisions of this act.*

[2.]* *3. There is hereby appropriated to the State Department of Environmental Protection from the *[State]* Beaches and Harbor Fund *[from funds made available]* **created** pursuant to the "Beaches and Harbors Bond Act of 1977" (P. L. 1977, c. 208) the sum of $4,000,000.00 for the purpose of State matching grants **to municipalities** for researching, planning, acquiring, developing, constructing and maintaining beach restoration, maintenance and protection facilities, projects and programs including administrative costs. State grants to municipalities shall provide a minimum of 50% of the costs with a maximum of 50% to be provided by grantee municipalities.

[3.]* *4. Such sums shall be made available by the sale of bonds authorized by the "Beaches and Harbors Bond Act of 1977" (P. L. 1977, c. 208).

[4.]* *5. Within 90 days of the effective date of this act the Department of Environmental Protection is directed to prepare a comprehensive beach protection plan for a 5-year capital program for beach protection facilities, projects and programs. **Such plan shall serve as the basis for State matching grants to municipalities for the $20,000,000.00 allocated pursuant to section 2 of this act; provided, however that the department is hereby authorized, prior to the preparation of such plan, to make such grants as the department deems immediately necessary in order to prevent or alleviate damage to the beach areas of this State.***

[5.]* *6. The Department of Environmental Protection is directed to research and develop a funding formula for State matching grants made under this act, taking into consideration the need of a municipality for beach protection, the benefit to a municipality from a proposed beach protection project, the ability of a municipality to pay their matching share and the availability of beaches within the municipality for members of the general public. In no case shall a State grant exceed 75% or be less than 50% of the cost of a beach protection project.

[6.]* *7. Within 90 days of the effective date of this act, the Department of Environmental Protection shall report to the New Jersey Legislature on the recommended funding formula. Such formula shall be used *[only if it is adopted by the Legislature by concurrent resolution]* ***unless, within 60 days of the date of such***

EXPLANATION—Matter enclosed in bold-faced brackets [thus] in the above bill is not enacted and is intended to be omitted in the law.

reporting, the Legislature shall pass a concurrent resolution stating in substance that the Legislature does not favor such formula.

[7.] *8.* The Department of Environmental Protection shall apply the formula developed pursuant to this act *[and adopted by the Legislature]* *, *unless disapproved by the Legislature as provided in section 7 herein,* to all State beach protection grants made after the *[date of adoption]* **expiration date for legislative disapproval* of the formula. In the case of 50% matching grants under this act made prior to the *[date of adoption]* **expiration date for legislative disapproval* of the formula, the Department of Environmental Protection shall review such grants and shall reimburse those municipalities which, under the formula, are determined to have been eligible for more than 50% in State matching funds, had the formula been applied to them at the time the 50% grant was made.

[8.] *9.* The expenditure of the sums appropriated by this act are subject to the provisions and conditions of P. L. 1977, c. 208.

10. The department is hereby empowered and directed, pursuant to the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.) to promulgate such rules and regulations concerning grant application and approval procedures as are necessary in order to implement the provisions of this act.

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[9.] *11.* This act shall take effect immediately.

199th LEGISLATURE

ENVIRONMENTAL PROTECTION, DEPARTMENT OF-APPROPRIATION

CHAPTER 89

SENATE NO. 1618

An Act appropriating $5,365,000.00 from the Beaches and Harbors Fund for State projects and State matching grants to local governments to research, plan, acquire, develop, construct and maintain beach restoration, maintenance and protection facilities, projects and programs, amending the title of "An act appropriating $4,000,000.00 from the Beaches and Harbor Fund for State matching grants to municipalities to research, plan, acquire, develop, construct and maintain beach restoration, maintenance and protection facilities, projects and programs; directing the Department of Environmental Protection to prepare a comprehensive beach protection plan and to research a funding formula for such facilities and to report to the Legislature on such funding formula; and providing for possible reimbursement to certain municipalities based on such formula," approved November 24, 1978 (P.L.1978, c. 157) so the same shall read: "An act appropriating $4,000,000.00 from the Beaches and Harbor Fund for State matching grants to local governments to research, plan, acquire, develop, construct and maintain beach restoration, maintenance and protection facilities, projects and programs; directing the Department of Environmental Protection to prepare a comprehensive beach protection plan and to research a funding formula for such facilities and to report to the Legislature on such funding formula; and providing for possible reimbursement to certain local governments based on such formula," and to amend the body of said act.

Be it enacted by the Senate and General Assembly of the State of New Jersey:

1.
There is appropriated to the Department of Environmental Protection from the "Beaches and Harbors Fund" created pursuant to the "Beaches and Harbors Bond Act of 1977," P.L.1977, c. 208, the sum of $5,365,000.00 for the purpose of State projects and State matching grants to local governments for researching, planning, acquiring, developing, constructing and maintaining beach restoration, maintenance and protection facilities, projects and programs, and for administrative costs.

2.
The expenditure of the sums appropriated by this act is subject to the provisions and conditions of P.L.1977, c. 208 and P.L.1978, c. 157.

3. The title of P.L.1978, c. 157 is amended to read as follows:
An act appropriating $4,000,000.00 from the Beaches and Harbor Fund for State matching grants to ~~municipalities~~ local governments to research, plan, acquire, develop, construct and maintain beach restoration, maintenance and protection facilities, projects and programs; directing the Department of Environmental Protection to prepare a comprehensive beach protection plan and to research a funding formula for such facilities and to report to the Legislature on such funding formula; and providing for possible reimbursement to certain ~~municipalities~~ local governments based on such formula.

4. Section 2 of P.L.1978, c. 157 is amended to read as follows:
Of the $30,000,000.00 authorized by the "Beaches and Harbors Bond Act of 1977," the sum of $20,000,000.00 is hereby allocated for State matching grants

to ~~municipalities~~ local governments for the researching, planning, acquiring, developing, constructing and maintaining of beach restoration, maintenance and protection facilities, projects and programs, which grants shall be made in accordance with the provisions of this act.

5. Section 3 of P.L.1978, c. 157 is amended to read as follows:
There is hereby appropriated to the State Department of Environmental Protection from the Beaches and Harbor Fund created pursuant to the "Beaches and Harbors Bond Act of 1977" (P.L.1977, c. 208) the sum of $4,000,000.00 for the purpose of State matching grants to ~~municipalities~~ local governments for researching, planning, acquiring, developing, constructing and maintaining beach restoration, maintenance and protection facilities, projects and programs including administrative costs. State grants to ~~municipalities~~ local governments shall provide a minimum of 50% of the costs with a maximum of 50% to be provided by grantee ~~municipalities~~ local governments.

6. Section 5 of P.L.1978, c. 157 is amended to read as follows:
Within 90 days of the effective date of this act the Department of Environmental Protection is directed to prepare a comprehensive beach protection plan for a 5-year capital program for breach protection facilities, projects and programs. Such plan shall serve as the basis for State matching grants to ~~municipalities~~ local governments for the $20,000,000.00 allocated pursuant to section 2 of this act; provided, however, that the department is hereby authorized, prior to the preparation of such plan, to make such grants as the department deems immediately necessary in order to prevent or alleviate damage to the beach areas of this State.

7. Section 6 of P.L.1978, c. 157 is amended to read as follows:
The Department of Environmental Protection is directed to research and develop a funding formula for State matching grants made under this act, taking into consideration the need of a ~~municipality~~ local government for beach protection, the benefit to a ~~municipality~~ local government from a proposed beach protection project, the ability of a ~~municipality~~ local government to pay ~~their~~ its matching share and the availability of beaches within the municipality or county for members of the general public. In no case shall a State grant exceed 75% or be less than 50% of the cost of a beach protection project.

8. Section 8 of P.L.1978, c. 157 is amended to read as follows:
The Department of Environmental Protection shall apply the formula developed pursuant to this act, unless disapproved by the Legislature as provided in section 7 herein, to all State beach protection grants made after the expiration date for legislative disapproval of the formula. In the case of 50% matching grants under this act made prior to the expiration date for legislative disapproval of the formula, the Department of Environmental Protection shall review such grants and shall reimburse those ~~municipalities~~ local governments which, under the formula, are determined to have been eligible for more than 50% in State matching funds, had the formula been applied to them at the time the 50% grant was made.

9. This act shall take effect immediately.
Approved and effective March 27, 1981.

4. DUNE AND SHOREFRONT PROTECTION ACT

ASSEMBLY BILL 1825 (JUNE 1980) WITHDRAWING AUGUST 1980

STATE OF NEW JERSEY

INTRODUCED JUNE 9, 1980

By Assemblyman HOLLENBECK

Referred to Committee on Energy and Natural Resources

AN ACT providing for the protection of dune and shorefront areas through the adoption and enforcement of regulations on the use and development of these areas by the Department of Environmental Protection and municipalities, directing the establishment of a consolidated coastal permit process, and amending P. L. 1975, c. 232.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. (New section) This act shall be known and may be cited as the "Dune and Shorefront Protection Act".

2. (New section) a. The Legislature finds and declares that the ocean and bayfront beaches, dunes, and adjacent shorefront areas of New Jersey's coast are an irreplaceable physical feature of the natural environment possessing outstanding geological, recreational, scenic, and protective value; that protection and preservation in a natural state of beach, dune, and adjacent shorefront areas is vital to this and succeeding generations of citizens of the State and the Nation; that ocean and bayfront dunes are a dynamic, migrating natural phenomenon that help protect lives and property in adjacent landward areas, and buffer barrier islands and barrier beach spits from the effects of major natural coastal hazards such as hurricanes, storms, flooding, and erosion; that natural dune systems help promote wide sandy beaches; and that dunes provide important habitat for wildlife and vegetative species.

b. The Legislature further finds and declares that the beach, dune, and shorefront areas along the New Jersey coastal zone are strikingly diverse; that extensive destruction of dunes has taken place in this century along most of the coast; and that the resulting disruption of the natural processes of the beach-dune system has led to severe erosion of some beach areas, jeopardized the safety of some existing structures on and behind the remaining dunes and

upland of the beaches, increased the need to manage development in shorefront areas no longer protected by dunes, interfered with the sand balance that is so essential for recreational beaches and the coastal resort economy, necessitated increased public expenditures by citizens of the entire State for shore protection structures and programs, and increased the likelihood of major losses of life and property from flooding and storm surges. The Legislature further recognizes that all citizens of this and other states are entitled to access to the ocean and bay shorelines of the State.

c. The Legislature, therefore, determines it to be the policy of the State to encourage the natural functioning of the dune-beach system, including overwash, to encourage restoration of destroyed dunes, to protect and enhance coastal beach and dune areas and protect, shorefront areas of New Jersey and the coastal lands they shelter and protect, including both existing and potential dune areas, and adjacent landward areas, and to devote these precious areas to only those limited land uses which preserve, protect, and enhance the natural environment of the dynamic beach-dune system, protect public and private property, promote the public health, safety, and welfare, and further the public interest. The Legislature further determines that it is in the best interest of the public welfare to protect the integrity of certain new structures built in the dune and shorefront area. The Legislature further declares that it is in the best short-term and long-term interest of the people of the State and Nation to manage New Jersey's coastal beaches, dunes, and shorefront areas, including potential dune areas, through a regulatory program administered by the Department of Environmental Protection, but with primary enforcement responsibilities vested in municipalities.

3. (New section) As used in this act:

a. "Commissioner" means the Commissioner of the Department of Environmental Protection, or his designated representative;

b. "Department" means the Department of Environmental Protection;

c. "Governmental agencies" means the Government of the United States, the State of New Jersey, or any other states, their political subdivisions, agencies, or instrumentalities thereof, and interstate agencies;

d. "Beach" means gently sloping, unvegetated areas of sand or other unconsolidated material that extend landward from the ocean and bay waters to either: (1) the vegetation line, (2) a man-made feature generally parallel to the water body such as a retaining

structure, seawall, bulkhead, road, or boardwalk, provided that sandy areas that extend fully under and landward of an elevated boardwalk are considered to be beach areas, or (3) the seaward or bayward foot of dunes, whichever is closest to the water;

e. "Dune" means a wind or wave deposited formation of vegetated or drifting sand between the inland limit of the sandy beach and the foot of the most inland dune slope, including primary, secondary, and tertiary dunes where they exist. Formations of sand immediately adjacent to beaches that are stabilized by retaining structures, snow fences, planting vegetation and other measures are considered to be dunes regardless of the degree of modification of the dune by wind or wave action or disturbance by development. Overwash deposits, those sand lobes or fans created by storms and which begin immediately adjacent to beaches and are extended landwash beyond the inland extent of dunes by overwash process, become dunes;

f. "Dune and shorefront area" include those land areas along the Atlantic Ocean from Cape May Point north to Sandy Hook, lying between ocean waters and the first paved public road for motor vehicles that is generally parallel and closest to the ocean waters, as of the effective date of this act. "Dune and shorefront area" also includes the land area at the tips of barrier islands and spits, at the inlets between ocean and bay waters and where there is no parallel paved public road for motor vehicles. "Dune and shorefront area" further includes existing or future barrier islands without paved public roads or connecting bridges for motor vehicles. "Dune and shorefront area" includes existing and future beaches and dunes that are along the Delaware Bay in Cape May County and Cumberland County, the Raritan Bay east of Cheesequake Creek, Sandy Hook Bay, and the back bays of barrier islands and spits. Beach and dune areas are included within the geographic scope of dune and shorefront areas. Dune and shorefront areas shall not include coastal wetlands regulated pursuant to "The Wetlands Act of 1970" (P. L. 1970, c. 272; C. 13:9A–1 et seq.).

4. (New section) a. The commissioner may, after scientific study, propose and adopt, pursuant to the provisions of the "Administrative Procedure Act", P. L. 1968, c. 410 (C. 52:14B–1 et seq.) and after public hearing, modifications to the landward definition of dune and shorefront areas, as defined in section 3.f. of this act. Such modifications shall exclude built up areas distant from the erosional forces of ocean and bay waters and may, in response to naturally changing shoreline conditions, include post-storm

overwash areas, provided that the modifications are consistent with the purposes and intent of this act. Any such modifications may be made by written description of the areas or by graphic changes on maps prepared pursuant to this section, or both, as the case may be.

b. The commissioner may, pursuant to the provisions of the "Administrative Procedure Act", P. L. 1968, c. 410 (C. 52:14B–1 et seq.), delineate beach, dune, and dune and shorefront areas as defined in section 3 of this act or as modified pursuant to this section, on suitable maps, to assist in the management of these areas. The maps, which may use aerial photographs as a base, shall be filed in the office of the county recording officer of the county or counties in which the mapped beach, dune, and dune and shorefront areas are located, and maintained available to the public in the offices of the department. To be entitled to filing, no map prepared pursuant to this subsection need meet the requirements of R. S. 47:1–6.

5. (New section) a. Subsequent to the effective date of this act, the provisions of any other law to the contrary notwithstanding, no person shall undertake, or cause to undertake, a regulated activity in a dune and shorefront area until he has applied for and received a permit issued by the department, unless the commissioner, by rule, has excluded the minor activity from the permit requirements of the act, or unless the commissioner has delegated the enforcement of this act to the affected municipality pursuant to section 10 of this act.

b. Regulated activities shall include, but not be limited to:

(1) The construction, relocation, reconstruction, major modification, major expansion, or demolition of any temporary, mobile or permanent structure;

(2) The removal, excavation, filling or deposition of any soil, mud, sand, gravel, or any material;

(3) The construction, reconstruction, or major repair of any public facilities, including but not limited to roads, sewers, bridges, electric power, telephone, gas, and water lines;

(4) The siting and construction of pipelines and other linear development;

(5) The development of pedestrian paths and walkways;

(6) The large-scale planting of non-native vegetation or removal of native vegetation on the dune and beach portion of the dune and shorefront area.

c. Regulated activities shall not include:

(1) The operation of motor vehicles by governmental agencies for public safety, beach maintenance, and emergency purposes;

(2) The operation of motor vehicles outside of beach and dune areas; and

(3) The construction of a facility regulated pursuant to the "Coastal Area Facility Review Act", P. L. 1973, c. 185 (C. 13:19–1 et seq.) or a waterfront development pursuant to R. S. 12:5–3.

d. Any person proposing to undertake a regulated activity in a dune and shorefront area shall file an application for a permit with the department, in such form and with such information as the commissioner may prescribe, including information concerning the environmental impact of the regulated activity.

6. (New section) The department shall review filed applications, including any written comments from the public and any information submitted at a public hearing, held at the discretion of the commissioner, and shall approve and issue a permit only if it finds that the proposed regulated activity:

a. Has no prudent or feasible alternative in an area other than a dune or beach;

b. Will not cause significant adverse long-term impacts to the natural functioning of the dune-beach and dune and shorefront area system, either individually or in combination with other existing or proposed structures or activities;

c. Conforms with the purpose and intent of this act or otherwise promotes the public health, safety, and welfare; and

d. Complies with any rules and regulations adopted pursuant to section 9 of this act.

7. (New section) Subsequent to the effective date of this act, the provisions of any other law, ordinance, rule or regulation to the contrary notwithstanding, the following activities are prohibited in dune and shorefront areas:

a. The construction of any industrial commercial or residential structures on existing beach and dune areas;

b. The reconstruction of any structure, with the exception of publicly owned and maintained boardwalks, structures for public safety, if the fair market value of the structure is reduced by more than 50% as a result of water, wave, wind or other coastal storm-related damage;

c. The operation of any motor vehicle in any portion of the dune area except in designated access ways.

8. (New section) The commissioner may, at his discretion, issue provisional permits necessary to authorize emergency work required in beach, dune, or dune and shorefront areas to protect the public safety in response to major storms and disasters.

9. (New section) The commissioner shall, within 90 days of the effective date of this act, prepare, promulgate, adopt, amend or repeal rules and regulations, pursuant to the provisions of the "Administrative Procedure Act", P. L. 1968, c. 410 (C. 52:14B–1 et seq.), to effectuate the purposes of this act. The commissioner shall adopt rules and regulations that establish specific and different development and resource protection regulations within discrete types of areas, such as beach, dune and other areas within the dune and shorefront area. The commissioner shall adopt rules and regulations specifying structural standards designed to insure the integrity of structures from storms.

10. (New section) a. The commissioner is hereby authorized to delegate the responsibility for enforcement of this act to any municipality which adopts an ordinance for the management of dune and shorefront areas which the commissioner certifies meets the standards adopted by him. Every municipality within the dune and shorefront area is hereby authorized and directed to adopt such an ordinance within 2 years of the effective date of this act.

b. The commissioner shall monitor the enforcement by municipalities of certified dune and shorefront area ordinances and may, after public hearing, revoke any such certification if, in his estimation, a municipality fails to enforce its ordinance in a manner consistent with the department's enforcement of this act.

c. In any municipality where enforcement has been delegated pursuant to this section, any interested person may appeal any municipal decision under the certified ordinance to the commissioner. The commissioner may, after all local administrative appeals have been exhausted, accept the appeal and after public hearing uphold, modify, or reverse the municipal decision. The commissioner's decision on appeal shall be the final administrative action.

11. (New section) The commissioner shall, by rule or regulation, develop a single permit process for any State approval required by this act, by the "Coastal Area Facility Review Act", P. L. 1973, c. 185 (C. 13:9A–1 et seq.), and R. S. 12:5–3, concerning waterfront development approvals. Subsequent to the effective date of this act, the provision of any other law to the contrary notwithstanding, this consolidated coastal permit process shall apply to any

activity which is regulated by any of the aforementioned statutes.

12. (New section) Any person who violates any of the provisions of this act or any rule or regulation adopted pursuant to this act shall be liable to the State for the full cost of restoration of the affected beach, dune, or dune and shorefront area to its condition prior to the violation and shall be subject to a penalty of not more than $3,000.00 for each offense to be collected in a summary proceeding under "the penalty enforcement law" (N. J. S. 2A:58–1 et seq.), and the commissioner may institute a civil action in the Superior Court for injunctive relief to prohibit and prevent the violation and the court may proceed in a summary manner. If the violation is of a continuing nature, each day during which it continues shall constitute an additional separate and distinct offense. The commissioner is hereby authorized to compromise and settle any claim for a penalty under this section in such amount, in the discretion of the commissioner, as may appear appropriate and equitable under the circumstances.

13. Section 1 of P. L. 1975, c. 232 (C. 13:1D–29) is amended to read as follows:

1. For the purposes of this act, unless the context clearly requires a different meaning, the following terms shall have the following meanings:

a. "Commissioner" means the State Commissioner of Environmental Protection.

b. "Construction permit" means and shall include:

(1) Approval of plans for the development of any waterfront upon any tidal waterway pursuant to R. S. 12:5–3.

(2) A permit for a regulated activity pursuant to "The Wetlands Act of 1970," P. L. 1970, c. 272 (C. 13:9A–1 et seq.).

(3) A permit issued pursuant to the "Coastal Area Facility Review Act," P. L. 1973, c. 185 (C. 13:19–1 et seq.).

(4) Approval of a structure or alteration within the area which would be inundated by the 100 year design flood of any nondelineated stream or of a change in land use within any delineated floodway or any State administered and delineated flood fringe area, all pursuant to the "Flood Hazard Area Control Act," P. L. 1962, c. 19 (C. 58:16A–50 et seq.) as amended and supplemented.

(5) Approval of plans and specifications for the construction, changes, improvements, extensions or alterations to any sewer system pursuant to R. S. 58:11–10.

(6) A permit for a regulated activity pursuant to the "Dune and Shorefront Protection Act," P. L. , c. (C.).

"Construction permit" shall not, however, include any approval of or permit for an electric generating facility or for a petroleum processing or storage facility, including a liquefied natural gas facility, with a storage capacity of over 50,000 barrels.

c. "Department" means the Department of Environmental Protection.

14. This act shall take effect immediately.

STATEMENT

This bill protects and enhances the existing and potential dunes and shorefront areas of this State and the coastal lands that they protect through the delineation of dune and shorefront protection areas and the enforcement of regulations for the use and development of such areas by the Commissioner of Environmental Protection and municipalities. The act protects the lives and property of people in shorefront communities through proper management of dune and shorefront areas. The act provides for both regular and provisional permits.

The bill authorizes and requires the delegation to municipalities by the Commissioner of Environmental Protection of the administration of the program of dune and shorefront area management, through the review and certification of municipal dune and shortfront protection ordinances.

The bill further directs the Commissioner to establish a consolidated coastal permit process which will authorize any activity regulated pursuant to this Dune and Shorefront Protection Act, the Coastal Area Facility Review Act, the Wetlands Act of 1970, and R. S. 12:5-3, concerning waterfront development permits. The new permit authorized by this act comes under the provisions of the 90 day construction permits law.

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5. BEACH AND DUNE PROTECTION ACT

ASSEMBLY BILL 2228 (NOVEMBER 1980)

STATE OF NEW JERSEY

INTRODUCED NOVEMBER 10, 1980

By Assemblyman HOLLENBECK

Referred to Committee on Energy and Natural Resources

AN ACT concerning the protection of beaches and dunes through the adoption and enforcement of municipal beach and dune protection ordinances certified by the Department of Environmental Protection, and amending P. L. 1975, c. 232.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. This act shall be known and may be cited as the "Beach and Dune Protection Act."

2. a. The Legislature finds and declares that New Jersey's beaches and dunes are an irreplaceable physical feature of the natural environment possessing outstanding geological, protective, recreational, and scenic value; that the protection and preservation in a natural state of beaches and dunes is vital to this and succeeding generations of citizens of the State and the nation; that beaches and dunes are a dynamic, migrating natural phenomenon that, if properly maintained and protected, help protect lives and property in adjacent landward areas and buffer the built-up areas of barrier islands and barrier island spits from the adverse effects of major natural coastal hazards such as hurricanes, storms, flooding, and erosion; that natural dune systems help promote wide sandy beaches; and that dunes provide important habitat for wildlife and vegetative species.

b. The Legislature further finds and declares that the beaches and dunes along the New Jersey coast are strikingly diverse; that extensive destruction of dunes has taken place in this century along most of the coast as the shoreline has been developed for residential and commercial uses; that the resulting disruption of the natural processes of the beach and dune system has led to severe erosion of some beaches, jeopardized the safety of some existing residential, commercial, and other structures on and behind the remaining dunes and areas upland of beaches, necessitated increased public expenditures by citizens of the entire State for shore protection

structures and programs, interfered with the natural sand balance along the shoreline that is so essential for recreational beaches and the coastal resort economy, and increased the likelihood of major losses of life and property from coastal storms and hurricanes through flooding and storm surges.

c. The Legislature, therefore, determines that it is in the interest of the safety, health and general welfare of the public to adopt land use regulations that prevent the misuse of fragile beaches and dunes that could lead directly to increased risk of natural coastal hazards, such as damage to property and loss of life from hurricanes, storms, flooding, and erosion. The Legislature further determines it to be the policy of the State to encourage the natural functioning of the beach and dune system; to encourage the restoration of destroyed dunes; to limit these fragile lands to only those land uses which preserve, protect and enhance the natural environment of the dynamic beach and dune system, protect public and private property, protect the coastal uplands that beaches and dunes shelter and protect; promote the public health, safety and welfare, and further the public interest. The Legislature further determines that it is in the best interest of the people of the State to manage New Jersey's beaches and dunes through a land use regulatory program with primary enforcement responsibilities vested in municipalities, with information dissemination, scientific inquiry and technical assistance provided by the Department of Environmental Protection; that the adoption and enforcement of municipal beach and dune protection ordinances shall be the primary regulatory mechanism for the implementation of this program; and that a program of land use regulation in beaches and dunes efficiently and effectively complements State and local coastal engineering and Federal policy actions, as part of the State's shore protection program pursuant to P. L. 1977, c. 208.

3. As used in this act:

a. "Beach" means gently sloping, unvegetated areas of sand or other unconsolidated material that extend landward from the mean high water line to either: (1) the vegetation line, (2) a man-made feature generally parallel to the ocean, inlet, or bay waters such as a retaining structure, seawall, bulkhead, road or boardwalk, provided that sandy areas that extend fully under and landward of an elevated boardwalk are considered to be beach areas, or (3) the seaward or bayward foot of dunes, whichever is closest to the bay, inlet or ocean waters;

b. "Commissioner" means the Commissioner of the Department of Environmental Protection, or his designated representative;

c. "Department" means the Department of Environmental Protection;

d. "Dune" means a wind or wave deposited formation of vegetated or drifting wind blown sand, that lies generally parallel, landward, and between the upland limit of the beach and the foot of the most inland dune slope. "Dune" includes the foredune, as well as secondary and tertiary dune ridges where they exist. Formations of sand immediately adjacent to beaches that are stabilized by retaining structures, sand or snow fences, planted vegetation, and other measures are considered to be dunes regardless of the degree of modification of the dune by wind or wave action or disturbance by development. A small mound of loose, wind blown sand found in a street or on a part of a structure as a result of storm activity is not considered to be a "dune";

e. "Municipal beach and dune protection ordinance" means an ordinance certified by the commissioner and adopted and enforced by a municipality pursuant to the provisions of this act;

f. "Person" means natural persons, partnerships, firms, associations, joint stock companies, syndicates and corporations, and any receiver, trustee, conservator or other officer appointed pursuant to law or by any court, State or Federal; "person" also means the State of New Jersey, counties, municipalities, authorities, other political subdivisions, and all departments and agencies within the aforementioned governmental entities.

4. The provisions of this act shall apply to beaches and dunes in Monmouth, Ocean, Atlantic, Cape May, and Cumberland counties and that portion of Middlesex county east of Cheesequake creek.

5. Subsequent to the effective date of this act, the provisions of any other law, ordinance, rule or regulation to the contrary notwithstanding, no person shall construct any structure or disturb any land, including the excavation and removal of sand and planting of vegetative material, until such person shall have complied with all the applicable provisions of a certified municipal beach and dune protection ordinance as hereinafter provided, or otherwise obtained the approval of the department pursuant to section 6. e. of this act, in the event that the municipality's beach and dune protection ordinance has not been certified or has been revoked by the department.

6. a. Every municipality is hereby directed to prepare and adopt a municipal beach and dune protection ordinance for the regulation of land uses in beach and dune areas, and submit the

ordinance, duly adopted by the governing body, to the commissioner for certification that the ordinance meets the minimum standards established in section 8 of this act. The governing body of every municipality shall prepare, adopt, and submit to the commissioner a municipal beach and dune protection ordinance no later than 6 months after the adoption by the commissioner of a model beach and dune ordinance as hereinafter provided.

b. Upon the receipt and review of any such municipal beach and dune protection ordinance, the commissioner shall approve, disapprove, or approve with conditions the certification of the ordinance, within 120 days of the date of the submission thereof, or, the ordinance shall be deemed certified.

c. The department is hereby directed to provide technical assistance to municipalities in the preparation of municipal beach and dune protection ordinances.

d. The commissioner shall monitor the enforcement by municipalities of certified municipal beach and dune protection ordinances and may, after public hearing, revoke any such certification if, in his estimation, a municipality has failed to enforce its ordinance in a manner consistent with the purpose and intent of this act.

e. Upon the failure of any municipality to adopt a municipal beach and dune protection ordinance based on the model ordinance adopted by the department as hereinafter provided, or to submit the adopted municipal beach and dune protection ordinance to the commissioner for certification within the time prescribed in subsection a. of this section, the department shall have the power, after public hearing, to prepare and adopt land use regulations for beaches and dunes in any such municipality, and enforce such regulations through a construction permit program.

f. Every municipality with a certified municipal beach and dune protection ordinance shall submit any amendments to such ordinance to the department for its review and approval. In the event that the department fails to approve, disapprove, or conditionally approve any such amendments within 60 days of the date of the submission thereof, the amendments shall be deemed approved.

7. The department shall, from time to time, pursuant to the provisions of the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.), prepare maps delineating beaches and dunes, to assist municipalities and the public in the enforcement of land use regulations in these areas. The department shall reassess the mapping of beaches and dunes after significant coastal storms to assist the management of the dynamic beach and dune system and overwash fans. The maps, which may use aerial photographs as a

base, shall be filed in the office of the county recording officer of the county or counties in which the mapped beaches and dunes are located, and shall be made available to the public in the offices of the department. To be entitled to filing, no map prepared pursuant to this section need meet the requirements of R. S. 47:1–6.

8. The commissioner shall, within 6 months of the effective date of this act, pursuant to the provisions of the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.), prepare and adopt a model municipal beach and dune protection ordinance, defining prohibited uses, conditional uses, and permitted uses on beaches and dunes. The aforementioned model ordinance shall include, but not necessarily be limited to, the interim standards as hereinafter provided, and the following provisions:

a. On beaches, no person shall undertake, or cause to be undertaken, any construction or land disturbance including the relocation, reconstruction, modification, or expansion of any temporary, mobile, or permanent structure, or removal of sand except for the following uses:

(1) Open space, beach, and water recreation activities;

(2) Necessary shore protection structures and projects undertaken by the department; and

(3) Other uses that meet the interim standards provided in section 9 of this act.

b. On dunes, the following uses are prohibited:

(1) The operation of any motor vehicle, except in limited, designated access ways;

(2) The large scale planting of non-native vegetation or removal of native vegetation unless the removal is part of site preparation for a use approved pursuant to section 9 of this act; and

(3) The removal of any sand or sediment or the artificial lowering or narrowing of the dune, except as part of an activity approved pursuant to section 9 of this act.

c. On dunes, no person shall undertake, or cause to be undertaken, any construction activity or land disturbance, including the construction of any industrial, commercial or residential structures on existing dunes, except for the following uses:

(1) Limited access ways between public streets and the beach that provide for the minimum feasible interference with the beach and dune system and are so oriented as to provide the minimum feasible threat of overtopping as a result of storm surges or wave runup;

(2) Limited stairs, walkways, pathways and boardwalks to permit access across dunes to beaches, provided they are so oriented as to cause minimum feasible interference with the beach and dune system;

(3) The reconstruction and repair of any existing lawful residential structure, subject to applicable Federal laws, rules and regulations pertaining to building in flood plain areas; and

(4) The construction of a small, pile-supported platform of less than 200 square feet in area directly connected to an existing lawful residential structure.

d. Beaches and dunes shall be maintained in a natural state, to the maximum extent practicable and feasible, and the dunes protected and stabilized with natural vegetation.

9. Subsequent to the effective date of this act, the provisions of any other law, ordinance, rule or regulation to the contrary notstanding, no municipality shall grant a permit or approve any application for construction of any structure or any land disturbance in a beach or dune, prior to certification of the municipal beach and dune protection ordinance by the commissioner, unless the proposed activity meets the following interim standards:

a. Has no prudent or feasible alternative in an area other than a beach or dune;

b. Will not cause significant adverse long-term impacts to the natural functioning of the beach and dune system, either individually or in combination with other existing or proposed structures, land disturbances, or activities; and

c. Conforms with the purpose and intent of this act or otherwise promotes the public health, safety, and welfare.

10. The provisions of this act concerning a certified municipal beach and dune protection ordinance shall not apply to any of the following uses:

a. Shore protection structures and projects undertaken by the department pursuant to P. L. 1977, c. 208 and P. L. 1978, c. 157;

b. Necessary buildings and structures for public safety and convenience, including first aid stations, life guard stations, and comfort stations, constructed by the department for the State parks system;

c. The operation of motor vehicles by governmental agencies for public safety, beach maintenance, and emergency purposes; and

d. Any facility subject to the provisions of the "Coastal Facility Review Act," P. L. 1973, c. 185; (C. 13:19–1 et seq.).

11. a. Whenever the strict application of the provisions of any certified municipal beach and dune protection ordinance would result in undue hardship to the owner of any lands affected by the provisions of such ordinance, attributable to the cost or practical difficulty in compliance with such provisions, the owner may, in his discretion, submit a written application to the zoning board of adjustment for a waiver of the strict application of any such provision. In its consideration of an application for a waiver of strict application, the zoning board of adjustment shall follow the procedure established by law for granting variances from zoning ordinances pursuant to the "Municipal Land Use Law," P. L. 1975, c. 291; (C. 40:55D–1 et seq.).

b. Any interested party may appeal the decision of the zoning board of adjustment pursuant to subsection a. of this section to the governing body of the affected municipality by following the procedure established by section 8 of P. L. 1975, c. 291 (C. 40:55D–17).

c. Upon making a determination on any waiver application submitted pursuant to this section, the zoning board of adjustment or the governing body, as the case may be, shall transmit to the commissioner a copy of the application for waiver, together with its determination. Within 30 days of the receipt of such transmittal, the commissioner may, in his discretion, review and approve, disapprove, or approve with conditions the application for a waiver and the determination thereon to grant or deny the waiver. In the event that the commissioner makes no determination within the 30 day period, the determination on the application for waiver made by the zoning board of adjustment or by the governing body, as the case may be, shall be deemed to be the final administrative action. The commissioner may require the applicant for the waiver, the zoning board of adjustment, or the governing body of the affected municipality, or both, to provide further information concerning any aspect of the application for waiver or the determination thereon.

12. The commissioner shall adopt, and may amend or repeal rules and regulations, pursuant to the provisions of the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.), to effectuate the purposes of this act.

13. The commissioner shall transmit copies of all rules and regulations adopted pursuant to sections 8 and 12 of this act to the Senate and General Assembly on a day on which both Houses shall be meeting in the course of a regular or special session. The provisions

of the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.), or any other law to the contrary notwithstanding, no such rule or regulation, except a rule or regulation adopted pursuant to a storm-related emergency declared by the Governor, shall take effect, if, within 60 days of its transmittal to the Senate and General Assembly, the Legislature shall pass a concurrent resolution stating in substance the Legislature's disapproval of such proposed rule or regulation.

14. Any person who willfully violates any of the provisions of this act or any rule or regulation adopted pursuant to this act shall be liable to the State for the full cost or restoration of the affected beach or dune to its condition prior to the violation and shall be subject to a penalty of not more than $5,000.00 for each offense to be collected in a summary proceeding under the "penalty enforcement law" (N. J. S. 2A:58–1 et seq.). The commissioner may institute a civil action in the Superior Court for injunctive relief to prohibit and prevent the violation is of a continuing nature, each day during which it continues shall constitute an additional separate and distinct offense. The commissioner is hereby authorized to compromise and settle any claim for a penalty under this section in such amount, in the discretion of the commissioner, as may appear appropriate and equitable under the circumstances.

15. Section 1 of P. L. 1975, c. 232 (C. 13:1D–29) is amended to read as follows:

1. For the purposes of this act, unless the context clearly requires a different meaning, the following terms shall have the following meanings:

a. "Commissioner" means the State Commissioner of Environmental Protection.

b. "Construction permit" means and shall include:

(1) Approval of plans for the development of any waterfront upon any tidal waterway pursuant to R. S. 12:5–3.

(2) A permit for a regulated activity pursuant to "The Wetlands Act of 1970," P. L. 1970, c. 272 (C. 13:9A–1 et seq.).

(3) A permit issued pursuant to the "Coastal Area Facility ReviewAct," P. L. 1973, c. 185 (C. 13:19–1 et seq.).

(4) Approval of a structure or alteration within the area which would be inundated by the 100 year design flood of any nondelineated stream or of a change in land use within any delineated floodway or any State administered and delineated flood fringe area, all pursuant to the "Flood Hazard Area Control Act," P. L. 1962, c. 19 (C. 58:16A–50 et seq.) as amended and supplemented.

(5) Approval of plans and specifications for the construction changes, improvements, extensions or alterations to any sewer system pursuant to R. S. 58:11-10.

(6) A permit issued pursuant to the "Beach and Dune Protection Act," P. L. c. (C.).

"Construction permit" shall not, however, include any approval of or permit for an electric generating facility or for a petroleum processing or storage facility, including a liquefied natural gas facility, with a storage capacity of over 50,000 barrels.

c. "Department" means the Department of Environmental Protection.

16. It is the intent of the Legislature that, except as otherwise specifically provided in this act, in the event of any conflict or inconsistency in the provisions of this act and any other acts pertaining to matters herein established or provided for in any rules and regulations adopted under this act or said other acts, to the extent of such conflict or inconsistency, the provisions of this act and the rules and regulations adopted hereunder shall be enforced and the provisions of such other acts and rules and regulations adopted thereunder shall be of no force and effect.

17. If any section, part, phrase, or provision of this act or the application thereof to any person be adjudged invalid by any court of competent jurisdiction, such judgment shall be confined in its operation to the section, part, phrase, provision, or application directly involved in the controversy in which such judgment shall have been rendered and it shall not affect or impair the validity of the remainder of this act or the application thereof to other persons.

18. The object, design, and purpose of this act being the protection of beach and dune areas and the property and lives they protect, this act shall be liberally construed to effectuate the purpose and intent thereof.

19. This act shall take effect immediately.

STATEMENT

This legislation would protect and maintain the beach and dune areas of this State through a land use regulatory program enforced by shore municipalities, with the assistance and oversight of the Department of Environmental Protection.

The bill requires every coastal municipality to adopt a certified municipal beach and dune protection ordinance. The department is directed to provide technical assistance to shore municipalities

in the preparation of such ordinances; the Commissioner of Environmental Protection would be given 6 months to adopt a model ordinance which would define prohibited, conditional, and permitted uses on the beaches and dunes. Subsequently, municipalities would be given 6 months to prepare and adopt municipal beach and dune protection ordinances. The commissioner, after certifying such ordinances, would monitor their enforcement by municipalities. Any amendments to such ordinances proposed by municipalities would also require departmental approval. The commissioner could, after public hearing, revoke such certification if a municipality fails to enforce its ordinance in a manner consistent with the purposes and intent of the act.

In addition, the bill permits the department, after public hearing, to prepare and adopt land use regulations for beaches and dunes in any municipality which either fails to adopt a municipal beach and dune protection ordinance within the 1 year time frame or has otherwise failed to obtain certification for its ordinance, or which has had its certification revoked. Any such regulations would be enforced through a construction permit program to be implemented by the department for these contingencies.

This bill regulates activities in coastal communities in Monmouth, Ocean, Atlantic, Cape May, and Cumberland counties and that portion of Middlesex county east of Cheesequake creek. The department is required to periodically delineate beach and dune areas and to prepare maps to be made available to the public and municipalities in order to assist in the management of these areas. Such delineation would be revised and updated following significant coastal storms.

In order to meet the certification requirements provided in the act, every municipal beach and dune protection ordinance would have to include the following minimum standards:

1. Within beach areas, no construction activity or land disturbance would be permitted; all recreational uses would be permitted; building would be limited to necessary shore protection structures and projects undertaken by the department.

2. Within dune areas, no new construction would be permitted; the reconstruction and repair of exixsting residential structures would be allowed, subject to applicable Federal regulations pertaining to construction in flood hazard areas; the removal of sand and the planting of non-native vegetation would be prohibited; motor vehicles would only be allowed on designated access ways.

The other major provisions of the bill are as follows:

1. A variance procedure would be provided for local residents in beach and dune areas who wish to qualify for a waiver from the strict application of the municipal beach and dune protection ordinance for reasons of hardship. Upon making a determination on any waiver application, the municipality would be required to submit such determination to the commissioner. Whenever the commissioner fails to respond to the municipal determination within 30 days, the municipal decision would be deemed to be the final administrative action. In the event that the commissioner reviews the municipality's determination with respect to a proposed variance, the commissioner's approval, disapproval or conditional approval would be considered to be the final determination.

2. The rules and regulations adopted by the commissioner to effectuate the purpose and intent of the act would be subject to legislative oversight.

3. Penalties of up to $5,000.00 for violations of the act would be imposed; the commissioner would be permitted to compromise and settle any claim for a penalty in such an amount as may appear appropriate and equitable.

6. NEW JERSEY SHOREFRONT PROTECTION ACT
ASSEMBLY BILL 2262 (DECEMBER 1980)

STATE OF NEW JERSEY

INTRODUCED DECEMBER 8, 1980

By Assemblymen HURLEY, CHINNICI and GORMLEY

Referred to Committee on Agriculture and Environment

AN ACT concerning the protection of dune and shorefront areas through a regulatory program administered by the Department of Environmental Protection with primary enforcement responsibilities vested in municipalities, and providing for the adoption and enforcement of shorefront protection ordinances and departmental regulations to effectuate these purposes.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. This act shall be known and may be cited as the "New Jersey Shorefront Protection Act of 1981."

2. The Legislature finds and declares: a. It has been clearly demonstrated that well established and protected sand dunes, together with properly maintained beach and dune areas, along with necessary functional structures in critical areas, are an effective protection against high tides and flooding, and against property damage by the ocean under storm conditions, and provide desirable protection of the coastal areas adjacent thereto, and the State of New Jersey, along with its political subdivisions and their inhabitants have an interest in the continued protection and preservation thereof, and in the restoration of them in the event of property damage or destruction.

b. The developed coastal areas of New Jersey, including developed barrier islands and adjacent shorefront areas, represent in their developed state, a unique and invaluable social, economic, recreational and aesthetic resource. These areas differ dramatically in purpose, nature and protection requirements from the 68 undeveloped barrier islands lying off the Atlantic and Gulf waters of the United States.

c. Given the present degree of commercial and residential development in these areas, given the measurable and intangible benefits that accrue to the residents of the State of New Jersey

and the public at large from the beach, boating, fishing and vacationing facilities that this diversely developed coastal area offers, and given the present extensive knowledge of the protective and restorative nature of beach nourishment and other selected coastal engineering programs, it is hereby declared that it is appropriate, essential, feasible and in the public interest to preserve, protect and enhance these coastal regions in their developed state.

d. It is necessary that all municipalities develop strict building codes and ordinances to protect the fragile beach-dune system of each respective area with coastal engineering programs, consisting of beach nourishment projects, dredging, and other feasible measures undertaken in a concerted and ongoing fashion to maintain and enhance the health of these vital beach-dune areas and thus preserve and promote and restore the unique social, economic and recreational resources that New Jersey's developed barrier islands and adjacent shorefront areas represent.

e. The Legislature, therefore, determines that it is in the interest of the safety, health and general welfare of the public to adopt land use regulations that prevent the misuse of fragile beaches and dunes that could lead directly to increased risk of natural coastal hazards, such as damage to property and loss of life from hurricanes, storms, flooding, and erosion. The Legislature further determines it to be the policy of the State to (1) encourage the natural functioning of the beach and dune system; (2) encourage the restoration of destroyed dunes and eroded beach areas by nourishment and other constructive means; (3) protect and preserve coastal beach and dune areas through the installation of engineered functional structures in critical areas; (4) limit these fragile lands to only those land uses which preserve, protect and enhance the natural environment of the dynamic beach and dune system, protect public and private property, protect the coastal uplands that beaches and dunes shelter and protect; (5) promote the public health, safety and welfare, and further the public interest. The Legislature further determines that it is in the best interest of the people of the State to manage New Jersey's beaches and dunes through a land use regulatory program with primary enforcement responsibilities vested in municipalities with information dissemination, scientific inquiry and technical assistance provided by the Department of Environmental Protection; that the adoption and enforcement of municipal beach and dune protection ordinances shall be the primary regulatory mechanism for the implementation of this program; and that a program of land use regulation in

beaches and dunes efficiently and effectively complements State and local coastal engineering and Federal policy actions, as part of the State's shore protection program pursuant to P. L. 1977, c. 208.

3. As used in this act:

a. "Commissioner" means the Commissioner of the Department of Environmental Protection, or his designated representative;

b. "Department" means the Department of Environmental Protection;

c. "Governing body" means the elected officials of any municipality of the State of New Jersey;

d. "Beach" means gently sloping, unvegetated areas of sand or other unconsolidated material that extend landward from the mean high water line to: (1) the vegetation line, (2) a manmade feature generally parallel to the water body such as a retaining structure, seawall, existing structure, bulkhead, road or boardwalk, provided that sandy areas that extend fully under and landward of an elevated boardwalk are considered to be beach areas, or (3) the seaward or bayward foot of dunes, whichever is closest to the water.

e. "Dune" means a wind or wave deposited formation of vegetated or drifting windblown sand, generally parallel and landward between the inland limit of the beach and the foot of the most inland dune slope, including primary, secondary, and tertiary dunes where they exist. Formations of sand immediately adjacent to beaches that are stablized by retaining structures, snow fences, planting vegetation and other measures are considered to be dunes regardless of the degree of modification of the dune by wind or wave action or disturbance by development. A small mound of loose, windblown sand found in a street or on a part of a structure as a result of storm activity is not considered to be a "dune."

f. "Dune line" means that certain line established by the municipality, after public hearing, which shall consist of a series of connected points closest to the ocean which are (1) 200 feet landward from the vegetation line of the beach, (2) 200 feet landward from the seaward foot of the dunes, (3) at the landward foot of dunes, or (4) at a seawall or revetment, providing such seawall or revetment has a minimum elevation of 10 feet above mean sea level. In isolated cases where there is no vegetation line or dunes, the dune line shall be the landward termination of the beach.

g. "Shorefront protection ordinance" means an ordinance adopted by a municipality pursuant to the provisions of this act and certified by the commissioner.

h. "Shorefront protection area" means that area which extends from the mean high water line to the dune line, as hereinbefore defined, along the Atlantic ocean from Cape May Point north to Sandy Hook, the Delaware bay in Cape May county and Cumberland county, the Raritan bay east of Cheesequake creek, Sandy Hook bay, and the open bays and semi-enclosed bays of undeveloped barrier islands and spits. "Shorefront protection area" shall not include coastal wet lands regulated pursuant to "The Wetlands Act of 1970" P. L. 1970, c. 272 (C. 13:9A-1 et seq.).

i. "Person" means natural persons, partnerships, firms, associations, joint stock companies, syndicates and corporations, and any receiver, trustee, conservator or other officer appointed pursuant to law or by any court, State or Federal: "person" also means the State of New Jersey, counties, municipalities, authorities, other political subdivisions, and all departments and agencies within the aforementioned governmental entities.

4. a. The governing body of every municipality containing a shorefront protection area shall prepare and adopt a shorefront protection ordinance within 1 year of the effective date of this act. The department is authorized to provide technical assistance to municipalities in the preparation of ordinances and in preparing, implementing and funding desirable protective, restorative and preservative actions.

Any municipality which adopts a shorefront protection ordinance, as hereinafter provided, for the regulation of shorefront protection areas which the commissioner certifies meets the minimum standards established in section 5 of this act shall have the responsibility for enforcement of this act and for joining with the department in achieving the intent and purposes of this act.

b. Upon the receipt and review of any such municipal beach and dune protection ordinance, the commissioner shall approve, disapprove or approve with conditions the certification of the ordinance, within 120 days of the date of the submission thereof, or, the ordinance shall be deemed certified.

c. The commissioner shall monitor the enforcement by municipalities of certified shorefront protection ordinances and may, after public hearing, revoke any such certification if, in his estimation, a municipality fails to enforce its ordinance in a manner consistent with the purpose and intent of this act. A revocation by the commissioner shall be subject to judicial appeal by the municipality.

d. Upon the failure of any municipality containing a shorefront protection area to adopt a shorefront protection ordinance and to submit same to the commissioner for his certification within the

time prescribed in subsection a. of this section, the department shall develop and formulate, and in accordance with procedures required by law, adopt and enforce through a construction permit program a shorefront protection regulation for any such municipality, which shall meet the criteria set forth in section 5 of this act.

e. Every municipality with a certified municipal beach and dune protection ordinance shall submit any adopted amendments to such ordinance to the department for its review and approval. In the event that the department fails to approve, disapprove, or conditionally approve any such amendments within 60 days of the date of the submission thereof, the amendments shall be deemed approved.

5. In order to meet the certification requirements provided in section 4 of this act, any such shorefront protection ordinance or departmental regulation shall include, but not necessarily be limited to the following provisions:

a. Within beach areas, no person shall undertake, or cause to be undertaken, any activity, including the construction, relocation, reconstruction, modification, expansion, or demolition of any temporary, mobile or permanent structure, except at the option of the governing body one or more of the following uses:

(1) Open space, beach and water recreation;

(2) Boardwalks and steps to permit access across the dunes to the beach, without damage to the dunes themselves;

(3) Sandfences to encourage the accumulation of sand;

(4) Pavilions or similar small platforms of less than 300 square feet in area, provided they do not have more than 40% solid walls, are mounted on suitable pilings, and provided further that it shall be established to the satisfaction of the municipal engineer that the proposed design and construction methods, as applied to the particular site situation and time, will not:

(a) Unreasonably disturb the existing dunes;

(b) Be likely to create wind currents detrimental to the existing dunes; or

(c) Be likely to create, increase or prolong any other hazard.

(5) Necessary buildings and structures for public safety and convenience, including first aid stations, lifeguard stations, boardwalks and attached buildings, comfort stations, piers and related facilities;

(6) Necessary shorefront protection and stabilization improvements, including jetties, groins, bulkhead and activities related to beach restoration projects;

(7) The operation of specially permitted and licensed vehicles for recreational purposes only.

b. Within the dune areas, the following activities are prohibited:

(1) The operation of any motor vehicle in any portion of the dune area, except in designated access ways;

(2) The removal of native vegetation unless the removal is part of site preparation.

c. Within shorefront protection areas unless otherwise controlled elsewhere in this section 5 of this act, no person shall undertake or cause to be undertaken a regulated activity as hereinafter defined until he has applied for and received a permit issued by the governing body of the affected municipality.

(1) "Regulated activities" means and includes:

(a) The construction, relocation, modification, expansion, or demolition of any temporary, mobile or permanent structure, subject to the building standards as hereinafter defined;

(b) The removal, excavation, filling or deposition of any soil, mud, sand, gravel, or any material;

(c) The construction, reconstruction, or major repair of any public facilities, including but not limited to roads, sewers, bridges, electric power, telephone, gas and water lines;

(d) The construction of pipelines and other linear development;

(e) The designation and development of accessways and pedestrian paths and walkways through dunes;

(2) "Regulated activities" does not mean or include:

(a) The operation of motor vehicles by governmental agencies for public safety, beach maintenance, and emergency purposes;

(b) The operation of motor vehicles outside of beach and dune areas;

(c) The reconstruction and repair of any existing structure provided it is authorized by a building permit if so required by the municipality;

(d) The expansion of any single or two-family dwelling unit, provided the proposed expansion would not distrub a dune or beach and is authorized by a building permit if so required by the municipality; and

(e) The construction of a facility regulated pursuant to the "Coastal Area Facility Review Act," P. L. 1973, c. 185 (C. 13:19-1 et seq.) or a waterfront development pursuant to R. S. 12:5-3;

(f) Those uses permitted under subsection 5a.

d. Within shorefront protection areas, no affected municipality shall permit building activity of any kind unless plans and specifications have been submitted to the municipality, showing compliance with the following building standards:

(1) All new buildings and structures shall be designed and constructed to remain in place and standing under flood conditions of 10 feet above mean sea level and in winds of hurricane intensity.

(2) Construction standards of all new buildings and structures shall conform with the provisions of the State Uniform Construction Code and standards set forth in the National Flood Insurance Act.

(3) The municipality shall review all building permit applications, including new construction and substantial improvements to existing residential and nonresidential buildings and structures, to assure that any such building activity conforms to the aforementioned building standards, and to assure that any such proposed construction has otherwise received all necessary Federal, State and local approvals and permits, as may be provided by law.

6. Each municipality which has adopted a shorefront protection ordinance shall, within 1 year of the commissioner's certification of such ordinance or within 18 months of the effective date of this act, whichever is later, delineate beach and dune areas, dune lines, and shorefront protection areas as defined in section 3 of this act, on suitable maps to assist in the management of these areas. The delineation shall be revised, updated and reassessed by the municipality at least once every 5 years thereafter or after a significant coastal storm. Copies of the maps, which may use aerial photographs as a base, shall be filed with the commissioner and in the office of the county recording officer of the county or counties in which the mapped beach and dune areas, dune lines, and shorefront protection areas are located. To be entitled to filing, no map prepared pursuant to this subsection need meet the requirements of R. S. 47:1–6.

7. Whenever the strict application of the provisions of any shorefront protection ordinance adopted by a municipality or departmental regulation adopted in lieu of an ordinance would result in undue hardship to the owner of any lands affected by the provisions of such ordinance, attributable to the cost or practical difficulty of compliance with such provisions, the owner may apply to the governing body of the municipality or to the commissioner, as the case may be, for a waiver of the strict application of any such provision or provisions. In considering an application for waiver

of strict application of any of the provisions of the shorefront protection ordinance, the governing body of the municipality shall follow the procedure established by law for granting and appealing variances from zoning ordinances. Denial of an application for waiver of strict application of a departmental shorefront protection regulation shall be subject to review on appeal to the Superior Court, Appellate Division.

8. The commissioner shall transmit copies of all rules and regulations adopted, amended or repealed pursuant to this act to the Senate and General Assembly on a day on which both Houses shall be meeting in the course of a regular or special session. The provisions of the "Administrative Procedure Act," P. L. 1968, c. 410 (C. 52:14B–1 et seq.) or any other law to the contrary notwithstanding, no such rule or regulation, except a rule or regulation adopted pursuant to a storm related emergency declared by the Governor, shall take effect if, within 60 days of its transmittal to the Senate and General Assembly, the Legislature shall pass a concurrent resolution stating in substance the Legislature's disapproval of such proposed rule or regulation.

9. Section 1 of P. L. 1975, c. 232 (C. 13:1D–29) is amended to read as follows:

1. For the purposes of this act, unless the context clearly requires a different meaning, the following terms shall have the following meanings:

a. "Commissioner" means the State Commissioner of Environmental Protection.

b. "Construction permit" means and shall include:

(1) Approval of plans for the development of any waterfront upon any tidal waterway pursuant to R. S. 12:5–3.

(2) A permit for a regulated activity pursuant to "The Wetlands Act of 1970," P. L. 1970, c. 272 (C. 13:9A–1 et seq.).

(3) A permit issued pursuant to the "Coastal Area Facility Review Act," P. L. 1973, c. 185 (C. 13:19–1 et seq.).

(4) Approval of a structure or alteration within the area which would be inundated by the 100 year design flood of any nondelineated stream or of a change in land use within any delineated floodway or any State administered and delineated flood fringe area, all pursuant to the "Flood Hazard Area Control Act," P. L. 1962, c. 19 (C. 58:16A–50 et seq.) as amended and supplemented.

(5) Approval of plans and specifications for the construction changes, improvements, extensions or alterations to any sewer system pursuant to R. S. 58:11–10.

"Construction permit" shall not, however, include any approval of or permit for an electric generating facility or for a petroleum processing or storage facility, including a liquefied natural gas facility, with a storage capacity of over 50,000 barrels.

(6) A permit issued pursuant to the "Beach and Dune Protection Act," P. L. , c. (C.).

"Construction permit" shall not, however, include any approval of or permit for an electric generating facility or for a petroleum processing or storage facility, including a liquefied natural gas facility, with a storage capacity of over 50,000 barrels.

c. "Department" means the Department of Environmental Protection.

10. Any person who violates any of the provisions of this act or any rule or regulation adopted pursuant to this act shall be liable to the municipality for the full cost of restoration of the affected beach, dune, or shorefront protection area to its condition prior to the violation and shall be subject to a penalty of not more than $3,000.00 for each offense to be collected in a summary proceeding under the "penalty enforcement law" (N. J. S. 2A:58-1 et seq.). The municipality or commissioner may institute a civil action in the Superior Court for injunctive relief to prohibit and prevent the violation and the court may proceed in a summary manner. If the violation is of a continuing nature, each day during which it continues shall constitute an additional separate and distinct offense. The municipality or commissioner is hereby authorized to compromise and settle any claim for a penalty under this section in such amount as may appear appropriate and equitable under the circumstances.

11. Except as otherwise specifically provided in this act, in the event of any conflict or inconsistency in the provisions of this act and any other acts pertaining to matters herein established or provided for or in rules and regulations adopted under this act or said other acts, to the extent of such conflict or inconsistency, the provisions of this act and the rules and regulations adopted hereunder shall be enforced and the provisions of such other acts and rules and regulations adopted thereunder shall be of no force and effect.

12. If any section, part, phrase, or provision of this act or the application thereof to any person be adjudged invalid by any court of competent jurisdiction, such judgment shall be confined in its operation to the section, part, phrase, provision, or application directly involved in the controversy in which such judgment shall

have been rendered and it shall not affect or impair the validity of the remainder of this act or the application thereof to other persons.

13. The object, design and purpose of this act being the protection and management of the New Jersey shorefront and the resources thereof, this act shall be liberally construed to effectuate the purpose and intent thereof.

14. This act shall take effect immediately.

STATEMENT

This bill has been developed as a result of a series of meetings of approximately 25 mayors of shorefront municipalities in Monmouth, Ocean, Atlantic and Cape May counties.

This bill protects the existing and potential dunes and shorefront areas of this State and the private properties and structures situated therein that they protect through the delineation of beach and dune areas, dune lines, and shorefront protection areas by shorefront municipalities.

The bill authorizes and delegates to the Commissioner of Environmental Protection the enforcement of the management of shorefront protection areas through the review and certification of shorefront protection ordinances.

Within 1 year of the effective date of this act, the bill requires that municipalities shall adopt a shorefront protection ordinance.

The bill requires that thereafter the municipality shall define the landward boundaries of shorefront protection areas, delineate beach and dune areas, dune lines, shorefront protection areas, and publish maps of these areas. The municipality shall thereafter revise and update such delineations at least once every 5 years or after a significant coastal storm.

The shorefront protection ordinances shall include, but not necessarily be limited to, the following provisions:

(1) Within beach areas, no construction is permitted except for protective works, necessary buildings and structures for public safety and convenience and small pavilions.

(2) Within shorefront protection areas, all activities shall be regulated by the municipality, including construction and reconstruction of buildings and structures, subject to strict building standards.

Other provisions of the bill include:

(1) The commissioner is authorized to impose regulations for shorefront protection on any municipality which fails to prepare and adopt a certified ordinance of its own.

(2) Any person seeking a waiver from the strict application of any provision or provisions of a shorefront protection ordinance must apply in writing to the governing body of the affected municipality.

CHAPTER XII

GLOSSARY OF TERMS

ABIOTIC
Not involving or produced by organism.

ACCRETION OR AGGRADATION
May be either natural or artificial. Natural accretion is the buildup of land, solely by the action of the forces of nature, on a beach by deposition of waterborne or airborne material. Artificial accretion is a similar buildup of land by reason of an act of man, such as the accretion formed by a groin, jetty, breakwater, or beach fill deposited by mechanical means.

ALGAE
Marine, brackish, and fresh-water plants (including marine seaweeds), ranging in size from microscopic unicellular plants to the giant kelps. Marine algae often have leaflike and stemlike parts similar to those of terrestrial plants, but differ from them in cellular structure.

AQUATIC
Growing or living in, or frequenting, water as opposed to land.

ARMOR
The outer layer of material of a shore protection structure, usually stone, exposed to direct wave attack.

ARTIFICIAL DUNE
Accumulation of sediment in dune form which has been built by any non-natural process, such as bulldozing or sand fencing.

ARTIFICIAL NOURISHMENT
The process of replenishing a beach with material (usually sand) obtained from another location. Also BEACH FILL or BEACH NOURISHMENT.

BACKBAY, BACKWATER OR BARRIER LAGOON
A partially confined tidal estuary roughly parallel to the coast and separated narrowly from the open ocean by barrier islands.

BACKSHORE OR BACKBEACH
That zone of the shore or beach lying between the foreshore and the coastline and acted upon by waves only during severe storms, especially when combined with exceptionally high water. It comprises the berm or berms.

BACKWATER
Tidal tributaries semi-enclosed bays or a series of connected bays (including inland waterways) separated from the open ocean by barrier islands.

BAR
A submerged or emerged embankment of sand, gravel, or other unconsolidated material built on the sea floor in shallow water by waves and currents.

BARRIER BEACH

A narrow strip of land made of unconsolidated material (i.e., predominantly sand and gravel) that extends roughly parellel to the general coastal trend and is separated from the mainland by a narrow body of water.

BARRIER ISLAND

A wave built deposit of sand mainly, raised above sea-level by constructive wave action and separated from the shore by a lagoon. A detached portion of a barrier beach between the inlets. Its height may be increased by dune formations.

BATHYMETRIC

Pertaining to depth measurement.

BEACH

A gently sloping area of unconsolidated material, typically sand, that extends landward from the water to the area where there is marked change in material or physiographic form, or to the line of permanent vegetation. The upland limit of beaches is typically defined by the vegetation line or the first cultural feature, such as a road, seawall, or boardwalk. Beaches are divided into the wet beach, the area at and below the mean high water line, and the dry beach, the areas above the mean high water line.

BEACH AND DUNE SYSTEMS

Include five components: beaches, dunes, high risk erosion areas, sand accretion areas, and overwash areas.

BEACH AND SHORE PRESERVATION

Includes, but is not limited to beach erosion control, coastal flood control, shoreline and offshore rehabilitation and regulation of work and activities likely to affect the physical condition of the beach or shore.

BEACH BERM

A nearly horizontal part of the beach or backshore formed by the deposit of material by wave action. Some beaches have no berms, others have one or several.

BEACH CAPACITY

The total number of people that can be sustained on a given beach area. Usually described in terms of a minimum area necessary per person.

BEACH EROSION

The carrying away of beach materials by wave action, tidal currents, littoral currents, or wind causing a landward migration of the shoreline.

BEACH FACE

The section of the beach normally exposed to the action of the wave uprush and backwash. The foreshore zone of a beach.

BEACHFILL AND NOURISHMENT

The process of artificially replenishing a beach with material (usually sand) obtained from another location.

BEACH PROFILE

The intersection of the ground surface with a vertical plane; may extend from the top of the dune line to the seaward limit of sand movement.

BEACH RIDGE

An essentially continuous mound of beach material behind the beach that has been heaped up by wave or other action. Ridges may occur singly or as a series of approximately parallel deposits.

BEACH SCARP

An almost vertical slope along the beach caused by erosion by wave action. It may vary in height from a few inches to several feet, depending on wave action and the nature and composition of the beach.

BEACH WIDTH

The horizontal width of the beach from the Mean High Water Line to the back of the beach, measured normal to the shoreline.

BENTHIC

Pertaining to the subaquatic bottom.

BENTHOS

A collective term describing: (1) bottom organisms attached or resting on or in the botton sediments, (2) community of animals living in or on the bottom.

BERM

This means a low, incipient, nearly horizonal or landward sloping bench, shelf, ledge, or narrow terrace on the landward side of a beach, usually composed of sand deposited by wave action.

BERM WIDTH

The horizontal width of a sandy beach area between the back of the beach and the crest (or seaward edge) of the existing or design beach berm.

BIOTA

The animal and plant life of a region; flora and fauna collectively.

BLUFF

A cliff with a broad face, or a relatively long strip of land rising abruptly above surrounding land or a body of water.

BREAKWATER

A structure protecting a shore area, harbor, anchorage, or basin from waves.

BULKHEAD

A class of vertical structures constructed of steel, concrete sheet piling or of timber usually placed parallel or nearly parallel to the shoreline to retain or prevent sliding of the land and afford protection against damage by wave action.

BYPASSING, SAND

Hydraulic or mechanical transfer of sand from the accreting updrift side to the eroding downdrift side of an inlet or harbor entrance.

CENTRAL PLACE

Cluster of retail and service establishments that serve as a focal point for local consumer's purchases of required goods and services.

COAST

A strip of land of indefinite width (may be several miles) that extends from the shoreline inland to the first major change in terrain features.

COASTAL BLUFFS

The seaward face or side of any elevated land form, other than a coastal dune, which lies at the landward edge of a coastal beach whose land is subject to tidal action, or other water-wave actions. The seaward limit of the bluff is the toe of the bluff slope. The landward limit of the bluff is the first major break in the face of the bluff. A bluff may be a steep or gently sloping surface composed of various fairly loose sediment. Coastal bluffs, exist primarily in Middlesex, Monmouth, Burlington, and Gloucester Counties.

COASTAL CONSTRUCTION

Includes any work or activity which is likely to have a material physical effect on existing coastal conditions or natural shore processes.

COASTAL ENGINEERING

The application of the physical and engineering to the planning, design, and construction of works to modify or control the interaction of the air, sea, and land in the coastal zone for the benefit of man and for the enhancement of natural shoreline resources. A variety of structural and non-structural measures to manage water areas and the shoreline for natural effects of erosion, storms, and sediment and sand movement. Beach nourishment, sand fences, pedestrian control on dunes, stabilization of dunes, dune restoration projects, and dredged spoil disposal and the construction of retaining structures such as bulkheads, revetments and seawalls are all examples of coastal engineering.

COASTAL WETLANDS

Any low-lying salt marsh, swamp, meadow and flat land areas subject to regular or occasional tidal action as delineated by the NJDEP on official maps at a scale of 1:2400.

COASTLINE

Technically, the line that forms the boundary between the COAST and SHORE. Commonly, the line that forms the boundary between the land and the water.

COLONIZATION

A natural phenomenon where a species invades an area previously unoccupied by that species and becomes established. To be successful the species must be able to reproduce in that area.

COST EFFECTIVE ALSO COST BENEFICIAL

A project or activity for which the present value of all direct benefits (revenues) is greater than the present value of all future costs or outlays.

CREST OF BERM
The seaward limit of a berm.

CULTURAL RESOURCES
Historical sites, archeological sites, indigenous craft forms and coastal region's maritime heritage.

CURRENT, LITTORAL
The nearshore currents primarily due to wave action, e.g. longshore currents and rip currents.

CURRENT, LONGSHORE
The inshore current moving essentially parallel to the shore, usually generated by waves breaking at an angle to the shore line.

CUSPATE
Having a series of naturally formed low mounds of beach material separated by crescent-shaped troughs spaced at more or less regular intervals along the beach face.

DAMAGE
Is defined as any erosion caused harm to property which results in either an insurance claim or government loan application for fund to make repairs.

DELTA
An alluvial deposit, roughly triangular or digitate in shape, formed at a river mouth or inlet.

DENSITY
In an ecological sense density is usually subdivided into two catagories: (1) crude density-the number or biomass per unit of total area, and (2) specific density-the number or biomass per unit of habitable (colonizable) area.

DESIGN STORM
A representative storm, with specific wave and surge characteristics, that is assumed to occur in a particular study area.

DETRITUS
Any fine particulate debris, usually of organic origin, but sometimes defined as organic and inorganic debris.

DEVELOPMENT
A facility, use, or alteration of the coastal zone. "Action, activity, development, project, proposal, or use," are used interchangably to describe the proposed use of coastal resources that is under scrutiny using the coastal resource and development policies.

DIATOM
A microscopic alga with an external skeleton of silica, found in both fresh and salt water.

DINOFLAGELLATE
A chiefly marine plankton organism usually with plant like flagellates which are important in the marine food chain.

DISCOUNTED PRESENT VALUE

The value today of a future cost or revenue such that a person is equally well off between receiving the lesser amount now or the larger amount later.

DOWNDRIFT

The direction of predominant movement of littoral material.

DREDGED SPOIL DISPOSAL

The discharge on land, water's edge, or water areas of sediments, known as spoils, removed during dredging operations.

DUNES, SAND DUNES

Are formations of vegetated or drifting windblown sand roughly parallel and upland from the beaches on ocean and bay shores. The inland limit of dunes is defined topographically. Typically, the land surface rises above a beach as a fore-dune, flattens on a ridge line, and then falls as a back dune. This is the primary dune. Sometimes the surface rises and falls again one or more times, creating secondary or tertiary dunes. The term dune includes all areas between the inland limit of the dry, sandy beach and the foot of the most inland dune slope. Two types of dune areas exist along the New Jersey shoreline: natural dunes and developed dunes. Natural dunes modified, but not totally destroyed by man, are defined as "developed dunes."

Dunes include the following subcategories:

1. Foredunes or primary dunes. These are the front dunes immediately behind the backshore of the beach,
2. Primary backdunes and secondary and tertiary dunes. These are backslope of the foredune and extend from the dune ridges immediately landward of the foredune to the inland toe of the most inland slope,
3. Migrating dunes. These are dunes which have changed location through time. Coastal dunes generally migrate inland,
4. Artificial dunes. These are accumulation of sediment in dune form which have been built by any non-natural process such as bulldozing or sand fencing,
5. Stabilized dunes. These are dunes maintained in a fixed location by artificial means,
6. Dune fields. These include but are not limited to any combination of the dune types defined in this section.

DUNE CREST

The point or line where the dune's highest elevation is located.

DUNE MANAGEMENT DISTRICT

An artificial area whose boundaries are defined scientifically. Where natural process are allowed to function without interference and where the dune is protected and maintained.

DUNE SCARP

Located on the seaward side of the foredune. An almost vertical slope along the dune caused by wave action.

EBB CURRENT

The tidal current away from shore or down a tidal stream; usually associated with the decrease in the height of the tide.

EBB TIDAL DELTA

Accumulation of sediment, generally sub-aqueous, located at the oceanside end of an inlet.

EBB TIDE

The period to tide between high water and the succeeding low water; a falling tide.

ECONOMIC MARKET AREA

The geographic area served by a control place.

ECOSYSTEM

The living organisms and the non-living environment interacting in a given area.

EFFECTIVE PROPERTY TAX RATE

Total on which tax rate is computed (taxes needed to be raised) divided by the net valuation on which county taxes are apportioned.

EMERGENCY

This means any unusual incident resulting from natural or unnatural causes which endangers the health, safety or resources of the residents of the State including damages or erosion to any shoreline resulting from a hurricane, northeast or other such violent storms or high water.

EQUALIZED VALUATION PER CAPITA

Aggregate true value of real property plus the assessed valuation of class II railroad property and personal property divided by the estimated local population.

EQUALIZED VALUE

Aggregate true value of real property plus the assessed valuation of Class II railroad property and personal property.

EROSION

The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

EROSION CONTROL STRUCTURES

This means any groin, jetty, breakwater, seawall, revetment, artificial nourishment or other deposition of beach material or other structure of a solid or highly impermeable design, when same is located, or is proposed to be located below the mean high-water line of any tidal waters.

EROSION HAZARD AREA

Are shoreline areas that are eroding and/or have a history of erosion, causing them to be highly susceptible for further erosion and damage from storms. Erosion Hazard Areas may be identified by any one of the following characteristics:

1. Lack of beaches
2. Lack of beaches at high tide
3. Narrow beaches
4. High beach mobility
5. Foreshore extended under a boardwalk
6. Low dune or no dunes
7. Escarped foredune
8. Gaps in dune fields
9. Steep beach slopes
10. Cliffed bluffs adjacent to beach
11. Insufficient dune or bluff vegetation
12. Exposed, damaged or breached jetties, groins or seawalls
13. High long-term erosion rates
14. Pronounced downdrift effects of groins (jetties)

Erosion Hazard Areas extend inland to the limit of the area likely to be eroded in less than 50 years, including developed and undeveloped areas, if no shore protection project, including beach nourishment, is implemented. The risk in, and therefore the extent of, Erosion Hazard Areas can be decreased by the implementation of a shore protection project, such as creation of dunes, berms, beach nourishment, or other shore protection techniques.

The extent of the Erosion Hazard Area may be calculated by multiplying, by fifty, the annual erosion rates found in Nordstrom et al. (1977), Coastal Geomorphology in New Jersey, Center for Coastal and Environmental Studies, CCES (1979), Coastal Dunes: Their Function, Delineation, and Management, or other appropriate sources including verifiable serial photography, may also be consulted.

ESTUARY

In ecological usage: a semi-enclosed coastal body of water which has a free connection with the open sea. The seawater is usually measurably diluted with freshwater.

FAIR MARKET VALUE

The price in cash, or in terms equivalent to cash, that property would bring in a transaction between a willing buyer and a willing seller.

FAUNA

Animal life as opposed to flora (plant life). Generally the entire group of animals found in an area.

FEEDER BEACH

An artificially widened beach serving to nourish downdrift beaches by natural littoral currents or forces.

FEE SIMPLE
A fee without limitation or restriction on transfer of ownership; the maximum possible ownership in real estate.

FISCAL CAPABILITY
Ability of a municipality to incur additional debt to finance a capital investment (erosion control measure) as limited by the local tax base.

FLANKING
The erosion that occurs either updrift or downdrift of the terminus of a shore protection structure.

FLOOD
A general and temporary condition of partial or complete innundation of normally dry land areas, form overflow of inland or tidal water, or runoff of surface waters from any source.

FLOOD TIDAL DELTA
Accumulation of sediment, generally sub-aqueous, located at the bayside end of an inlet.

FLOOD TIDE
The period to tide between low water and the succeeding high water; a rising tide.

FLORA
Plant life as opposed to fauna (animal life). The entire group of plants found in an area.

FOREDUNE
The front dune immediately behind the backshore.

FORESHORE
The part of the shore lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low water mark that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall.

GEOMORPHOLOGY
That branch of both physiography and geology which deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of landform.

GROIN
Shore protection structure designed individually on in a series to build a protective beach or to retard erosion of an existing or restored beach by trapping littoral drift. Groins are usually perpendicular or nearly perpendicular to onshore and extend from a point landward of predicted shoreline recession into the offshore zone far enough to accomplish their purpose.

GROIN SYSTEM
A series of groins acting together to protect a section of beach. Commonly called a groin field.

HEADLAND
A high steep-faced promontory extending into the sea.

HERBIVORES
Animals that feed primarily on plants.

HIGH WATER LINE
In strictness, the intersection of the plane of mean high water with the shore. The shore line delineated on the nautical charts of the Coast and Geodetic Survey is an approximation to the high water line.

HISTORICALLY ERODING SHORES
Any area of shore where natural or artifical forces are causing the location of the mean high water line to retreated landward over a specific interval of time.

HISTORICALLY STABLE OR ACCRETING SHORES
Any area of shore where natural or artificial force are causing the position of the mean high water line has moved seaward or remained relatively constant over a specific interval of time.

HISTORIC/CULTURAL RESOURCES
Include objects, structures, neighborhoods, districts, and man-made or man-modified features of landscape, including archaelogical sites, which are either on or are eligible for inclusion in the State or National Register of Historic Places.

HYDROGRAPHY
The characteristics of the sea, lakes, rivers and other aqueous portions of the earth's surface.

IMPERMEABLE GROIN
A groin through which sand cannot pass.

INFRASTRUCTURE
The basic support facilities, equipment, services and installations (including roads, parking areas, utilities, sewer system) needed for the growth and functioning of a community.

INLET
A short, narrow tidally influenced, waterway connecting a bay, lagoon, or similar body of water with the ocean.

INSHORE (ZONE)
In beach terminology, the zone of variable width extending from the low water line through the breaker zone. Shoreface.

INVERTEBRATE
A classification including all animals without a backbone or spinal column.

ISOBATH
A contour line connecting points of equal water depths on a chart.

JETTY

On open seacoasts, a structure extending into a body of water, and designed to prevent shoaling of a channel by littoral materials, and to direct and confine the stream or tidal flow. Jetties are built at the mouth of a river or tidal inlet to help deepen and stabilize a channel.

LAND USE

A use of land which may result in an earth change, including but not limited to subdivision, residential, commercial, industrial, recreational or other development private and public highway, road and street construction or drainage construction.

LITTORAL

In ecology: (1) the zone between extreme high and extreme low tides, (2) occasionally the zone from the shore to the light compensation level.

LITTORAL CURRENT

Any current in the zone extending seaward from the shoreline to just beyond the breaker zone, caused primarily by wave action, e.g., longshore current, rip current.

LITTORAL DRIFT

The material that moves in the littoral zone under the influence of waves and currents.

LITTORAL TRANSPORT

The movement of littoral drift in the littoral zone by waves and currents. Includes movement parallel (longshore transport) and perpendicular (on offshore transport) to the shore.

LITTORAL TRANSPORT RATE

Rate of transport of sedimentary material parallel to or perpendicular to the shore in the littoral zone. Usually expressed in cubic yards per year. Commonly used as synonymous with Longshore Transport Rate.

LITTORAL ZONE

In beach terminology, an indefinite zone extending seaward from the shoreline to just beyond the breaker zone.

LONGSHORE BAR

A bar which extends generally parallel with the shoreline and is submerged at least by high tides.

LONGSHORE TROUGH

An elongate depression formed in the foreshore or in the bottom just offshore by waves or tidal currents.

MACROFAUNA

Those animals equal to or larger than 1 millimeter in size.

MACROPHYTE

A macroscopic aquatic plant.

MARINE SANCTUARY

A specific geographic area located within the ocean waters, from the highest extent of total action seaward to the outer edge of the continental shelf, which has been designated by the Secretary for Commerce of the approval by the President.

MEAN HIGH WATER (MHW)

The average height of the high waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semi-diurnal or mixed. Only the higher high water heights are included in the average where the type of tide is diurnal.

MEAN LOW WATER (MLW)

The average height of the low waters over a 19 year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19 year value. All low water heights are included in the average where the type of tide is either semidiurnal or mixed. Only lower low water heights are included in the average where the type of tide is diurnal. So determined, mean low water in the latter case is the same as mean lower low water.

MEAN SEA LEVEL

The average height of the surface of the sea for all stages of the tide over a 19 year period, usually determined from hourly height readings.

MEIOFAUNA

Generally those interstitial animals between 1.0 and 0.5 millimeters in size.

MIDDEN

A refuse heap.

MONEY INCOME

Sum of wage and salary income, net non-farm self-employment income, net farm self-employment income, social security and railroad retirement income, public assistance, interest, dividends, pensions, etc.

MORPHOLOGY

The study of the form and structure of organisms.

NATURAL AREA

Lands that support native plant and animal community and provide habitat conditions and characteristics that have remained essentially unchanged by human activity.

NEAP TIDE

A tide occurring near the time of quadrature of the moon with the sun. The neap tidal range is usually 10 to 30 percent less than the mean tidal range.

NEARSHORE (ZONE)
In beach terminology an indefinite zone extending seaward from the shoreline well beyond the breaker zone. It defines the area of nearshore currents.

NET DEBT PER CAPITA
Total net debt (as defined in NJSA 40A:2-42) is defined by estimated local population.

NODAL ZONE
A beach area in which the predominant direction of the longshore transport changes.

NOURISHMENT
The process of replenishing a beach. It may be brought about naturally, by longshore transport, or artificially by the deposition of dredged materials.

NUISANCE STRUCTURE
Any fence, wall or other barrier or obstruction which would interfer with public access to beaches.

OFF ROAD VEHICLES
Self-propelled vehicle capable of traveling in land areas which are not designated as roads or highways including but not limited to dune buggies, snowmobiles, self-propelled carts, cycles and other vehicles capable of traveling on both land and water.

OFFSHORE
In beach terminology, the comparatively flat zone of variable width, extending from the breaker zone to the seaward edge of the Continental Shelf. Also a direction seaward from the shore.

OFFSHORE BREAKWATERS
Shore protection structure designed to protect an area from wave action thus serving as a depositional basin for littoral drift.

OPPORTUNITY COST
The benefit received and costs incurred by adopting one course of action as compared with those that would accompany the adoption of an alternative course of action.

OPEN COAST
A coast that is not sheltered from the sea.

ORGANISM
Any living individual whether plant or animal.

OVERWASH
That portion of the wave uprush that carries over the crest of a berm or of a structure. One of several basic mechanisms by which barrier islands naturally migrate landwards over decades, in addition to the creation of inlets and migration of dunes.

OVERWASH AREAS

Consist of an overwash fan and throat. An overwash fan is a gently sloping, conical accumulation of sediment deposited landward of the beach by the overwash processes that result from storm wave activity. An overwash throat is a low narrow area through the foredune where water passes during storms and carries sediment to the overwash fan. The seaward limit of overwash sediment is the throat.

PER CAPITA MONEY INCOME

Estimated average amount per person of total money income received per year.

PER CAPITA RETAIL SALES

Estimated retail sales divided by estimated local population.

PERCHED BEACH

A beach or fillet of sand retained above the otherwise normal profile level by a submerged dike.

PERMEABLE GROIN

A groin with openings large enough to permit passage of appreciable quantities of littoral drift.

PHYTOPLANKTON

Plant plankton. Members of this group are in the ocean and are important primary producers.

PLANKTON

Those organisms passively drifting or weakly swimming in marine or freshwater.

POSITIVE NET BENEFITS

The lump sum present value of all future benefits or economic returns minus the lump sum present value of all future costs is a positive number.

PRESENT WORTH COST

The sum of the discounted present value of all future costs.

PROFILE, BEACH

The intersection of the ground surface with a vertical plane; may extend from the top of the dune line to the seaward limit of sand movement.

PROPENSITY TO IMPORT

The percent of a tourist expenditure that is sent out of a local area to purchase goods and services.

PUBLIC ACCESS TO THE SHOREFRONT

Is the ability of all members of the community at large to pass physically and visually to and from the ocean shore and other waterfronts.

PUBLIC BEACH/SHORE

Any beach/shore owned in fee simple title by the Federal or State government or any county, city, town or municipality.

PUBLIC OPEN SPACE

Constitute land areas owned and maintained by State, Federal, county and municipal agencies or non-profit private groups (such as conservation organizations and homeowner's associations) and dedicated to conservation of natural resources, public recreation, or wildlife protection or management. Public Open Space also includes State Forests, State Parks, and State Fish and Wildlife Management Areas and designated Natural Areas (N.J.S.A. 13:1B-15.12a et seq.) within DEP-owned and managed lands.

PUBLIC SERVICES

Include a variety of essential facilities provided by either public or private institutions. Health, education, welface, fire, police and community facilities are principal examples. Others such as child care and home services for the elderly may be important for certain developments.

PUBLIC TRUST LANDS

Tidal lands between the mean high and low water marks as well as the ocean covered land owned by the State, in fee simple, held in trust for the people of the State.

RANGE OF TIDE

The difference in height between consecutive high and low waters. The mean range is the difference in height between mean high water and mean low water. The great diurnal range or diurnal range is the difference in height between mean higher high water and mean lower low water. Where the type of tide is diurnal the mean range is the same as the diurnal range.

REAL PROPERTY

Land and structures.

RECESSION OR RETROGRESSION

A net landward movement of the shoreline over a specified time.

REGRESSION

The gradual emergence of land and subsequent seaward shoreline migration, as when sea level falls or land rises.

REVETMENT

An armor facing of stone, concrete blocks, or other nonerodible material placed to protect a bluff, embankment, or shore structure against erosion by wave action or currents.

RIDGE AND SWALE TOPOGRAPHY

The dominant feature of the Middle Atlantic Continental Shelf involving elongated sandy ridges and depressions which run somewhat obliquely to the shoreline and extending nearly to the shelf break.

RIPARIAN GRANT

Any legal conveyance of title by the State of New Jersey or lease to lands now or formerly flowed by the mean high tide as required by N.J.S.A. 12:3-1 et seq. and 13:1B-1 et seq.

RIPARIAN LANDS

Those tidal lands of the State of New Jersey which are now or were formerly flowed by mean high tide; held in trust by the State unless alienated.

RIP CURRENT

A strong surface current flowing seaward from the shore. It usually appears as a visible band of agitated water and is the return movement of water piled up on the shore by incoming waves and wind. With the seaward movement concentrated in a limited band, its velocity is somewhat accentuated. A rip consists of three parts: the Feeder Currents flowing parallel to the shore inside the breakers; the Neck, where the feeder currents converge and flow through the brreakers in a narrow band or "rip"; and the Head, where the current widens and slackens outside the breaker line.

RIPRAP

A layer, facing, or protective mound of stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment; also the stone so used.

RUBBLE MOUND STRUCTURE

A mound of random-shaped and random-placed stones protected with a cover layer of selected stones or specially shaped concrete armor units. (Armor units in primary cover layer may be placed in orderly manner or dumped at random.)

RUNNEL

A corrugation or trough formed in the foreshore or in the bottom just offshore by waves or tidal currents.

RUNUP

The rush of water up a structure or beach on the breaking of a wave. Also UPRUSH. The amount of runup is the vertical height above stillwater level that the rush of water reaches.

SALT MARSH

A marsh previously flooded by salt water.

SAND ACCRETION AREAS

Are areas where littoral offshore or other natural currents or storms have deposited sufficient sand that new land is forming. In some cases dune grasses and other water's edge vegetation may be starting to grow.

SAND AND GRAVEL EXTRACTION

Is the removal of sand or gravel from the water bottom substrate, usually by suction dredge, for the purpose of using the sand or gravel at another location.

SAND BYPASSING SYSTEMS

Any technique utilizing land-based dredge plants, floating dredges and/or mobile land-based vehicles for the purpose of artificially nourishing the shore downdrift from an inlet to improve it stability.

SAND DUNES

See Dunes.

SAND FENCE
Cedar strip and wire role fencing used in dune augmentation programs.

SCOUR
Removal of material by waves and currents, especially at the base or toe of a shore structure.

SEASONAL HOUSING STOCK
Percent of total housing units that are classified as seasonal.

SEASONALITY
Significant proportion of a housing stock or change in a socioeconomic indicator (employment, population) due to accomodation of tourists during summer months.

SEAWALLS
Rigid structures placed parallel or nearly parallel to the shoreline to deflect and withstand the wave energy with incidental functions as a retaining wall or bulkhead.

SEDIMENT BUDGET
An arithmetic relationship between the quantity of sediment added to a shoreline system form potential sources and the quantity of sediment moved to potential sinks.

SETBACK
Required horizontal distance between a building, road or other form of construction and a beach, bluff, drive, shoreline or similar erosion prone area, established as a buffer to limit erosion damage.

SETBACK LINE
The line seaward of which construction or excavation is prohibited under the provisions set forth by State or local government statutes.

SHELLFISH
Any aquatic invertebrate with hard external covering; more commonly mollusks and crustaceans.

SHELLFISHERIES
Estuarine bay and river bottoms which are potentially productive for hard clams, soft clams, eastern oyster, bay scallops or blue mussels. Potentially productive areas are those which do not have a history of natural recruitment for any of the above species, but could be used as a shellfish culture planting area.

SHOAL
A detached elevation of the sea bottom, comprising any material except rock or coral, which may endanger surface navigation.

SHOALING
To become shallower.

SHORE

That narrow strip of land bordering any body of water which is alternately exposed, or covered by tides and waves (including the zone between high and low water lines). A shore of unconsolidated material is (e.g., sand) usually called a beach.

SHOREFACE

The narrow zone seaward from the low tide shoreline covered by water over which the beach sands and gravels actively oscillate with changing wave conditions.

SHORELAND

Land, water or submerged land which is in close proximity to the shoreline of the ocean bay, or a connecting waterway.

SHORELINE

The intersection of a specified plane of water with the shore or beach (e.g., the highwater shoreline would be the intersection of the plane of mean high water with the shore or beach). The line delineating the shoreline of U.S. Coast and Geodetic Survey (NOS) nautical charts and surveys approximates the mean high water line.

SHORELINE RECESSION

This means the landward retreat of the shoreline caused by action of winds, waves, currents, and a rising sea level.

SHORE PROTECTION

Work designed to stabilize the shores where wave action is the principal cause of erosion.

SPAWN

To produce or deposit eggs or sperm. Also the young produced.

SPECIES

An aggregate of interbreeding populations that under natural conditions is reproductively isolated.

SPIT

This means a low tongue or narrow embankment of land, commonly consisting of unconsolidated materials deposited by wave and current action and having one end attached to the shore and the other terminating in open water.

SPLASH ZONE

The zone immediately landward of the mean higher high water level affected by the wave spray.

SPRING TIDE

A tide that occurs at or near the time of new or full moon (syzygy), and which rises highest and falls lowest from the mean sea level.

STABILIZED DUNE

A dune which is maintained in a fixed location by artificial means.

STATIC SHORELINE
A shoreline which remains fixed in one location through time.

STILLWATER LEVEL
The elevation that the surface of the water would assume if all wave action were absent.

STOCKPILE
Sand piled on a beach foreshore to nourish downdrift beaches by natural littoral currents or forces.

STORM SURGE
A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes that rise in level due to atmospheric pressure reduction as well as that due to wind stress.

STRUCTURE
Any assembly of materials constructed or erected above or below the surface of land or water, including but not limited to buildings, fences, dams, pilings, breakwaters, fills, levees, bulkheads, dikes, jetties, embankments, causeways, culverts, pipes, pipelines, roads, railroads, bridges and the facilities of any utility or governmental agency. Trees or other vegetation are not considered to be structures.

SURF ZONE
The area between the outermost breaker and the limit of wave uprush.

SWASH
The rush of water up onto the beach face following the breaking of a wave. Also Uprush or Runup.

THALWEG
The line joining the deepest points of a waterway channel.

TIDAL INLET
A natural inlet maintained by tidal flow.

TIDE
The periodic rising and falling of the water that results from the gravitational attraction of the moon and sun acting upon the rotating earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as Tidal Current, reserving the name tide for the vertical movement.

TOMBOLO
An area of unconsolidated material, (sand) such as a bar or spit, deposited by wave action or currents, that connects a rock, island, or offshore structure, etc., to the mainland or to another island.

TOPOGRAPHY
The general configuration of the land surface (or the ocean bottom); the sum total of the results of erosion and deposition of the physiographic features of a region.

TRANSGRESSION
The progressive submergence of land and subsequent landward shoreling migration, as when sea level rises or land subsides.

TURBIDITY
A condition where transparency or translucency of water is reduced as when sediment in water is stirred up. It is an optical phenomenon and does not necessarily have a direct linear relationship to particulate concentration.

TURBULENCE
The state or condition of being violently agitated or disturbed, as a stream which meets an obstacle, or air flowing over an uneven surface.

UPDRIFT
The direction opposite that of the predominant movement of littoral material.

UPRUSH
The rush of water up onto the beach following the breaking of a wave.

URBAN CENTER
A central city or cluster of contiguous cities having a population of 50,000 or more.

VARIANCE
Government authorization to perform certain specific work or activity in an area regulated by certain statutes.

VEGETATION
Is the plant life or total plant cover that is found on a specific area, whether indigenous or introduced by humans.

WAVE CLIMATE
The nature of incident waves including the characteristic wave height, period, length, and direction.

WAVE HEIGHT
The vertical distance between a crest and the preceding through.

WAVE PERIOD
The time for a wave crest to traverse a distance equal to one wavelength. The time for two successive wave crests to pass a fixed point.

WRACKLINE
Debris (dead plants, etc.) which wash up on the beach and deposited at the high tide line.

ZOOPLANKTON
Animals in the plankton.

NOTE: Glossary definitions provided herein are for information purposes only and are not intended to supercede or otherwise replace definitions provided in the New Jersey Coastal Management Program (NJDEP/NOAA, August 1980) or other State documents.

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LIST OF ACRONYMS

BCPD	Bureau of Coastal Planning & Development (NJDEP)
CAFRA	Coastal Area Facility Review Act
CCES	Center for Coastal and Environmental Studies (Rutgers)
CEQ	Council on Environmental Quality
CERC	Coastal Engineering Research Center
COE	Corps of Engineers
COST	Continental Offshore Stratigraphic Test
CZMA	Coastal Zone Management Act
DCR	Division of Coastal Resources (NJDEP)
DEP	New Jersey Department of Environmental Protection
DEIS	Draft Environmental Impact Statement
DMD	Dune Management District
DOT	U.S. Department of Transportation
DSPA	Dune and Shorefront Protection Act
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FDAA	Federal Disaster Assistance Administration
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
FIA	Federal Insurance Administration (FEMA)
FWS	U.S. Fish and Wildlife Service
GSA	General Services Administration
HCRS	Heritage Conservation and Recreation Service
HUD	U.S. Department of Housing and Urban Development
L.F.	Linear Feet
LWCF	Land and Water Conservation Fund
MAS	Maine Audubon Society
MHW	Mean High Water
MLW	Mean Low Water
MSL	Mean Sea Level

NEPA	National Enviornmental Policy Act
NERBC	New England River Basin Commission
NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NJDEP	New Jersey Department of Environmental Protection
NRDC	National Resources Defense Council, Inc.
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
OCS	Outer Continental Shelf
OCZM	Office of Coastal Zone Management (NOAA)
SBA	Small Business Administration
SCORP	Statewide Comprehensive Outdoor Recreation Plan
USGS	U.S. Geological Survey

CHAPTER XIII

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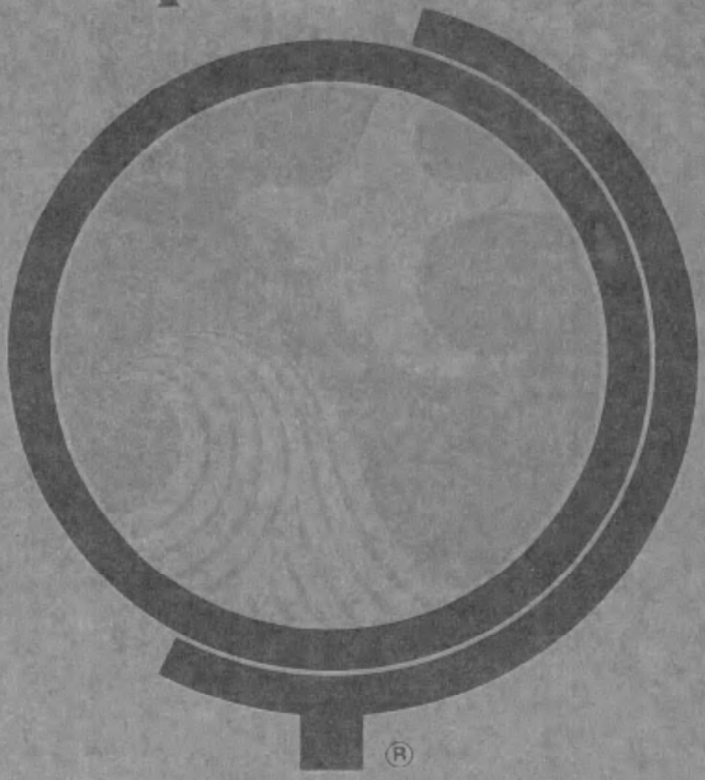
A complete list of agencies, groups, companies, and individuals who commented on the Draft Shore Protection Master Plan is provided in Volume 3, Chapter II.

Let's protect our earth



NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

COVER PHOTO by Susan D. Halsey