CITY OF VIRGINIA BEACH

Beach Management and Restoration Plan

September, 1988

Prepared by:
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Reston, Virginia

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ABBREVIATIONS AND ACRONYMS

AADT	Annual Average Daily Traffic
CERC	Coastal Engineering Research Center of the United States Army Corps of Engineers
cm	centimeters
cy	cubic yards
cy/yr	cubic yards/year
ft/yr	feet/year
m	meters
mi.	Statute Miles
MHW	Mean High Water
MLW	Mean Low Water
mm	milimeters
mm/yr	milimeters/year
NGVD	National Geodetic Vertical Datum
OEM	Office of Environmental Management
OIC	Office of Intergovernmental Coordination of the City of Virginia Beach
RAAC	Resort Area Advisory Commission
TRT	Tidewater Regional Transit
USA(COE)	United States Army Corps of Engineers
VBEAC	Virginia Beach Erosion Advisory Commission
VBEC	Virginia Beach Erosion Council
VDOT	Virginia Department of Transportation
VIMS	Virginia Institute of Marine Science
VPA	Virginia Port Authority
WES	Waterways Experiment Station of the United States Army Corps of Engineers

EXECUTIVE SUMMARY

The proposed Beach Management and Restoration Plan for Virginia Beach consists of the following elements:

- o Proposed Beach Nourishment Programs
- o Use Recommendations
- o Improvements to the Existing Local Management System
- o State-Wide Recommendations
- o Information Needs and Future Studies

Together these five elements represent a set of comprehensive actions that should be undertaken by Virginia Beach to begin to improve the management and restoration of the City's most valuable economic and natural resource-its oceanfront and bayfront beaches. Beach management is defined at the beginning of this study to be broadly inclusive. It encompasses both engineering programs for beach nourishment, as well as accompanying steps for increasing recreational use of the beaches, and improvements in the local and state systems for planning and managing the City's beaches.

The Plan is organized according to seven beach segments that contain the entire length of non-governmental shoreline within Virginia Beach. The seven segments addressed by the plan are:

- o Chesapeake Beach
- o Ocean Park Beach
- o Cape Henry Beach
- o North Beach
- o Resort Beach
- o Croatan Beach
- o Sandbridge Beach

These segments are shown on Figure 1-2, and individual segment maps are presented in Figures 1-3 through 1-9.

The first five Chapters of this report contain the baseline information that was used to develop the Plan. Chapter 1 describes the land use, locational, and recreational characteristics of each segment. Chapter 2 describes the coastal setting of Virginia Beach, focusing on the nature of the erosional processes at work. Chapter 3 discusses the previous efforts at managing erosion in Virginia Beach. Chapter 4 presents a description of the local, state and federal agencies with responsibility for coastal planning and beach nourishment. Chapter 5 describes the range of beach nourishment techniques that have been used in different settings. Finally, Chapter 6 of this document presents the above five components of the plan in full detail.

The remainder of this executive summary presents in condensed form the elements of the Plan presented in Chapter 6.

Proposed Beach Nourishment Programs

Chesapeake Beach

The recommendation for Chesapeake Beach is to provide nourishment approximately every three years in the amount of 50,000 cubic yards (cy). The current width of the beach is sufficient to provide protection to shorefront property and recreational capacity. Thus, no initial placement of sand is recommended. The City should monitor the beach width and once it erodes to a 50' wide design berm, nourishment should then be performed. The recommended amount of nourishment of 50,000 cy would be sufficient to compensate for three years of erosion losses, based on historical erosion trends.

Ocean Park Beach

The nourishment recommendation for Ocean Park is similar to that for Chesapeake Beach. The beach is presently wide enough that initial beach fill is not required. The City should monitor beach width, and once it declines to a 50' wide design berm, nourishment should be undertaken. Nourishment in the amount of 33,000 cy every three years is recommended.

The second recommendation for Ocean Park concerns Lynnhaven Inlet. There is currently a high erosion rate immediately west of the Inlet. This Plan recommends that the City make a formal request to the Norfolk District of the United States Army of Corps of Engineers (COE) for a study to determine if the construction of a jetty would be feasible. The purpose of this jetty would be to stabilize the inlet such that the erosion problem would be alleviated. This jetty could also serve to better maintain the navigability of the inlet.

Cape Henry

The Cape Henry Beach is an accretional area, with the result that the beach is becoming wider, particularly in the western portion near Seashore State Park. For this reason, neither an initial fill nor periodic nourishment is required. However, the City should monitor the beach width along this segment.

North Beach and Resort Beach

These segments are considered together as both will be part of the Beach Erosion Control and Hurricane Protection Project for Virginia Beach being proposed by the Norfolk District of the COE. This plan assumes a project similar to one that has been proposed by the COE (see Figure 4-2 on page 4-11) will eventually be constructed along these two segments during the next 2-5 years. We agree with the COE that the plan should consist of two components: 1) a protective seawall between Rudee Inlet and 58th Street, and dunes north of 58th Street; and 2) beach nourishment. We concur that both elements of the project are necessary to provide the desired level of protection to oceanfront real property.

RGH and Cubit Engineering did not undertake the very substantial effort required to confirm the COE preliminary design shown in Figure 4-2. Therefore, this plan cannot either recommend the adoption of the project with the seawall as presently designed, nor recommend an alternative design. It is recommended that landscape design and aesthetic measures be used to improve the appearance of seawall. The installation of benches,

street furniture, and design features should be used to expand the function of the seawall from being only a protective structure to a linear feature that promotes interaction among tourists and provides opportunities for views of the sea.

It is imperative that final design of the Erosion Control and Hurricane Protection Project be acceptable to both the City and the COE. At the present time (September, 1988) the Division of Engineering, Department of Public Works of the City of Virginia Beach and COE are working together to arrive at a mutually acceptable project design.

Croatan Beach

The erosional characteristics of Croatan Beach indicate accretion in the north near Rudee Inlet and erosion in the south near Camp Pendleton. It is recommended that a 100' wide beach berm be maintained along Croatan Beach. This would not require any initial placement of sand. However, the long-term erosion rate near Camp Pendleton, if it continues unchanged, would result in substantial losses of property over the next 50 years. For this reason the Plan recommends a beach nourishment program for this section, consisting of approximately 27,000 cy of sand placed on the beach every three years.

A preliminary Benefit Cost analysis indicates that a beach nourishment project at this location could very likely qualify for a 50% local cost share under Section 933 of the 1986 Water Resources Development Act (see page 4-6). It should be noted that a COE analysis of the economic feasibility of a beach nourishment project will consider the total cost of placing sand on the beach, and not the smaller, local cost share. Section 933 can only consider property protection benefits resulting from beach nourishment. If the ratio of property protection benefits to the cost of beach nourishment is greater than one, a project would be defined as being in the federal interest.

Sandbridge

The erosion problem is more severe at Sandbridge than at any of other beach segments. It estimated that $99,965,300 of private real property, streets, and utilities would be lost to erosion at Sandbridge over the next 50 years. This assumes that the historical erosion rates continue into the future.

It is recommended that a 100' wide beach berm be maintained at Sandbridge. The required nourishment plan would consist of an initial placement of 1,210,000 cy of beach fill, followed by nourishment every three years of 990,000 cy of sand. Benefit Cost analysis indicates that the proposed project would likely be cost justified if sand can be placed at Sandbridge for a reasonable cost. Analysis indicated that a project would be economically justifiable if the cost was less than $7.70/cy for each cubic yard of sand remaining on the beach (i.e., cost/cy in-place).

In summary, a determining factor of whether a beach nourishment project at Sandbridge would likely be cost justified, and in the federal interest, is the cost of placing the sand on the beach. A high cost for placing sand on the beach would produce a Benefit Cost ratio less than one, similarly a low cost for sand would produce a ratio greater than one. If a project was determined by the COE to be cost-justified, the City could be eligible for a 50/50 sharing of the increment between the cost of placing the sand on the beach and the cost of taking it to the Dam Neck disposal site.

Public Access

The issue of public access to the City's beaches will have to be resolved prior to the implementation of any of the recommended projects. Participation by the COE in a beach nourishment project requires that the right of the public to have access to a beach be legally and definitively determined before a project can be declared to be in the federal interest. Even though the public has had access to and has been using a beach, a definitive legal determination of their right to do so may still be required in order to qualify for a beach nourishment project under Section 933.

Use Recommendations

Increase Public Access To and Use of the Chesapeake Bay Beaches

The three beach segments located along Chesapeake Bay appear to be underutilized recreational resources. The City should adopt a formal policy of increasing public access to and public use of these beach segments. The location of the Chesapeake Bay beaches makes them particularly well suited for use by day visitors residing in the tidewater region due to excellent transportation accessibility. Day users do not require the full range of tourism facilities present in the Resort Area.

Improved public access to and use of the Chesapeake Bay beach segments would be improved by the establishment of city-owned and operated beaches in the Ocean Park and Cape Henry beach segments. The public should have the ability to move freely along the entire length of the three segments after gaining access to the beach at either of the city-owned beaches. In effect, the city-owned beaches would act as funnels for persons desiring access to any part of the Chesapeake Bay beaches. The city should supply support services such as lifeguards, concessions, bath houses, and changing areas only at the two recommended public beaches. Additional parking the either at the two beaches, or in nearby satellite parking lots, should be established to provide the necessary automobile access for the day users.

Chesapeake and Ocean Park Beaches

The existing access to these two beaches through the neighborhoods via the public access right-of-ways should remain unchanged. These are strong, viable neighborhoods with a high residential quality of life. Encouraging additional flows of day visitors through these areas by increasing on-street parking capacities near the ROW's would adversely affect the residential quality of these areas, and conflict with recommendations of the Virginia Beach Comprehensive Plan for these neighborhoods.

It is recommended that a public beach be established just west of Lessner Bridge in the Ocean Park beach segment. This area is less residential than the western portion of Ocean Park, and has excellent regional transportation access via Shore Drive. A public beach at this location would provide day users with direct access onto the beach. They could choose to proceed west beyond the public beach. No city services such as lifeguards, concessions, changing & bath houses should be provided outside of the public beach.

Cape Henry Beach

It is recommended that the City establish a public beach near the intersection of Great Neck Road and Shore Drive. In addition, the City should encourage the development of a smaller resort activity center adjacent to the Beach that serves day users from the surrounding tidewater region. This area has locational and land use characteristics (i.e., proximity to Shore Drive and Seashore State Park, existing concentration of hotels & motels, restaurants) that make it suitable for the establishment of a secondary resort node. The OEM should investigate with the Department of Planning the feasibility of designating this area as an RT-3 zoning district.

Additional transportation accessibility to the public beach and resort node should be provided through additional off-street parking lots and better mass transit service from the rest of the City.

North Beach

Increased use of the beach leased by the City at Ft. Story should be promoted. This should be done through publicity, better mass transit service, and additional parking (if sufficient room exists).

The existing level of public access to North Beach should be maintained. No additional on-street parking should be provided in North Beach for the same reasons presented above for Chesapeake Beach. Two additional reasons for not providing additional on-street parking in North Beach are that 1) the area is readily accessible via mass transit from stops along Atlantic Avenue, and 2) beach goers can easily proceed northward along the beach from the Resort Area.

Resort Area

The use recommendations for the Resort Area concern the likely construction of the seawall as part of the Beach Erosion Control and Hurricane Protection project between Rudee Inlet and 58th Street. The City of Virginia Beach should:

- Assess with the COE the feasibility of constructing the seawall along the landward side of the boardwalk. Reasons for considering the option include: 1) maintaining unrestricted access between the beach and the boardwalk, and 2) not comprising the structural integrity of the seawall by having a large number access openings through the wall between the beach and boardwalk.

- Ensure that the seawall is as aesthetically pleasing and functional as possible. Landscape design improvements, textured surfaces, color schemes, and street furniture should be used to make the wall aesthetically pleasing and a place for persons to gather.

- Assess the feasibility of a raised boardwalk between Rudee Inlet and 58th. This would be done to maintain an unrestricted view of the Ocean from the Boardwalk.

If a seawall is constructed, the City should monitor visitation to the Resort Area. This effort should attempt to determine if visitation is declining, whether visitors are going to competing areas such as Ocean City Maryland, and what visitors perceptions are

concerning the presence of the seawall. One issue that should be focused on is whether visitation to the Resort Area begins to return to pre-seawall levels after several years. Virginia Beach should also undertake a public education effort to explain the need for and function of the seawall. Any efforts taken by the City to improve the appearance and functionality of the wall should also be publicized.

Improvements to the Existing Local Management System

The decision-making authority for coastal planning, beach nourishment, coastal engineering should be consolidated in one department. The City's beaches are its most valuable economic and environmental resources, and decisions concerning their management fall directly or indirectly under the responsibilities of a number of different City departments. Without one agency having overall management responsibility, the potential exists for fragmented decision-making and no overall focus or coherence on management of the beaches. Overall responsibility should be given to one agency to prevent a continuation of these problems. The OEM appears to be the logical choice for assuming planning and management responsibility for beach management.

A closely related recommendation is the establishment of a Coastal Planning Committee within city government. The purposes of this Committee would be 1) serve as a vehicle for developing a consensus among city agencies on important coastal planning issues and policies, and 2) provide a structured mechanism to promote planning and regular communication among various City agencies on coastal planning and beach nourishment matters. The existence of such a committee would attempt to eliminate the current problem of a number of agencies all competing to promote their views to the City Manager and the Council. It would be important for the Council and City Manager to view proposals from the Committee as representing a consensus of all participating City agencies.

The Virginia Beach Erosion Council (VBEC) should be abolished and its responsibilities given to the Division of Engineering. It doesn't make sense for the City to continue to fund the major portion of the VBEC's budget without any direct authority over how it is spent. The conditions that led to the establishment of the VBEC have since disappeared, particularly as the Division of Engineering has the ability to perform all of the functions currently the responsibility of the VBEC.

The city should undertake a regular program for determining the use of the beaches outside of the Resort Area. A major gap encountered during the preparation of this plan was the existence of any data on the use of these beaches. This program should determine the amount of use (i.e., number of users on week-day and week-end summer days), the type of use, and also the origin or place of residence of the users. One issue deserving of further research is the potential for the City to better serve day use beach goers residing in the tidewater region. It appears that this is a significant and growing market segment that Virginia Beach is well partitioned to capture. Regional transportation accessibility and parking would be major issues that would have to be resolved in accommodating day users.

The City's Coastal Primary Sand Dune Zoning Ordinance (Article 16 of the Virginia Beach Zoning Ordinance) should be revised in two ways. First, Section 1602 (h) should be changed to prohibit recreational activities on coastal primary sand dunes. Second, the term "governmental activity" in Section 1602 (l) should be better defined.

State-Wide Recommendations

Long-rang planning capability for beach nourishment and other coastal management issues should be developed in the Public Beach Board. To a certain extent, this is already beginning to happen. Issues to be addressed at the state level could include: a long-term needs assessment of erosion problems, provision of technical information and services on beach erosion to Virginia municipalities, and research into innovative technologies for beach nourishment. The state should increase its funding of beach nourishment, particularly those projects that may not qualify for federal cost sharing.

Information Needs and Future Studies

The preparation of the study identified a number of information needs and future studies that should be performed to provide a better data base for making informed decisions on managing the City's beaches. These include:

- The preparation of routine profile studies on all of the City's beaches. This data base should be developed in a digital format which would greatly increase its retrieval and usefulness in analytical studies.

- Investigate the feasibility of using off-shore sand deposits as sources of sand for beach nourishment. Studies being undertaken by the Virginia Institute of Marine Science (VIMS) should be used.

- Investigate the feasibility of using near shore disposal of sand (also known as an "underwater stable berm") as a beach nourishment technique. The City, in cooperation with the Public Beach Board, has recently requested the Norfolk District of the COE to study the feasibility of the concept, known also as the Murdens Mound project.

1.0 INTRODUCTION

1.1 Program Objectives

For thousands of years shoreline changes have occurred along the Atlantic coast beaches of what is today the City of Virginia Beach (Figure 1-1). With the exception of the area around Cape Henry, the Virginia Beach shoreline from Virginia/North Carolina border north and west to the City of Norfolk has been eroding for over a hundred years. Between 1932 and 1946, beaches in the southern Resort area eroded by as much as 80 ft. while the beaches in the northern Resort area gained as much as 9 ft. In 1946 attempts were initiated to replenish the beaches with sand. Even with the beach nourishment efforts over the last 50+ years, erosional forces continue, placing more shoreline structures in risk of damage, especially during storm events.

The City commissioned this study to evaluate past trends and to look at existing and future land uses that would lead to the development of a shoreline management strategy for the City's beaches. Since many studies have been previously undertaken to look at various components of the beach erosion problem, this plan has been formulated from available data to aid local, state, and federal decision-makers in the areas of restoration and maintenance.

The plan is organized into five major sections. The first section is introductory in nature and provides descriptive summaries of existing land use and socioeconomic conditions in each of seven shoreline segments. Section 2 describes the existing physical characteristics of the Virginia Beach shoreline and how they affect shoreline stability. This section also includes summaries of shoreline changes and the effects of two major events -- the March 1962 storm and the Hurricanes of 1933. In Section 3, the plan presents a description of the previous efforts undertaken to control shoreline erosion in Virginia Beach. The roles played by various local, state and federal agencies in controlling erosion and in funding those controls are described in Section 4. Finally, the alternative approaches and potential sand sources for nourishment are discussed in Section 5. The shoreline management plan is presented in Section 6. Alternative engineering solutions are described and specific recommendations are provided for each shoreline segment where applicable. This section also includes a cost-benefit analysis used to determine which alternatives provide the greatest public benefits. A number of recommendations for future studies are also presented.

1.2 Coastal Development

This section presents a "thumbnail" sketch of the following beach segments in the City of Virginia Beach. Boundary definitions for each segment include:

- Chesapeake Beach: Little Creek Naval Base east to Woodlawn Avenue.
- Ocean Park Beach: Woodlawn Avenue east to the west side of Lynnhaven Inlet.
- Cape Henry Beach: The east side of Lynnhaven Inlet east to the western boundary of Seashore State Park.

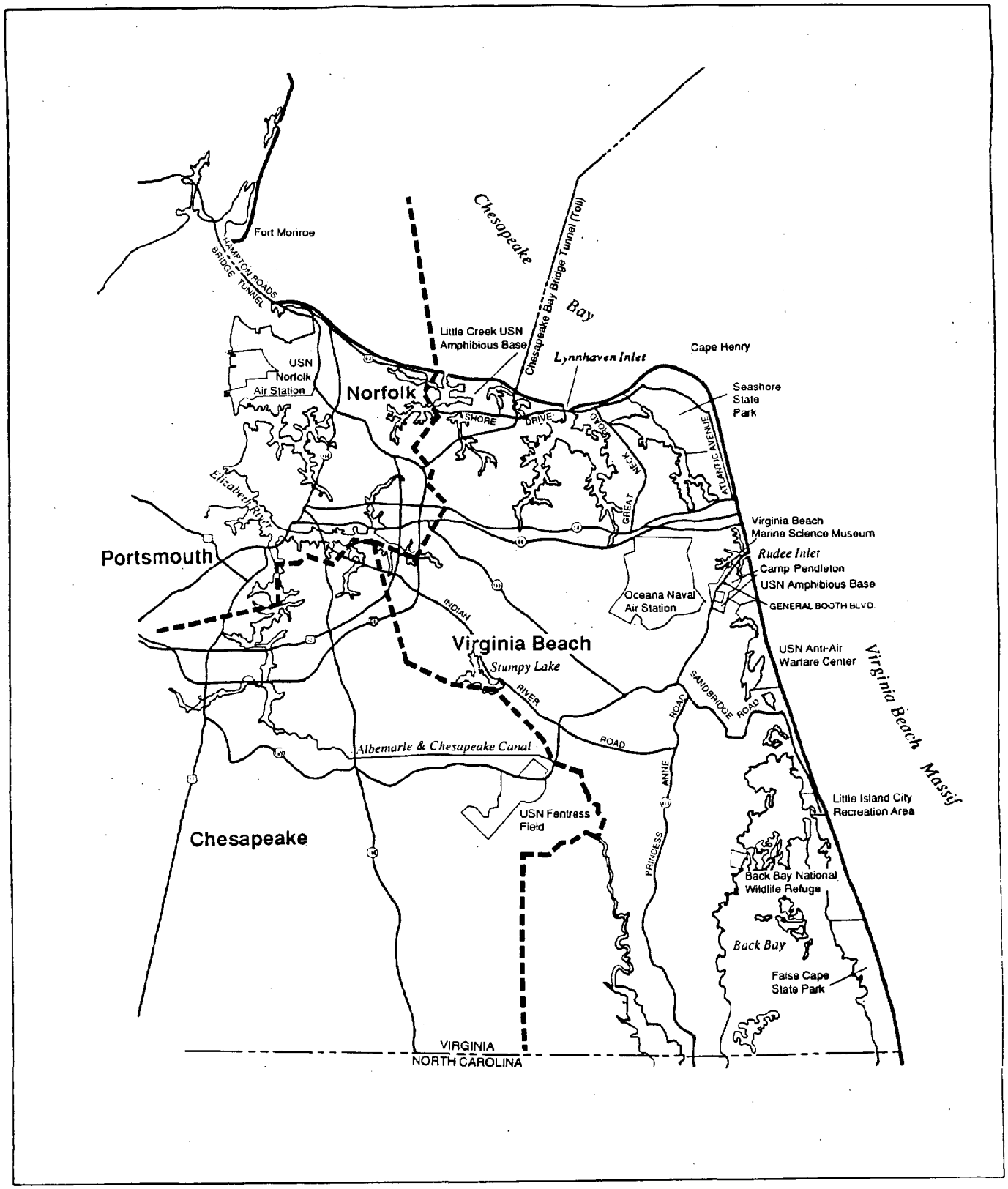

FIGURE 1-1

Regional Location Map

RGH

- o North Beach: The southern edge of Ft. Story at 89th Street south to 41st Street.
- o Resort Beach: 41st Street south to the north side of Rudee Inlet.
- o Croatan Beach: South side of Rudee Inlet south to Camp Pendleton.
- o Sandbridge: Dam Neck Naval Base south to the southern boundary of Little Island City Park.

These are shown in Figure 1-2.

This section describes each of these beach segments from a recreational perspective in terms of the types of uses that occur there, the support facilities present, (i.e., lifeguards, showers, public parking, etc.), and the land use characteristics of the adjacent shorefront areas. The land use information is based on a helicopter fly-over of the entire shoreline of Virginia Beach and a walking reconnaissance of the shorefront area the following day. A video camera was used both days to produce a visual record of the condition of the beach segments and the adjacent shorefront areas. The fly-over and the ground reconnaissance occurred during the second week of February, 1988. The recommended development mix for each segment is also presented as contained in the Virginia Beach Comprehensive Plan.

1.2.1 Chesapeake Bay Beach Segments

Existing Land Use Adjacent to Beach. The Chesapeake Bay Beach area is comprised of three separate beach segments: Chesapeake Beach (Figure 1-3), Ocean Park (Figure 1-4), and Cape Henry Beach (Figure 1-5). Due to common conditions among the three beach segments, we discuss the entire area as the Chesapeake Bay beach section, except when referring to specific characteristics such as land use & zoning, etc., or giving locations.

Zoning. These three beach segments comprise an area of mixed land use as determined from our fly-over and field surveys. Medium density, single family residential uses are found in the western part of Chesapeake Beach and the eastern part of Cape Henry. Closer to Lynnhaven Inlet (i.e., west from Great Neck Road to the inlet) commercial and high density residential land uses (e.g., condominiums, high-rise apartments) are located. Commercial and retail land uses are found along Shore Drive, a major east-west arterial road. According to the Comprehensive Plan, this section of Virginia Beach is an established community in which growth has stabilized with only 22% of the study area remaining undeveloped. However, much of this undeveloped land is floodplain and should remain undeveloped.

Current zoning for the Chesapeake Beach segments in areas immediately adjacent to the beach consists of medium and high density residential (e.g., R-7.5, R-5R, R-5S, R-2.5; and some PD-H1). Commercial zonings (B-4 Resort Commercial, and B-2 Community Business) are found along Shore Drive. Additional residentially zoned areas are found inland south of Shore Drive. Explanations of the various zoning codes are given in Appendix A.

Future land use recommendations in the Comprehensive Plan advise that the remaining small parcels of undeveloped land throughout this section which are primarily zoned residential, should not be considered for higher density development than is already permitted under existing zoning, to maintain "neighborhood compatibility." The Plan also recognizes that resort-related commercial growth will continue in the Cape Henry Beach

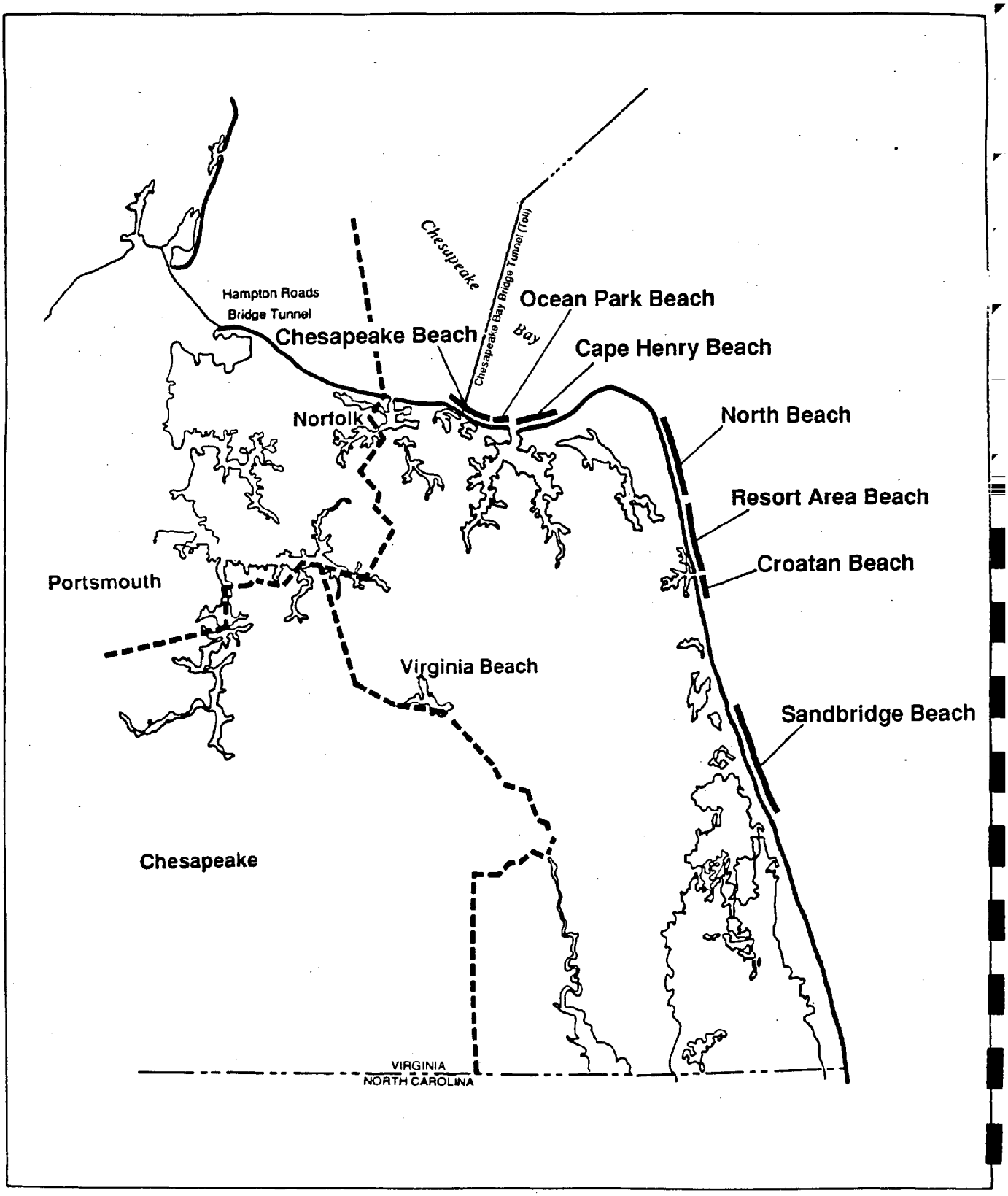

FIGURE 1-2

Beach Segments

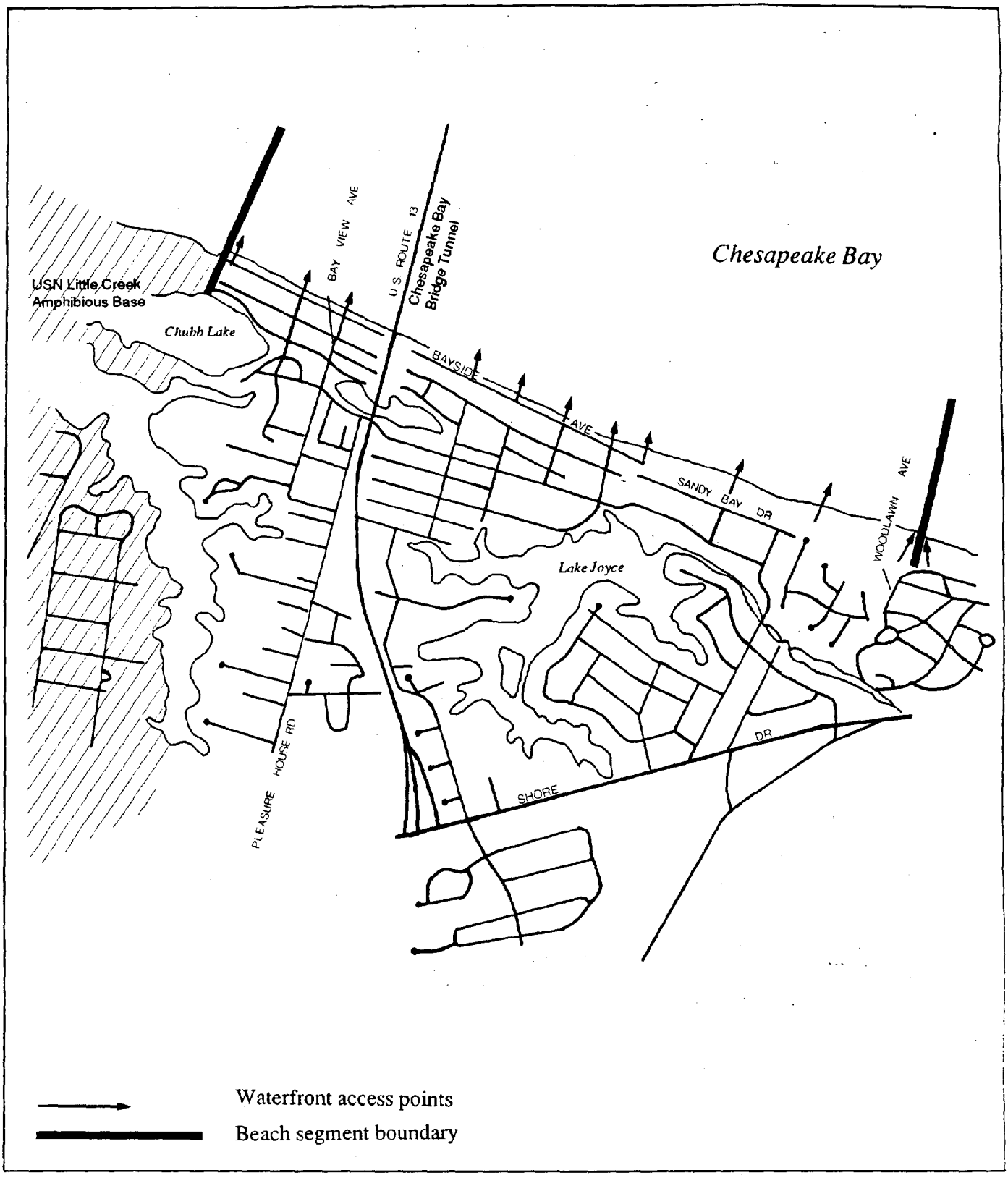

FIGURE 1-3

Chesapeake Beach

0 750' 1500'

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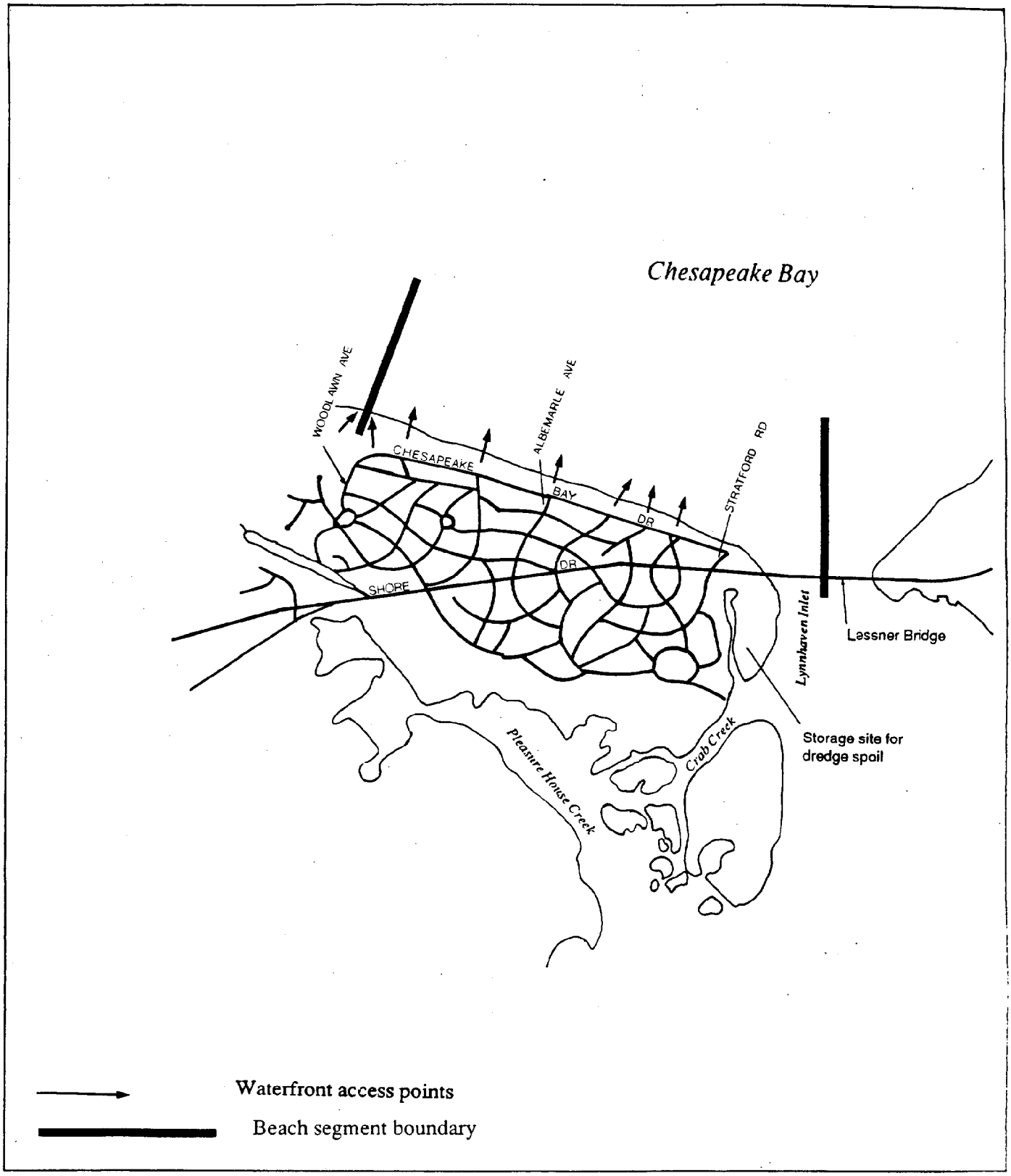

FIGURE 1-4

Ocean Park Beach

0 750' 1500'

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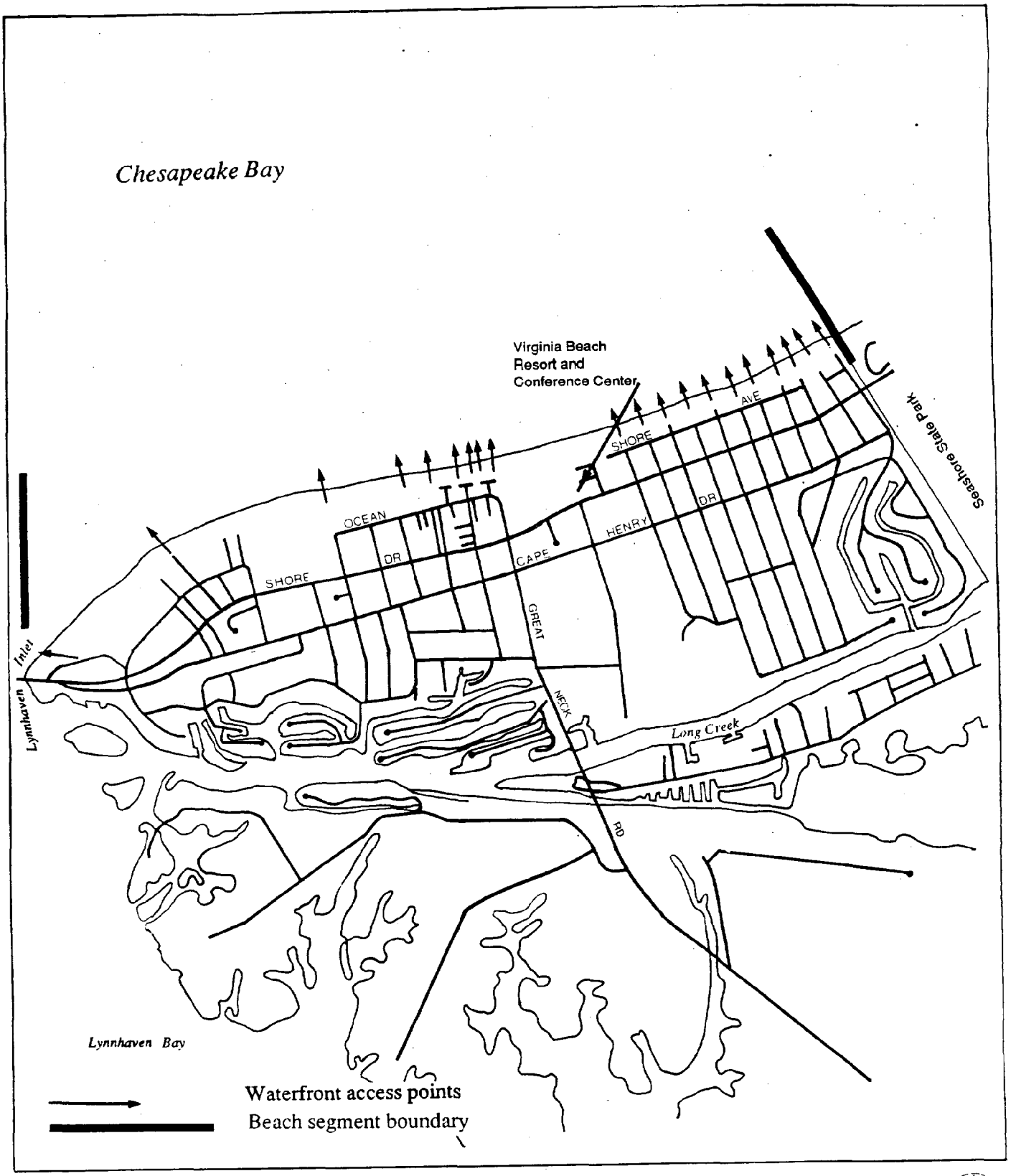


FIGURE 1-5

Cape Henry Beach

RGH

area, particularly in the B-2 zoned vacant area located just east of Great Neck Road. It appears likely that continued resort commercial growth in the western section of Cape Henry Beach will ultimately result in the formation of a new resort commercial activity node in this area.

Recreational Characteristics. Very little data on beach use exist for this area. The primary uses of the beach are sunbathing, swimming, and fishing at Lynnhaven Fishing Pier. The primary users of the beach appear to be residents of the adjacent areas who live within walking distance of the beach.

The City of Virginia Beach does not provide any public beach facilities or services such as life guards, showers, changing rooms and bathrooms in this area. Since no public facilities exist, day users would be the exception, with year-round residents and hotel visitors the rule.

Public Access to the Beach. The field survey indicated a number of public access points to the beach between beachfront, privately-owned residential properties. However, little if any parking is available near these access points so beach use is largely restricted to use by local residents. This was particularly true in Chesapeake Beach and Ocean Park. These access points are shown on Figures 1-3, 1-4, and 1-5.

The field survey indicated the presence of signs stating that sections of beach in front of several of the high-rise condominiums located just east of Lynnhaven Inlet were private.

Public Parking. Public parking is limited to on-street parking, with private off street parking at Fentress Avenue (Chick's Beach Baycove Restaurant) in Chesapeake Beach, with space for 40 cars; Duck Inn at the Inlet, at Lynnhaven Pier, and at Whaler, Ketch and Spinnaker Courts in the Cape Henry Beach section. Restaurant parking lots are often used by beach visitors before the restaurants open to serve dinner.

Beach Recreational Facilities and Services. The City of Virginia Beach does not provide any beach recreational facilities or services along the Chesapeake Bay beaches. Lifeguards are also not provided along the private beach sections controlled by the high rise apartments and condominiums. The City does provide trash pick-up along the Chesapeake Bay beaches.

Proximity to Other Resort Facilities and Resort Areas. Hotels and motels are located along Shore Drive near Lynnhaven Inlet. These include the Virginia Beach Resort and Conference Center Hotel on Croix Drive, an Econo Lodge, Comfort Inn and others. The Resort and Conference Center is located on the beach at the intersection of Shore Drive and Great Neck Road. The other motels are located south of Shore Drive. The total number of rooms available here is much less than those available in the resort section. Seashore State Park is located just to the east of Cape Henry. According to the 1984 Virginia Outdoors Plan, this is the most heavily visited State Park in Virginia.

Fort Story, North Beach and the Resort and Croatan beach sections of Virginia Beach are all easily accessible by taking Shore Drive south to Atlantic Avenue.

The Chesapeake Bay Bridge Tunnel (Route 13) which links tidewater Virginia with the southern Delmarva Peninsula enters Virginia Beach at the Chesapeake Beach area.

Restrictions on Beach Use. Beach use restrictions for the Chesapeake Beaches are listed in Appendix B. Section 6-108 of the City Code addresses the establishment of a boat harbor and marina for recreational and sport-fishing as well as terminals for commercial vessels in the Cape Henry bay area. Section 6-28 prohibits the use of fishing nets or lines in the waters of Lynnhaven Inlet.

Population Density. Two census tracts, 418 and 430.01 encompass the three Chesapeake Bay beach segments. The estimated 1988 population densities in these tracts are 4,888 and 4,201 persons per square mile respectively. This is the population density by permanent, year-round residents. Talks with a local realtor (Shephard, 1988) indicated that relatively little seasonal rental housing occurs in the three Chesapeake Bay beach segments. Thus, a dramatic increase in the summertime population does not occur.

Transportation Access. Major roads in this area include Shore Drive, Route 13 - Chesapeake Bay Bridge Tunnel, and Great Neck Road. Road systems in this area are deemed adequate to support current traffic volumes. Great Neck Road, however, experiences some traffic pressure. Corrective improvements to Great Neck Road are under construction and scheduled for completion in November, 1988.

The Virginia Beach Route 33 North Shore Trolley makes stops as far west in this section as Baylake Road in Ocean Park. Many restaurants, as well as Seashore State Park, North Beach, and the Resort Section are accessible by trolley. TRT Bus transit route 36 provides bus service all along Shore Drive from the Little Creek Amphibious Base to Great Neck Road. It also stops at Pembroke and Lynnhaven Malls, where other connections can be made, and then returns to Shore Drive.

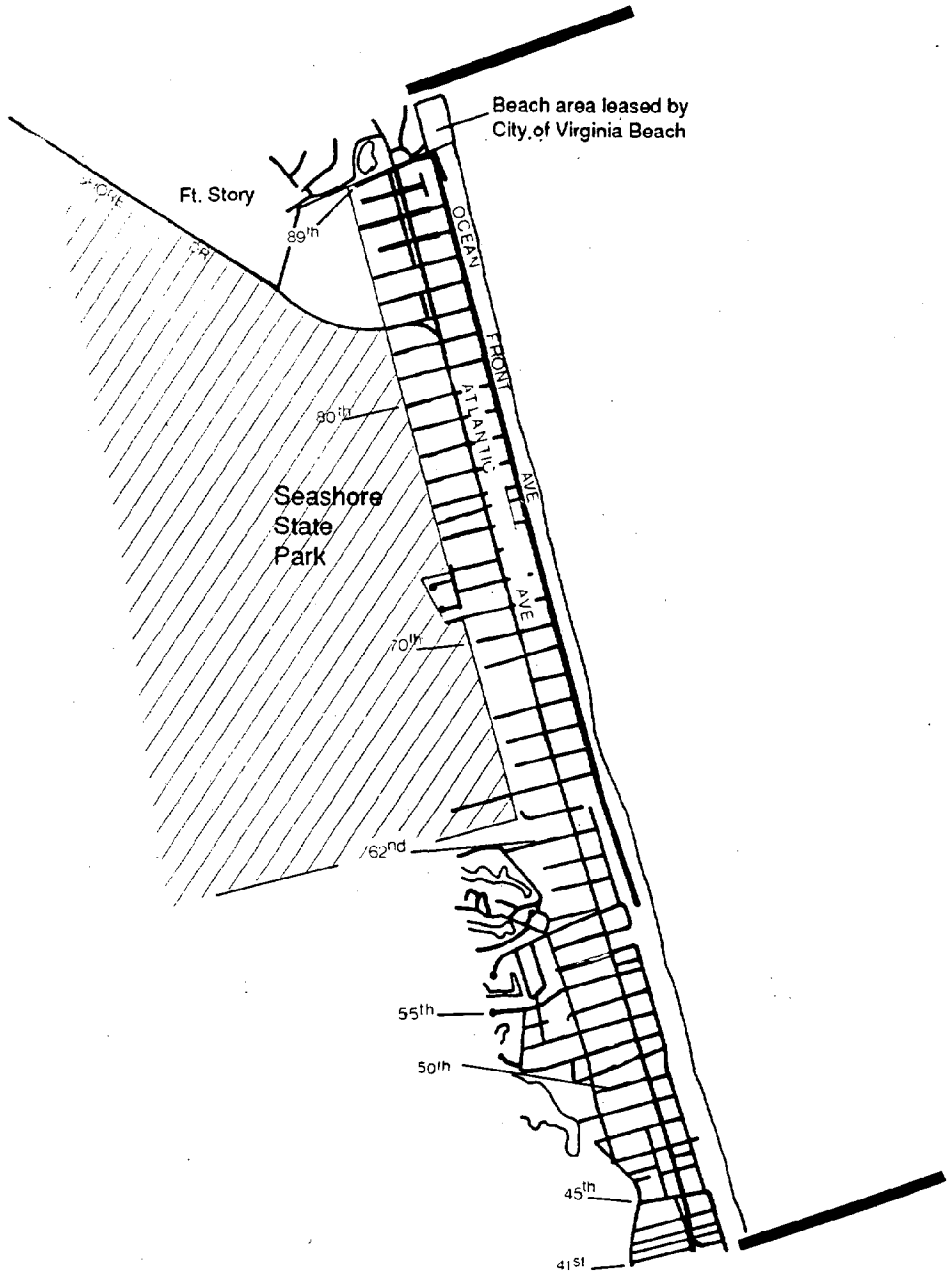
1.2.2 North Beach

Existing Land Use Adjacent to Beach. The North Beach segment (Figure 1-6) is a medium density, year-round residential area. Based on the field survey, this area appears to be an affluent residential area with expensive homes. The Comprehensive Plan describes this residential neighborhood as having a general land use policy of an "established single family and duplex residential use which should be preserved". Fort Story is the neighbor to the north, Seashore State Park to the west, and the Resort section is immediately to the south.

The residential land use pattern of North Beach is continuous from 89th Street south to approximately 45th Street. It consists primarily of single family, detached units, with an increasing trend toward condominium development. The non-residential uses located in North Beach include the Ramada Inn Ocean Site Tower located between 57th and 59th Streets, the Marshall Hotel at 66th Street between Atlantic Avenue and the beach, and the Navy Officers Club at 67th between Atlantic Avenue and the beach.

Zoning. Current zoning for the North Beach section consists of R-7.5 along Atlantic and Oceanfront Avenues. A small H-1 district is located at 57th and 56th streets encompassing the Ramada Inn Ocean Side Tower. Slightly higher residential zoning in the form of an R-6.5 district begins at 49th Street and extends south along Atlantic and Oceanfront Avenues to Cavalier Drive.

The Master Plan recommends that the entire North Beach area remain as a single family residential area, and that the existing single family and duplex residential uses be preserved. The only deviation from this is a small multi-family and commercial zone around the Ramada Inn.



Beach segment boundary

NOTE: Beach access Points from Oceanfront Avenue to the Beach exist at all but 75th, 43rd and 41st streets and at side streets between 55th & 56th, and 45th and 46th.

FIGURE 1-6

North Beach

0 1320' 2640'

RGH

Recreational Characteristics. Dominant types of beach use include sunbathing and swimming in this section. According to John Coates of the City's Department of Parks and Recreation, North Beach is heavily used on summer weekends, but not to capacity. Comparatively less parking exists in this section than at Croatan. According to Reed Jeavons, also from the Department of Parks and Recreation, volleyball nets are provided at 68th Street. Catamarans can be used on this beach if they carry a city permit.

Beach user surveys or statistics have not been compiled or documented for this section. North Beach has use characteristics similar to the Chesapeake Bay beaches as use is primarily by residents of adjacent shorefront residential areas. However, North Beach is also used by visitors to the Resort Area who walk northward up the beach and boardwalk, or take the Route 33 North Seashore Trolley. Little seasonal rental housing is present in North Beach.

The City rents a 19-acre parcel from Ft. Story (see Figure 1-5) that includes 885 ft. of beach with swimming the only activity permitted. The adjacent parking lot has room for 200 cars. Two or three lifeguard stands and portable toilets are provided by the City. This section of Ft. Story is open for use on Fridays, Saturdays, Sundays and holidays during the season, with Sunday the heaviest use period (Jeavons, 1988). Representatives of the City's Department of Parks and Recreation indicated that the Ft. Story beach is a somewhat under-utilized resource (Jeavons, 1988). Possible reasons for this include remoteness from the Resort Area, and possibly not enough persons being aware of this resource.

Public Access to the Beach. Public access to the beach has been inventoried in the Virginia Beach Waterfront Access Study. A right-of-way (ROW) is located at almost every block, with sandy walkways providing access between Oceanfront Avenue and the beach. Limited on-street parking exists in the residential neighborhoods of North Beach, although some parking improvements have been made recently. Some of the streets have up to four parking spaces at an access point.

Public Parking. No public parking lots are provided throughout this stretch of beach with the exception of the Fort Story public parking area. Only on-street parking is permitted.

Recreational Facilities and Supports Services. Life guards in North Beach are provided by hotels and condos in the vicinity of 41st, 42nd, and 57th Streets. The City does not provide lifeguards, public bathrooms or changing areas, and concessions north of 41st Street. This section has no boardwalk as it ends between 38th and 39th Streets. The City does provide clean-up services for North Beach.

Proximity to other recreational/resort facilities. Fort Story sponsors tours of the historic Cape Henry Lighthouse and also sponsors triathalon events which attract many olympic competitors, as well as other marathons and festivals. These attractions, according to Fort Story's Director of Recreation, provide a great service to the City by attracting visitors away from the already congested Resort section.

Seashore State Park borders North Beach to the west and has an extensive bike trail which cuts across North Beach and into the resort area. The Resort area lies directly to the south of North Beach and is easily accessible by walking, bicycling or driving south on Atlantic Avenue.

Relatively few homes available for seasonal or weekly rental are present in North Beach. The only hotel/motel accommodations are at the Ramada Inn between 56th and 57th Streets and the Marshall Hotel at 66th Street. Seashore State Park has camping facilities.

Restrictions on Beach Use. Many of the same restrictions applicable to the Resort Section also apply to North Beach (see Appendix B). However, ball playing (Section 6-3 of the City Code), fishing (Section 6-30), and use of sailboats and catamarans with permits (6-114) are allowed in North Beach.

Population Density. The estimated 1988 population density in the two Census tracts, 434 and 436, that comprise most of North Beach (as far south as 49th Street) are 4,302 and 4,388 person per square mile. Once again it should be noted that these are for year-round residents. The seasonal population density in the North Beach segment would rise only slightly during the summer as there are relatively few seasonal housing units for rent.

Transportation Access. Major roads in this area include Atlantic and Oceanfront Avenues running north/south the entire length of North Beach. Oceanfront Avenue is a narrow, two-lane urban secondary street that only provides access to and from the residences located in North Beach. Atlantic Avenue is an urban arterial which conducts traffic from the Resort Area toward Shore Drive and the Chesapeake Bay beaches. The 1987 24-hour traffic count for July 8th and 9th on Atlantic Avenue between 71st and 72nd Street was recorded at 19,810 vehicles. Between 44th and 45th on Atlantic traffic volume increased to 27,980 vehicles.

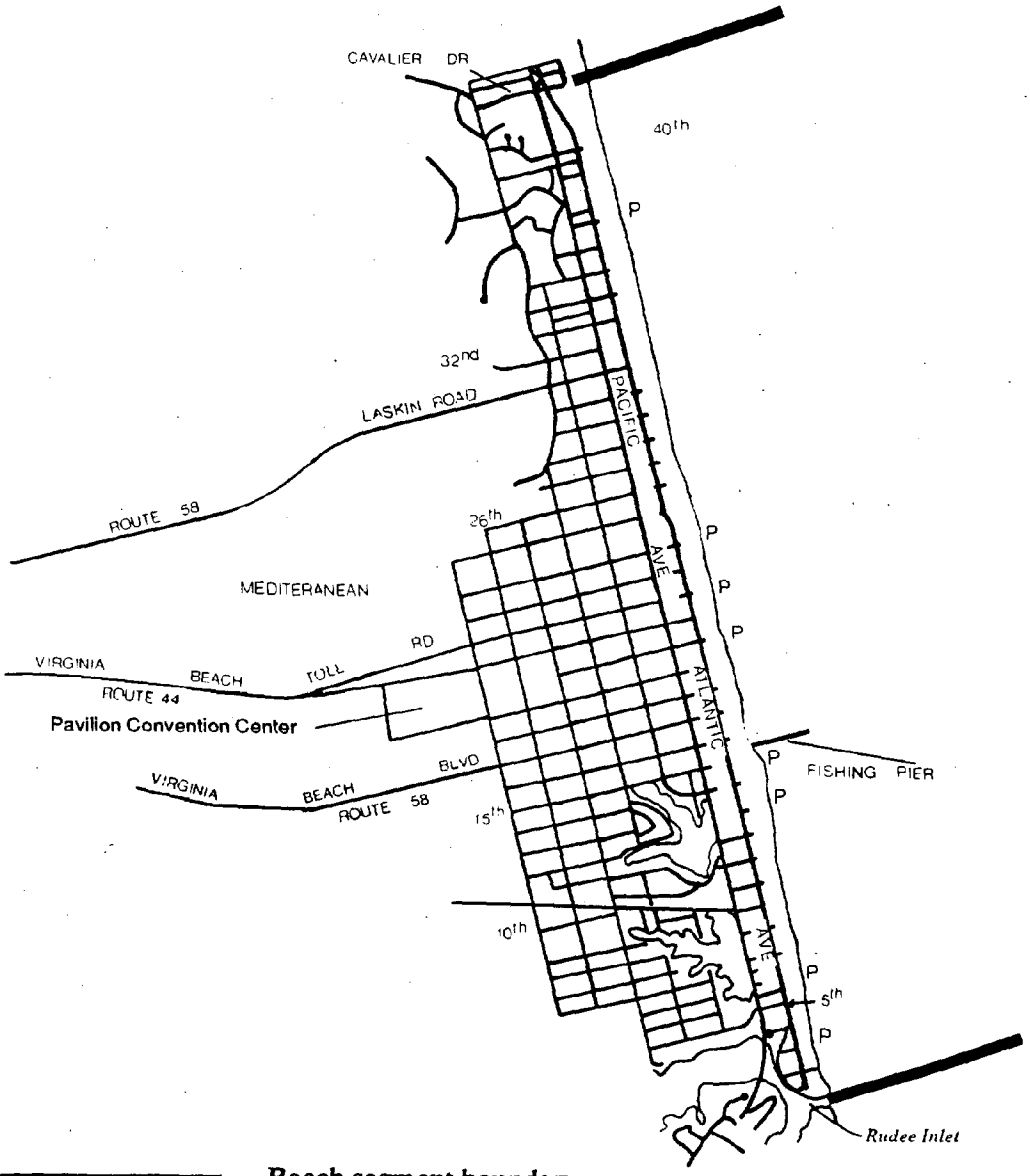
Mass Transit. The Route 33 North Seashore Trolley provides service between the Resort Area and North Beach. It begins at 9th and Atlantic Avenues and makes stops along Atlantic Avenue at 64th Street, 67th Street, Cape Henry Lighthouse, Fort Story, Seashore State Park Campgrounds, Lynnhaven Fishing Pier, Lynnhaven Inlet, and Baylake Road. It connects to other lines at Ninth Street.

The Route 20 Virginia Beach Boulevard bus line has local and express service with stops at Fort Story, 87th and Atlantic, 68th and Atlantic, and continues through to 19th Street, and Laskin Road, and Virginia Beach Blvd., west to City Hall in downtown Norfolk.

1.2.3 Resort Beach

Existing Land Use. The Resort area (Figure 1-7) is the "original Virginia Beach." Lining the beaches along this section (east of Atlantic Avenue) are many highrise hotel/motel structures. Tourism-related land uses are found along Atlantic and Pacific Avenues, which include restaurants, souvenir shops, clothing stores, night clubs, etc. Intermixed with these tourism-associated services are churches, municipal service buildings, high schools, and professional offices characteristic of a more permanent resident population.

Zoning. The City has proposed a rezoning of the Resort Beach area. The strip between the beach and Atlantic Avenue, from 41st Street south to Rudee Inlet, is proposed as a RT-1 (Resort Tourist District). The purpose of this district is to provide an area for high density, high rise resort hotels and their accompanying uses. An RT-2 district is proposed for the strip between the west side of Atlantic Avenue and the mid-point of the block between Atlantic and Pacific Avenues (i.e., this district is only a half a block



Beach segment boundary

P: Parks Located between Atlantic Avenue and the Boardwalk

NOTE: Beach access Points from Atlantic Avenue to the Boardwalk exist at all but 32nd, 23rd, 21st, and side streets between 6th & 7th, and 5th.

FIGURE 1-7

Resort Beach

0 1320' 2640'

RGH

wide). This district is also intended as a location for high density resort hotels and complimentary uses. It also acts as a transition zone between the intensely developed shorefront and the less intensely developed resort commercial district that exists west of Pacific Avenue. The remainder of the Resort area would be zoned RT-3. This includes the corridor between Virginia Beach Boulevard on the south and Route 44-22nd Street on the north extending west to Birdneck Road. The intensity of resort development would be less in the RT-3 district, with the maximum intensity of hotel development limited to 80 lodging units/acre as opposed to 160 units/acre in the RT-1 district.

The proposed changes would confine further high intensity resort hotel development and associated services to the prescribed areas, while allowing for associated uses. The rezoning is also intended to foster good design and development patterns through use of incentives. The rezoning recommendations are that expansion of high intensity resort development to the west should be considered on a "case-by-case basis" considering:

- o The current extent of tourist development in immediate area,
- o Existence of permanent residences in immediate area,
- o Compatibility with surrounding uses.

The Urban Land Institute (ULI) Report, conducted for the Resort Area Advisory Commission (RAAC), advised the City to amend zoning, subdivision, and site planning standards to:

- o Establish landscaping and site plan guidelines,
- o Provide incentives and flexibility to builders and developers to offer these amenities.

Recreational Characteristics. Dominant types of beach use include sunbathing, swimming and surfing. Surfing is restricted to certain times and locations as detailed in Appendix A. According to the Preliminary Comparison of 1987 Visitors from Boardwalk and Convention Surveys, compiled by the Resort Programs Office:

- o The highest percentage of visitors were from Virginia, New York, Pennsylvania, Ohio, New Jersey, Maryland and Canada. These states and Canada accounted for a combined 48.9% of all visitors.
- o Metropolitan areas with the highest percentage of visitors include Washington, D.C., New York, NY, Richmond, VA, Pittsburgh, PA, Philadelphia, PA, Hampton Roads, VA, Roanoke, VA and Boston, MA.
- o Close to 54% of the visitors surveyed were enjoying either a primary or secondary vacation. Weekend visitors accounted for 27.7% of the total.
- o 69% stayed at hotel/motels, 19% stayed with friends/relatives, 12% in cottages/campers.
- o Average length of stay was 4.3 days

- o No estimates exist for percentage of Virginia Beach year-round residents who use the beach on or off-season. However, the ULI report mentions that year-round residents tend to avoid the beach during the season because of the crowds.

The primary source for statistics on the use of the Resort and North Beach segments is a 1983 report by the U.S. Army Corps of Engineers (COE), Norfolk District -- a Recreation Benefit Analysis for Virginia Beach as part of a Beach Erosion Control and Hurricane Protection Study. The survey taken during the summer of 1981 gives the following estimates of use:

- o Total seasonal demand for the beaches between 1st and 89th Street from 12:00 PM to 2:00 PM was 1,406,500 persons in 1982. This number represents the total number of persons that were estimated to use these beaches over a 100 day season between 12 and 2 PM, including both weekdays and weekends.

- o Approximately 59% of the peak hour use over the course of the season occurs in the Resort segment. The peak hour counts were used as these drive the design capacity of the beach.

- o About 37% of the total seasonal, peak hour demand occurs during the 30 weekend days, which have the highest demand for beach space.

- o During weekends, 60% of the total use of beaches between 1st and 89th Streets occurs in the resort segment (1-42st Streets); during weekdays 58% of the use occurs in the resort segment.

- o On weekend peak hours on the resort beaches 81.4% of the total demand comes from overnight visitors; during weekdays overnight visitors account for 68.9% of the demand. In contrast, only 33.8% of the weekend peak hour demand in North Beach is from overnight visitors to Virginia Beach, while only 55.6% of the weekday peak hour demand is from overnight visitors.

The Corps study did not estimate total daily beach use for either weekdays or weekends as the purpose of their analysis was on design of the beach, which is determined by use during peak demand periods (i.e., between the hours of 12 and 2 PM). The conversion of peak period use to total daily beach use depends on the proportion of total daily use that occurs during the peak hours. Assuming an 8 hour day (10 AM to 6 PM), it would not be correct to assume that the peak period accounts for 25% of total daily use (2 peak use hours/8 total daily use hours) as the beach is, by definition, more fully utilized during the peak hours than during any other period. Thus, the proportion of total daily use that occurs during the peak hours would be greater than 25%.

Using the turnover factor of 1.8 (the number of persons/day that use a particular area on the beach-assumed to be 100-150 square feet/person) in the Corps study, the total seasonal (100 days) use of the beaches between Rudee Inlet and 89th Street in 1982 could be conservatively estimated to have been 2,531,700 persons, with 950,400 of these beach goers using the beach on weekend days, and 1,581,300 on weekdays. The use of this turnover factor assumes that peak hour use accounts for 55% of total daily beach use.

If it was assumed that peak period use represented 33% of total daily use, the above numbers in 1982 would have been 4,219,500 persons (total seasonal use between Rudee Inlet and 89th), 1,584,000 persons (weekends), and 2,635,500 persons (weekdays).

Public Access to the Beach. Beaches in the resort segment are very accessible to the public. Visitors can go directly from the boardwalk onto the beaches at any point between 38th & 39th (the end of the boardwalk) and Rudee Inlet. Public access ROW's are available at almost every block that enable beach users to go from Atlantic Avenue to the Boardwalk.

The City is developing a number of connector park projects along City streets and ROW's between Atlantic Avenue and the Boardwalk. Currently, new parks have been developed for ROW's at 3rd, 7th, 13th, 14th, 20th, 22nd, 24th, and 37th. The park at 24th was a vacant parcel that a citizens group did not want to see developed. Through the money they raised and City funding, the site was purchased and will be used as an open entertainment area with a temporary stage during the summer of 1988. Portable restrooms will be provided. Permanent use of this park has not been decided.

The connector park concept envisions development of connector ROW's at three levels. The highest would be on the level of the 24th Street park. Next would be areas with footwashing and vending facilities; the lowest level would be ROW's to the beach. The City plans to develop four more during the 1988/89 winter, and so on, until all connectors are developed into one of the three types of connector parks.

Public Parking. Parking is provided at several locations throughout the Resort section. The Convention Center Dome at 19th Street has parking for 212 cars on one lot and 225 spaces across the street at a municipal lot. The City's Tourism and Economic Development Office indicates that there is no charge for space in these lots. The Pavilion has space for 1,000 cars and 22 buses.

The Resort section has an estimated 620 metered parking spaces on Atlantic and Pacific Avenues from Rudee Inlet north to 30th Street. Some permitted restaurants which open only for dinner may open their lots to beach users for a nominal fee.

Beach Recreational Facilities and Services. Lifeguards are provided by the City and are stationed every 325 ft. (approximately 1 per block) from Rudee Inlet to 41st Street with five auxiliary stands to be placed as needed. Lifeguard service will be provided for a "shoulder season" this year which will begin two weeks before Memorial Day and extend to two weeks after Labor Day. Lifeguards are on duty from 9:30 a.m. - 6:00 p.m. All lifeguards are first aid certified. Lifeguard supervisors are Emergency Medical Technicians and are stationed one supervisor per eight blocks or stands. They ride on bicycles in their assigned patrol area.

Firms providing the lifeguard services also gain the right to the concessions for renting rafts, boogie boards, beach umbrellas, and beach chairs. Concessions are run through a vending program, whereby franchises are given to pushcart operators. These operators stay within certain areas on the boardwalk, and sell only food. Current locations are parks at 13th, 20th, 22nd, and 37th Streets. The boardwalk extends from just north of the Inlet to between 38th & 39th Streets.

Public restrooms are provided at 17th, 19th and 30th Streets. No public shower facilities exist in the resort area. Footwashing facilities can be found at 3rd, 7th, 20th, and 22nd Streets.

Proximity to other Resort Facilities. The resort beaches are located close to most of the major resort hotels and motels, restaurants, souvenir shops, etc. The

Pavilion Convention Center is located between 21st and 19th streets on the west side of Parks Avenue, six blocks west of Atlantic Avenue. Bicycles are available for rent at locations throughout the resort area. Tennis facilities are within reach either by driving or by trolley. The Maritime Historical Museum is located at 24th Street and Atlantic Avenue and an oceanfront park is located at the end of 24th Street. A privately-owned fishing pier is located at 15th Street. The land under the pier is public and leased from the City.

Several major tourist attractions are located a short distance southwest from the Resort Area down General Booth Boulevard. These include the Virginia Marine Science Museum, Wild Water Rapids, several campsites and the Red Wing Golf Course. The Sandbridge section of Virginia Beach lies to the south of Croatan, Camp Pendleton, USN Amphibious Base. Route 629 (Sandbridge Road) is the only access road from the Resort area and involves some distance going around the military bases. The North Beach section of Virginia Beach is accessible by walking, biking or driving a short distance north on Atlantic Avenue or by public transportation. The Ft. Story and Chesapeake Bay beaches are located further away.

Accommodations. As of 1988, a total of 9,837 hotel/motel units were listed in Virginia Beach, most of which are in or immediately adjacent to the resort strip. Adding in another 377 non-listed units and 398 condominium units gives a total of 10,612 available units. Accommodations in the resort strip (which encompasses the resort strip between the Boardwalk and Atlantic Avenue) include 4,987 hotel/motel/condo units. Extending one mile to the west, beginning at the west side of Atlantic Avenue, are another 2,884 hotel/motel units and 98 condominium units. Virginia Beach has six campgrounds with a total of 2,510 sites.

Restrictions on Beach Use. Use restrictions also apply to beach-related activities along the Resort Area beaches. These are contained in the Virginia Beach zoning ordinance. Relevant sections from the zoning ordinance are presented in Appendix B.

Population Density. Estimated population density of year-round residents in the two census tracts, 438 and 440, comprising the Resort segment is 3,803 people per square mile. This is considerably lower than the population density in the other shorefront sections of Virginia Beach. However, this is to be expected given this area has a large concentration of hotel and motel units, along with resort-related retail and service establishments. It should also be noted that census tract 440 includes all of the Croatan area plus the residential area located between Laskin Road and Route 44 and lying west of Parks Street. Within the resort area between the boardwalk and Pacific Avenue the year-round population density would be much lower than the above number.

According to the City, approximately 7,970 hotel/motel/condominium units are present in the oceanfront and adjacent areas. Assuming that all of these accommodation units lie within the two census tracts that contain the Resort Area, an average of 3.3 persons per hotel room (City of Virginia Beach, Tourist Development Division, 1988), and that all units are occupied, the summertime population in these two tracts would be about 26,300 persons. Including the 17,100 year-round residents, the seasonal population density would be at least 9,667 people per square mile.

Transportation Access. Major roadways through the Resort Area include Atlantic and Pacific Avenues, which run north/south direction paralleling the oceanfront. Major

east/west roads for the Resort Area include Route 58 (Laskin Road), Route 44 (Norfolk-Virginia Beach Toll Road), and Route 58 (Virginia Beach Boulevard). Traffic volumes (24-hour) for these roads in 1987 on weekdays in July (mid season) received from Virginia Department of Transportation (VDOT), Traffic Engineering are as follows:

- Atlantic Avenue at 17th and 18th - 24,280
- Pacific Avenue at 17th and 18th - 23,130
- Laskin Road at Oriole & Barberton Drives - 25,780
- Virginia Beach Boulevard at Great Neck & Laskin Road - 31,720

No estimates for weekend counts are available along these roads, but significantly heavier volumes are expected. Other major roads include: General Booth Boulevard, Birdneck Road, Lynnhaven Parkway all with counts in the same range or higher.

Mass Transit. Three bus lines, operating under the Tidewater Regional Transit Authority, service various sections of Virginia Beach and its resort area. They are routes 36 - Independence, which provides service to the Amphibious Base, TCC, Pembroke and Lynnhaven Malls, Virginia Beach General Hospital, Hilltop, and Westminster Canterbury. The line follows along Shore Drive to Great Neck Road, Laskin Road, Lynnhaven Parkway and Mall, crossing over Virginia Beach Boulevard and back up to Shore Drive.

Route 20 - Virginia Beach Blvd. provides express and local service to Virginia Beach Oceanfront section, Hilltop, Pembroke Mall, Military Circle, Waterside, Great American Outlet Mall, and Fort Story. The route originates at Fort Story follows Atlantic and Pacific Avenues to Virginia Beach Boulevard, to Pembroke Mall to City Hall and back.

Route 37 - Lynnhaven provides service to Dam Neck, Oceana, Lynnhaven Mall, Virginia Beach Oceanfront, and Hilltop. The route originates at Dam Neck north to Dam Neck Road, connects to London Bridge Road, north to Lynnhaven Mall, east on Va. Beach Boulevard through Hilltop to Laskin Road, south at Pacific and General Booth Blvd.

Connection points to other bus and trolley lines are available. Sandbridge, Seashore State Park, False Cape and Back Bay Parks are not accessible by public transportation from lines which service the Resort Area and other Virginia Beach communities.

Seasonal Trolley Service. A seasonal trolley service operates from as early as May 9 - September 27 daily. Service is every 10-15 minutes on Route 30 - Atlantic Avenue Trolley, and runs along the beachfront from Rudee Inlet to 42nd street from 10 a.m. to 2 a.m. During conventions at the Pavilion, when public transportation is in demand by a large group at one location; the Atlantic Avenue trolley will be diverted from their regular route and function as a shuttle service making irregular stops from hotel accommodations to convention attractions.

The Route 31 - South Rudee Trolley runs every 30 minutes from KOA campgrounds beginning at 8:05 a.m. to 10:05 p.m. From Atlantic Avenue and 25th street this line operates from 8:30 a.m. to 9:30 p.m. This route runs southwest along General Booth Boulevard south to the Red Wing Golf Course on Prosperity Road. It provides service to the Owl Creek Tennis Complex, the Virginia Marine Science Museum, Wild Water Rapids, and several campgrounds.

Route 32 is the Lynnhaven Mall Trolley which provides service every 90 minutes. This line services Lynnhaven Mall, Atlantic Avenue, 9th Street and the Pavilion. Route 27 is the Boardwalk Trolley with service every 45 minutes and travels from 6th Street to 36th Street. Lastly, the Route 33 North Seashore Trolley with service every 90 minutes from 9 a.m. to 5 p.m. and every 45 minutes until 12:00 a.m., makes stops in the North Beach section, Fort Story, and Seashore State Park. Connections from one route to the other can take place at several locations including 9th, 19th, and 42nd Streets.

1.2.4 Croatan Beach

Existing Land Use Adjacent to Beach. The Croatan section (Figure 1-8) of Virginia Beach extends from Rudee Inlet on the north to Camp Pendleton Beach at Lockhead Avenue on the south. Existing land use in this section of Virginia is residential, with single family detached construction being the dominant use. Marinas are located along Lake Wesley.

Zoning. Current zoning for the Croatan segment is medium density residential, consisting primarily of R-5s for the three beach blocks; with a few commercial districts (B-4) for the marinas. Lower density residential zoning, R-6 and agricultural zoning, A-1 is found back toward Lake Rudee.

The Master Plan recommends that the entire Croatan area remain as a single family residential area.

Recreational Use. Dominant types of beach use include sunbathing, swimming and surfing. The first 800 ft. south of the inlet is a designated surfing area. The remaining beach down to Camp Pendleton Beach is swimming only. The City does not provide lifeguards between the surfing area and Camp Pendleton. Residents opposed the concessions, which are included with life guard services, because they felt their presence would draw more beach users.

The City leases 600 ft. of the Camp Pendleton beach (see Figure 1-8) on an annual renewal basis, along with a parking lot behind the beach. This is used as a surfing beach only. Both the Croatan and Camp Pendleton beaches on a peak summer weekend are used to capacity because of the availability of on-street parking in the residential area and the parking lot at Camp Pendleton.

Officials at Camp Pendleton feel the beach is a day use beach by people living nearby, and to a lesser extent by people who drive to Croatan and park in the lot or on the side streets. It is estimated (Mendenhall, 1988) that daily use of the Camp Pendleton beach is 50% higher on weekends. In addition, the southern portion of Croatan is currently undergoing additional residential development, and the feeling is that these new residents may not appreciate their streets being used as all day parking areas. Croatan also has its share of day visitors, in addition to its residents and renters.

Public access to the beach from South Atlantic Avenue is shown in Figure 1-7. Public parking is available on-street and off-street on Vanderbilt Avenue at the Camp Pendleton parking lot. This lot has space for 300 cars. A parking fee of $3.00/day is charged.

Beach Recreational Facilities and Services. As mentioned previously, a life guard station is provided for the surfing area at Croatan located immediately south of Rudee Inlet. The City also provides life guards at the Camp Pendleton Beach. No public facilities exist at Croatan. The City provides portable toilets at Camp Pendleton.

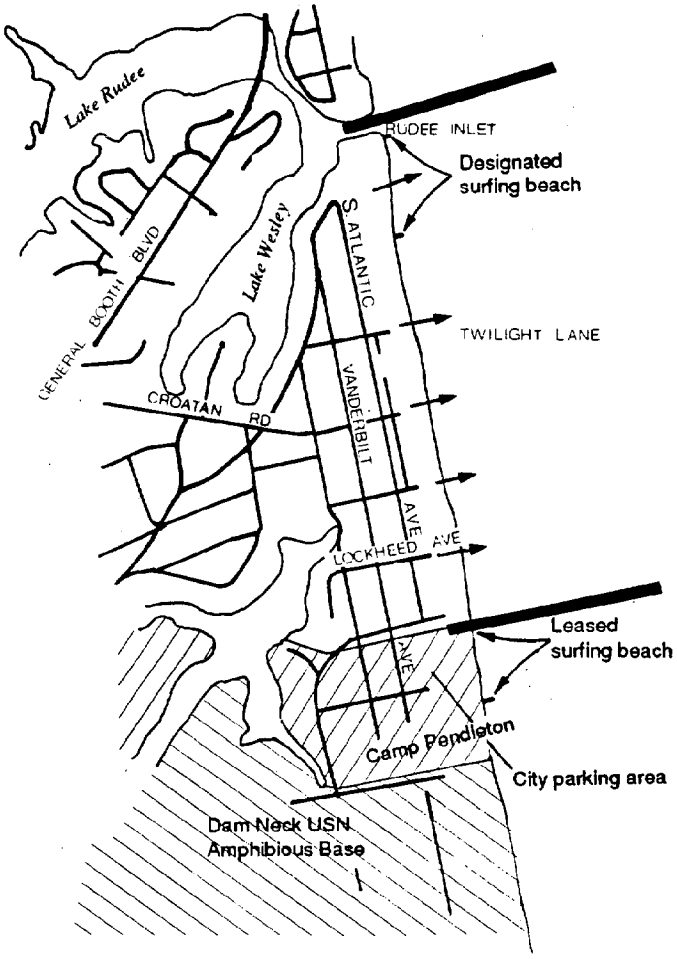


FIGURE 1-8

Croatan Beach

Proximity to other Resort/Recreation Facilities. The resort area can easily by reached from Croatan via General Booth Boulevard and Croatan Road. The same is true for Red Wing and Hell's Point Golf Courses, the Owl Creek Tennis Center, and the Virginia Marine Science Museum. Croatan's close proximity to the Resort Area enables visitors to venture in for dinners on occasion, yet is far enough to enjoy the residential setting as opposed to the more intense, high density, high rise pattern of the Resort Area.

Accommodations include the resort hotel section just a mile or so to the north and two campgrounds just off General Booth Boulevard to the west. Hotel and motel accommodations of the resort segment are located immediately to the north of Croatan. The accommodations located at the southern end of the resort segment are within walking distance of Croatan.

Restrictions on Beach Use. Many of the same restrictions apply from those mentioned in the Resort Section. Some specific references to Croatan from the city code are:

- Section 6-3b - . . . whereby the city manager is authorized to designate areas within the sand beach of Croatan Beach where activities such as playing ball or using a frisbee or any activity of like kind may be allowed. Such areas shall be designated with appropriate markers.
- Section 6-18 - Rudee Inlet jetties designated as unsafe areas.
- Section 6-116a4 - designates the surfing areas at Croatan, Section 6-116b - surfing not permitted in Inlet area.

Population Density. Croatan is a small part of Census tract 440 which also includes all of the resort section up to Laskin Road (31st Street). The current estimated year-round population density in this census tract is 5,375 persons/square mile. This figure is probably low for Croatan as tract 440 includes the resort strip where there are comparatively few permanent residents, and because the residential concentration within this tract is concentrated in Croatan. Given census tract 440's density for year-round housing units 2,971 units/square mile, the year-round population density in Croatan is much higher than the above figure.

Transportation Access. General Booth Boulevard proceeding southwest from the Resort Area and Croatan Road going eastbound from General Booth comprise the major access route into Croatan. Local streets providing access within Croatan are Vanderbilt and South Atlantic Avenues, running north/south. There are no 1987 24 hour traffic counts for these roads, except the already mentioned General Booth Boulevard and Dam Neck Road intersection (Dam Neck lies southwest of Croatan), with a fairly high count of 39,950.

Mass Transit. No bus routes or trolleys directly service Croatan. The closest bus line would be the Route 37 line with stops at NAS Oceana barracks, or Dam Neck Barracks. The Route 31 South Rudee Trolley can be accessed at Red Wing Golf Course, KOA Campsite, Holiday Inn Campsite, Owl Creek Tennis Courts and two other locations along General Booth Boulevard.

1.2.5 Sandbridge

Existing Land Use. The Sandbridge section (Figure 1-9) of Virginia Beach is bordered on the north by the Dam Neck USN Amphibious Base and Fleet Combat Training Center

Atlantic; and to the south by the Back Bay National Wildlife Refuge. This section of Virginia Beach is a very narrow 3-block stretch of land with the Atlantic Ocean to the east, and the North Bay and the eastern Courthouse section to the west. It includes the city-owned Little Island Park located at the southern part of the segment. Existing land use in this section of Virginia Beach consists of 1,200 single family homes. The overwhelming land use in Sandbridge consists of single family, detached residential units on lots ranging between 1/4 and 1/2 acre. The smaller lots are located on the beachfront, the larger ones back in away from the shore.

Approximately 500 homes are occupied by year-round residents, 600 are rental properties handled by Siebert Realty or Kabler/Riggs Realty, and the remaining 100 are rented by owners. A few open beach lots remain, with most houses having little to no setback from the beach.

Zoning. Current zoning for the Sandbridge consists of medium density residential zones (e.g., R-20, R-15), with two B-4 districts (Resort Commercial) near Sandbridge and Sandfiddler Roads, and near Little Island City Park. The eastern shore of Back Bay is zoned agricultural. The Park is zoned as a P-1 Preservation District.

The Comprehensive Plan describes Sandbridge as "primarily resort oriented but of a residential nature." It is recommended to remain as a predominately single family residential area. The only designated commercial node is the intersection of Sandbridge and Sandfiddler Roads.

Sandbridge is included with the Courthouse section in the Comprehensive Plan. This planning area is described as "the area of the city most likely to change in the years to come," with most of this growth expected to occur in the Courthouse area. South of Sandbridge Road adequacy of public facilities is an issue. According to the Plan, "the Sandbridge area should experience residential infilling at densities compatible with existing zoning. Commercial tourist development, as well as general commercial expansion, should be avoided as being inconsistent with the existing character of Sandbridge." In general, future land use recommendations do not deviate from the already existing pattern of development.

Recreational Characteristics. Dominant types of beach use include sunbathing, swimming, catamarans, surfing. A 1,200 ft. city-owned beach (see Figure 1-8) is present at the intersection of Sandbridge and Sandfiddler Road, and surfing is permitted. Most of the use of the beach outside of the Little Island Park and the city-run beach at the Sandbridge and Sandfiddler roads comes from year-round and seasonal residents of the adjacent residential area. According to the Office of Economic Development, more day use of the beach is seen because of development occurring in the neighboring Courthouse section (Moore, 1988). However, no actual beach user counts exist at Sandbridge outside of the two public-operated beaches.

Rentals are usually of a 1 week duration. Property values here are some of the highest in Virginia Beach. Kabler/Riggs Realty estimates that 50% of renters are from states other than Virginia. Siebert Realty has many renters from New Jersey, and the D.C. area.

Little Island Park is directly south of Sandbridge and is a popular beach area. According to Parks and Recreation (Coates, 1988; Nutter, 1988) the park is a popular spot for sunbathing, swimming, surfing (limited hours), and fishing during the weekend and

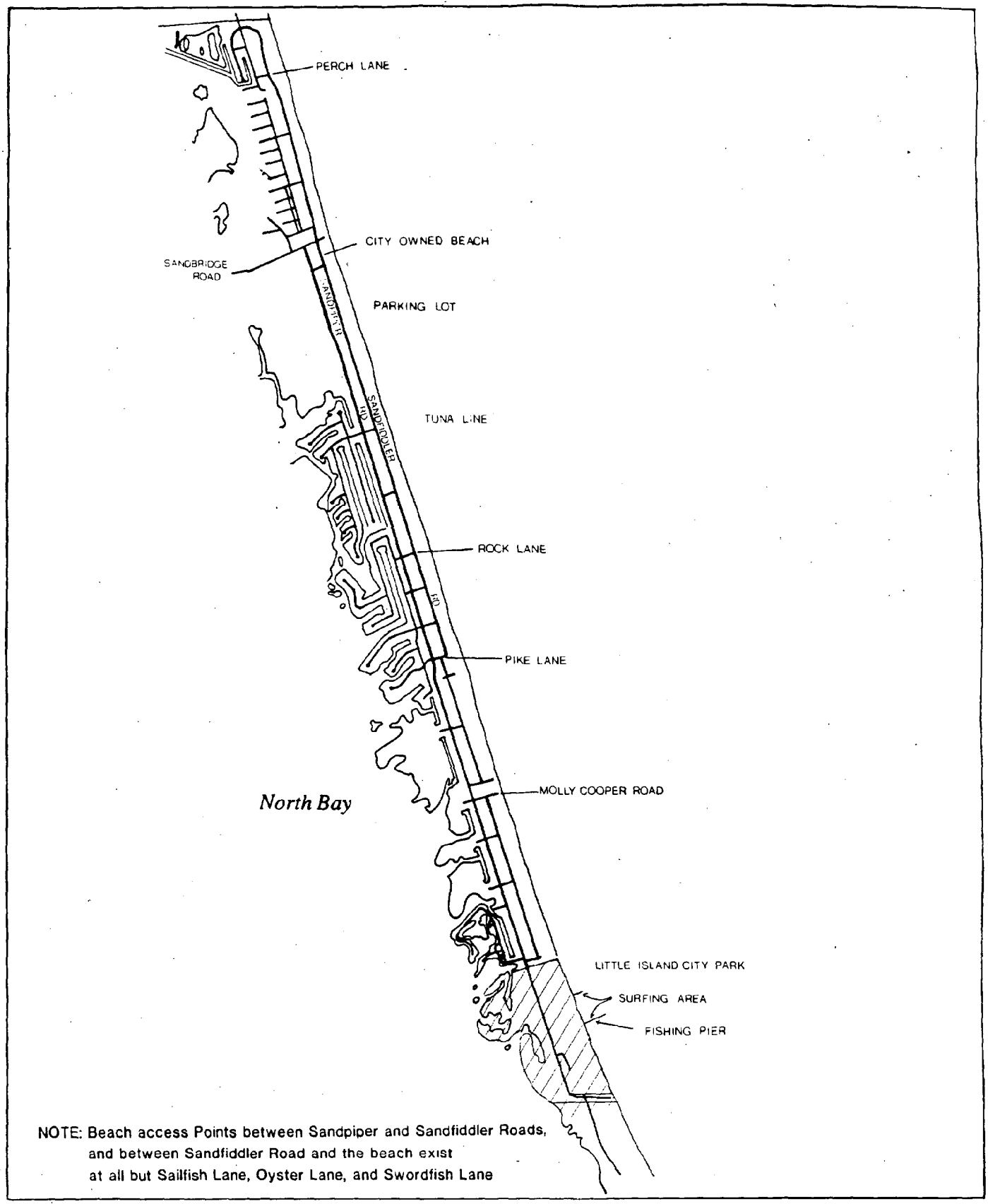


FIGURE 1-9

Sandbridge

0 1600 3200 feet

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RGH

holidays. The City provides facilities for picnics, basketball, permanent bathhouse/showers, parking, and lifeguards. A public fishing pier is located at Little Island Park.

During the summer of 1987 a total of 28,896 vehicles used the Little Island parking lot. Approximately 40% of all vehicles travelling to the park were from other sections of Virginia Beach. An additional 28% were from adjacent areas of tidewater Virginia such as Chesapeake, 17.5 % were from elsewhere in Virginia, and 14.5% were from out of state. The above number of vehicles is down from a high of 34,925 recorded during 1984. Recent development in the southern part of Virginia Beach, particularly the Courthouse area, has increased the proportion of day users from these nearby areas.

The first 775 ft. of beach north of the fishing pier is reserved for surfing, while the 2,155 ft. of beach immediately south of the pier is reserved for swimming. A minimum of 4 life guard stations are provided during weekdays and 8 lifeguard stations on the weekends (Jeavons, 1988).

Little Island appears to be an under utilized resource. A summer employee of the fishing pier in a conversation with RGH said that the Little Island beach area was never used to capacity except during peak weekend days. An analysis of parking data confirms that on a seasonal basis Little Island Park is under utilized. The vehicle count noted above represents about 21.7% of the park's annual parking capacity (based on a 113 day season, turnover factor of 1.8 and 656 vehicle capacity).

The constraint on peak days appears to be the size of the parking lot and not the dry sand area of the beach.

Public Access. The city-operated beaches at Sandbridge Road and Sandfiddler Road, and at Little Island City Park have excellent local public access. Outside of these areas the beaches are less accessible primarily due to the lack of on-street parking in Sandbridge. The degree of public access in Sandbridge outside of the two public beaches is similar to the access to the Chesapeake Bay beaches. That is, outside of residents and renters of adjacent homes it is difficult for non-residents to drive to Sandbridge and use the non-city operated beaches. Although there are 41 public ROW's between Sandfiddler Road and the beach, there is little or no parking near these ROW corridors which essentially serve adjacent residents. The non-city operated beaches in Sandbridge were classified in the 1982 Virginia Beach Waterfront Access Study as having restricted access.

Public Parking. Off-street parking is available at Sandbridge Park, (city-owned) just south of Sandbridge Road. Parking spaces for 60 cars are available and a fee is charged. Additional on-street parking is available starting at Pike Lane and south. A small Amoco station in Sandbridge has paved over some of their property and charges a fee to park. Parking is available for 656 cars at the Little Island Park lot. A fee is charged. Overflow from this lot sometimes uses the Back Bay/False Cape State Park Access Parking Lot.

Beach Recreational Facilities and Services. The City has one life guard station at the Sandbridge Road beach area. First aid is handled by life guards and life guard supervisors as described in the resort section. The city-owned beach at Sandbridge Road does not have any concessions, food stands, or boardwalk.

Both the city-owned beach at Sandbridge Road and Little Island City Park provide shower, restroom and changing area facilities.

Proximity to other Resort and Recreational Facilities. Located immediately south of Sandbridge is the Back Bay National Wildlife Refuge, and further south, the False Cape State Park (see Figure 1-1).

The primary purpose of the Back Bay National Wildlife Refuge is wildlife management. This purposes encompasses the protection of wildlife and enviromentally sensitive barrier island habitats, and management of wildlife populations. Public use activities permitted in the Refuge include nature study, birdwatching, photography, beach use, swimming, hiking, and bicycling. Camping in the Refuge is not permitted. The latter four activities are neither encouraged or discouraged, but permitted as long as they do not conflict with the primary purpose of the Refuge.

There is an entrance road leading approximately one mile into the park from its northern boundary with Little Island City Park. A 100-vehicle capacity parking lot is located at the southern terminus of this access road. The City of Virginia Beach provides a 40 car parking lot at the southern edge of Little Island City Park that is used by persons hiking or bicycling into the Refuge, in some cases, going further south to False Cape State Park. There are no support facilities for recreation activities in the Refuge such as bathrooms, changing areas, concessions, and camp sites.

The primary purposes of False Cape State Park are to provide recreational opportunities, and to protect the Park's environmental, wildlife, and scenic resources. Permitted recreational activities include primitive camping, hunting, hiking, bicycling, fishing and boating.

Public access to False Cape State Park is via water, bicycle, and hiking. Automobiles do <u>not</u> have access to the Park from the north through the Back Bay Wildlife Refuge, while hikers and bicylists can travel through the Refuge to the Park. There are two docking facilities for boaters traveling across Back Bay to the Park. The only facilities provided are pit toilets (MacAdoo, 1988).

A major change being planned, that could impact the Sandbridge area, is a proposal to provide transportation access through the Back Bay National Wildlife Refuge south to False Cape State Park. This would be done to increase recreational use of False Cape State Park by providing shuttle bus access from the north. The Barbours Hill area of the park would become a full service recreational beach with the provision of a bathouse, restrooms, and a visitor center. Only bus parking would be provided.

This proposal would increase recreational use of False Cape State Park by up to 2,000 persons/day. It would require the construction off-site of a staging area and parking for approximately 500 vehicles, possibly on city-owned land in the southern part of Little Island City Park.

Other nearby recreational facilities include Hell's Point Golf Course near Sandbridge and Dam Neck Roads, Red Wing Golf Course approximately 7-8 miles away on Prosperity Road, west of the Amphibious Base. The other attractions on General Booth Boulevard such as the Virginia Marine Science Museum, and the Owl Creek tennis courts are located slightly further away.

Sandbridge and Little Island Park are the most remote beach areas of Virginia Beach in terms of their proximity to population centers in the City. No public transit routes link the Sandbridge area with the resort section.

No overnight accommodations are available to visitors at Sandbridge. Surfside at Sandbridge Campgrounds has 20 camp sites. Another similar sized campsite is located nearby. A small commercial center exists at Sandbridge and Sandfiddler Roads, which consists of a small shopping center, restaurant and Amoco Station.

Restrictions on Beach Use. Many of the same restrictions apply from those mentioned in the Resort Section unless excluded in the description. Surfing is permitted all along Sandbridge between the hours of sunrise and sunset with one exception. Between the Friday before Memorial Day and Labor Day, surfing is not permitted between 10:00 a.m. and 4:00 p.m. (Sec. 6-116a3).

Population Density. The estimated 1988 population density for census tract 454.03, of which Sandbridge is only a small area, is 617 persons per square mile. This represents a 426% increase since 1980, with most of this growth occurring in the portion of the census tract away from Sandbridge. The seasonal population density in Sandbridge approaches 2,400-2,760 persons per square mile, assuming approximately 690 dwelling units/square mile, and 3.5 to 4 persons per dwelling unit.

Infrastructure. The one significant difference between Sandbridge and the other six segments being considered by this plan is that Sandbridge is not sewered. Thus, development intensity is, or should be, determined by the ability of the area to support on-site septic systems without adversely affecting water quality in the Ocean and Back Bay. The absence of sewers in this area also means that there is virtually no likelihood of increasing development intensity within the Sandbridge beach segment. Public water is available throughout Sandbridge.

Transportation Access. Sandbridge is relatively inaccessible from other parts of Virginia Beach. The route from the Resort Area is very indirect, proceeding southwest via General Booth Boulevard, looping west around the Dam Neck Naval facility, and then southeast via Sandbridge Road. The distance is approximately 18 miles. No public transit runs between Sandbridge and the resort beach area.

Major roadways through the Sandbridge area include Sandbridge Road (Route 629), Sandfiddler Road, and Sandpiper Road. General Booth Boulevard is the main access to the resort area. The only 24 hour 1987 traffic count for this area was conducted for General Booth Boulevard at Dam Neck Road on July 8th and 9th - 39,950 vehicles.

2.0 COASTAL SETTING

This section reviews the coastal conditions along the Virginia Beach shoreline. It describes the physical features and coastal processes affecting the changes in shoreline position which are of critical importance in assessing the resource value of the beach for property protection and recreational usage.

2.1 Physical Features

Most alongshore variations in shoreline change appear to be influenced by the proximity of the shoreline to inlets, capes, nearby shore-connected ridges and other bathymetric features (Everts, 1983). An understanding of the nature of the physical features along the Virginia Beach shoreline is therefore useful in understanding the overall pattern of erosion and accretion. The following paragraphs outline the significant coastal features in Virginia Beach.

2.1.1 Chesapeake Bay

The Chesapeake Bay entrance encompasses shallow portions of lower Chesapeake Bay and adjacent sand flats in and around the bay entrance. The entrance lies between two headlands; Cape Charles, Virginia to the north and Cape Henry to the south. Most of the area lies under less than 35 feet (ft) of water with deeper waters occurring in the channels.

The main inlet channel, which is less than 2 miles (mi) wide and ranges in depths from 45 to 90 ft, lies north-northeast of the Cape Henry coastline. West of Cape Henry, it subdivides into three smaller and shallower channels: Thimble Shoals Channel leading westward; Chesapeake Channel leading northward into the Bay; and a smaller channel leading into a shoal which lies off of Lynnhaven Inlet.

2.1.2 Cape Henry

Cape Henry is the large land protrusion which forms the southern limits of the Chesapeake Bay entrance. The headland of Cape Henry closely borders the deep water in the main inlet channel. Over the period of the last 150 years, the cape area has undergone a shoreline change which is equivalent to a counter-clockwise rotation of the cape. The eastern ocean-facing shore has advanced and the northern bay facing shore has retreated. Everts (1983) notes that changes to Cape Henry are likely to continue into the future. The advance of the ocean shore of the Cape could increase if additional beach fills are placed in the resort area. Some of the recently placed fill material moved north and was deposited along the ocean shore of Cape Henry.

Everts (1983) also indicates that Cape Henry's influence is reflected in the behavior of the adjacent ocean beaches located to the south of the Cape. It appears that Cape Henry dominates the changes in the ocean shoreline for at least nine miles to the south.

2.1.3 Barrier Beach

The barrier island system which extends south beyond Cape Hatteras, begins in Sandbridge. The barrier beach extends over about 3/4ths of the length of the Sandbridge community. The land width is less than 0.25 mi in areas of Sandbridge Beach and in excess of 1.5 mi in some areas of False Cape which lies further to the south. Numerous freshwater bays back the barrier beach.

2.1.4 Near Shore Bathymetry

Shoreface profiles are shallower off the Resort Beach than they are off Sandbridge Beach. The northern ocean beaches are fronted by a wide, shallow shoreface shoal area which causes appreciable frictional attenuation of larger waves. The upper shoreface profile fronting Sandbridge is relatively steep. Larger waves are able to propagate closer into shore in Sandbridge as a result.

2.1.5 False Cape Shoal

The False Cape Shoal is a shoreface-connected ridge located near the southern border of Virginia Beach. False Cape Shoal is a linear ridge with a maximum relief of 30 ft extending from the shoreface in a northeast direction. In his investigation of a series of four shore-connected ridges in his Cape Henry to Cape Hatteras study area, Everts (1983) notes that such ridges appear to significantly influence the ocean shoreline. Shoreline changes associated with these shore-connected ridges are predictable. Shorelines north of ridge intersections generally retreat, while those to the south usually prograde. Everts (1983) notes that the ridges typically intersect the shoreface at about three miles south of some of the most prominent concave seaward shorelines. In all cases, the site of the ridge intersection is along a reach where the shoreline is rapidly changing from a northwesterly to a northerly direction.

2.1.6 The Virginia Beach Massif

The Virginia Beach Massif (as shown in Figure 1-1) is an extensive shallow, relatively level- topped bathymetric high at a depth of about 60 ft. The Virginia Beach Massif is located offshore of Cape Henry. The extensive shoal areas of the Virginia Beach Massif greatly affects incoming wave patterns on the Virginia Beach shoreline. Goldsmith, et al. (1974) suggest that waves with periods of 10 seconds or shorter originating from the northeast are refracted away from the resort area to the Chesapeake Bay entrance and the False Cape area by the Virginia Beach Massif. Similarly, waves from the southeast are concentrated in the Virginia Beach and adjacent offshore area. A dominant northward littoral drift exists along Virginia Beach ocean shore as a result of greater wave energy reaching the area from the southern quadrants than from the northern.

An indication of the overall influence which the Virginia Beach Massif has on incoming waves is suggested by the distance from shore at which waves begin to be appreciably affected by the bottom features. Offshore of Cape Henry, a six second wave will begin to be affected at a distance of about 14 miles from shore. Offshore of the southern border of the City of Virginia Beach, the same wave can propagate to within about four miles of the shore before it becomes affected. Therefore large waves are able to travel closer in to shore in the southern portion of Virginia Beach.

2.1.7 Inlets

Two inlets exist in the Virginia Beach area: Rudee Inlet which opens into the Atlantic Ocean and Lynnhaven Inlet which opens into Chesapeake Bay. Rudee Inlet is maintained by the City of Virginia Beach while Lynnhaven Inlet is maintained by the U.S. Army Corps of Engineers (COE).

Lynnhaven Inlet. Lynnhaven Inlet is a tidal inlet located west of Cape Henry between two public beaches; Cape Henry Beach and Ocean Park. The mouth opens into Chesapeake Bay and is exposed to waves from the Bay and Atlantic Ocean. Presently, the width of the channel is approximately 1,500 ft across and nearly 30 ft deep at the throat which lies nearest the west bank of the inlet. The inlet is considerably wider than Rudee Inlet and has no man-made jetties for channel stabilization.

Lynnhaven Inlet is the mouth of a very large system of bays and estuaries. The large tidal exchange volume contributes to inlet currents of significant magnitude. The inlet is reported to be relatively dangerous with strong tidal currents sometimes averaging 7 ft/sec.

The inlet has no man-made jetties on either side and acts as a sink for sediments being transported by littoral drift. A net accretion trend is occurring on the east shoreface while a net erosion trend is occurring on the west shoreface of the inlet.

Since dredging began back in 1965, a shoal platform located seaward of Ocean Park beach has slowly eroded away. The gradual loss of the shoal has allowed greater wave energy to strike the beach. A narrow but strong longshore current now exists since little refraction or attenuation of wave energy occurs and sediment is readily carried into the inlet channel. Sediment is permanently lost to the inlet since the inlet channel is so deep. As a result, natural shore to shore sediment bypassing does not occur.

Rudee Inlet. Rudee Inlet is located between Croatan Beach and the Virginia Beach Resort area. Rudee Inlet is the mouth of a very small estuary into which Owl's Creek flows. Unlike most Atlantic Coast inlets, it has no extensive system of canals or lagoons. It is a relatively shallow and narrow inlet which is currently bordered by two man-made jetties. Bypassing of sand across the inlet is accomplished using a weir jetty and a hydraulic dredge.

A weir was constructed on the updrift side (south) of the inlet which extends perpendicular to the shore out to a fixed jetty. Sand is allowed to pass over the low weir crest into a sheltered depositional basin from which it is periodically pumped north across Rudee Inlet to the Virginia Beach Resort area.

Since 1962, accretion of sand has occurred on the outboard side of both jetties, which is a positive feature in terms of beach maintenance both north and south of the inlet. Approximately 300 ft of beach build- up has occurred on the north jetty between 1962 and 1980. On the south jetty where the source of sand bypassing exists, approximately 200 ft of beach build-up has occurred between 1962 and 1980 (Everts, 1983). This illustrates the beach width and does not indicate sediment transport direction since net transport is from south to north.

2.2 Waves

Jensen (1983) presents wave hindcast statistics covering a 20 year period for shallow water stations (32 feet) located offshore of Cape Henry and Sandbridge. Mean significant wave heights are about 1.8 feet. Waves at Virginia Beach are less than 3 ft. high more than 80% of the time. These hindcast values are substantiated by direct observational wave data compiled at the Corps of Engineers Field Research Facility at Duck, North Carolina (Birkemeier, et al., 1981).

By far, the largest and most frequent waves impinging on the Chesapeake Bay entrance and Virginia Beach enter from the east-northeast and northeast. The lowest waves occur in summer and the highest during the period October- February. The maximum significant wave height occurring at the shallow water stations off of Cape Henry and Sandbridge for the 20 year hindcast exceed 17 feet (Jensen, 1983). Dolan (1985) suggested that breaker heights can be expected to reach 19 ft at least once every ten years.

Most of the Bay entrance is open to easterly waves from offshore and to waves generated within the lower Bay which may reach heights of over 4 ft especially with northerly winds (Wright, et al., 1987).

2.3 Sediment Transport

The beaches are deposits of sand which are constantly being shaped and redistributed by the action of winds, waves, tides and currents. Longshore transport is the movement of sand in a shore-parallel direction. Four main mechanisms drive longshore transport. These are:

1. breaking waves approaching the beach at oblique angles;
2. longshore variations in wave height and setup;
3. longshore wind-induced currents; and
4. shore parallel tidal currents.

The magnitude of the longshore sediment transport rates is not a direct cause of erosion or accretion which a particular segment of shore may be experiencing. It is the changes in the rates of sediment transport along the shore which produce the changes in sand volume stored in the beach. When more sediment enters a coastal segment than leaves, the sediment budget has a positive balance and accretion results. When the transport out of a segment exceeds the transport in then erosion results.

Sediment can also move on the onshore-offshore direction. Storm wave conditions are the most common cause of this transport mode. Nearshore sands are transported offshore as a beach adjusts to a flatter profile in response to storm wave impact. Gentle swell of the summer months tend to transport sand back onshore and rebuild the beach. Sediment can also be moved upland off of the active beachface by storm overwash and by wind transport.

The erosion of Sandbridge Beach and the annual renourishment requirements of the Virginia Beach Resort area can not be totally explained in terms of littoral drift. This implies that a significant part of the erosion involves offshore transport from the intertidal beach, through the surf zone and out into deeper offshore where the sand is subjected to re-distribution by near-bottom currents (Wright.et al., 1987).

2.3.1 Atlantic Ocean Shore

In general sediment is transported toward the north along the Atlantic coast of Virginia Beach from Sandbridge to Cape Henry. This northward littoral transport may be caused by 1) the greater wave energy which reaches the area from the southern quadrant than from the northern (Goldsmith, et al. 1974) or by 2) northerly currents related to the circulation associated with the Chesapeake Bay entrance. Both effects may be occurring and neither process is mutually exclusive.

A sediment transport nodal point is an area where the littoral drift diverges. Over the long term, sediment tends to be transported both up and down coast away from the nodal point. Such a nodal point apparently exists in the area 2 to 3 mi south of Sandbridge. The pronounced local shoreline retreat in this area is attributed to the existence of this sediment transport node.

Sandbridge Beach is estimated to lose a total of 260,000 to 300,000 cubic yards per year (cy/yr) to erosion. The beach lies within an erosive regime bordered by Croatan Beach to the north and False Cape to the south, both of which are accretionary regions (Byrnes & Oertel, 1986). The influence of False Cape Shoals as a shoreface-connected ridge may also be important in the erosion at Sandbridge. About 104,000 cy/yr is considered to be lost to northward drift and 170,000 cy/yr is unaccounted for (Waterway Surveys and Engineering, 1986). This indicates that significant quantities of sand may be transported offshore, most of which occurs during storms. Some of this lost sand may be moved westward by overwash and wind transport. The effects of sea level rise can also account of some of the missing sand. The static effect of sea level rise of 0.4 millimeters/year (mm/yr) (Hicks, 1983) on a typical beach sloping at 1:30 would amount to an annual loss of 34,000 cubic yards (cy) or about 20% of the unaccounted for sand (Everts, 1983).

The beach at Croatan is accreting. The Rudee Inlet jetties which form the northern limits of this area help to impede the northerly drift of sand out of the Croatan segment of the shore. It is estimated that the net northward transport of sand bypassing Rudee Inlet by both artificial and natural means, is 200,000 cy/yr (Waterway Surveys and Engineering Ltd., 1986).

2.3.2 Chesapeake Bay Shore

In general, net sediment drift along the Chesapeake Bay shoreline is from east to west. However, inlet tidal currents and refracted waves often cause a west to east sediment drift along the Ocean Park Shoreline (Byrnes and Oertel, 1986). Lynnhaven Inlet is also a very effective littoral barrier which prevents bypassing of sediment from the accreting eastern shore of the Cape Henry Beach to the eroding shore of Ocean Park to the west of the inlet.

2.4 Shoreline Change

The physical features and coastal processes described in the previous sections are the agents of large scale change for the Virginia Beach shoreline. Long term shoreline change rates along the Virginia Beach coast are derived from the historical patterns of change over the 121/125 year period of 1855/59 to 1980 (Everts et al., 1983). Along the Atlantic Ocean front, the shoreline recession is the most severe near the southern end of the Sandbridge area where the long term rate reaches 9.6 ft/yr. The erosion rate gradually reduces as one moves north along the coast up through Croatan Beach and the resort Beach area. Shoreline recession actually reaches an apparent null point in the vicinity of North Beach. Beyond this point, the influences of the Chesapeake Bay Entrance and Cape Henry become dominant. Cape Henry appears to influence the changes in the Atlantic Ocean beaches over a distance of about nine miles to the south of the Cape (Everts, 1983). The east-facing shores of Cape Henry are advancing seaward at a rate of about 7 to 8 feet/year (ft/yr).

On the Chesapeake Bay shore of Cape Henry, the change reverses again to result in a net long term recession. The north facing shore of Fort Story at Cape Henry erodes at rates ranging from about 4.5 to 7 ft/yr. Further to the east at Cape Henry Beach, the shoreline shows an accretional tendency with a typical range of 7.8 to 10.7 ft/yr. The Ocean Park and Chesapeake Beach communities to the west of the Lynnhaven Inlet show long term shoreline recession trends.

2.4.1 Chesapeake Beach

Chesapeake Beach also experiences shoreline retreat at a rate of about 3.8 ft/yr (Byrne and Oertel, 1986). The long term shoreline change data indicate an erosion rate in the western portion of Chesapeake Beach of about 5.5 ft/yr. This rate diminishes toward the east. These are shown in Figure 2-1.

2.4.2 Ocean Park

Ocean Park Beach which borders the west side of Lynnhaven Inlet has experienced an average landward recession rate of 4.5 ft/yr between 1980 and 1985. However, since 1985 the recession rate has increased to an average greater than 35 ft/yr. Sediment transport processes on the Bay as well as local inlet sediment trapping are responsible for the erosion of the Ocean Park shore. The 0.5 mile segment of Ocean Park which is located immediately adjacent to the western shore of Lynnhaven Inlet is the most severely impacted area in Ocean Park. Erosion rates for Ocean Park are shown graphically in Figure 2-2.

2.4.3 Cape Henry Beach

Cape Henry Beach which is located on the eastern region of Cape Henry bordering the east side of Lynnhaven Inlet appears to be quite stable. It has experienced a constant rate of accretion which has been relatively continuous since 1852. The long term average accretion rate is about 9 ft/yr, and is shown in Figure 2-3.

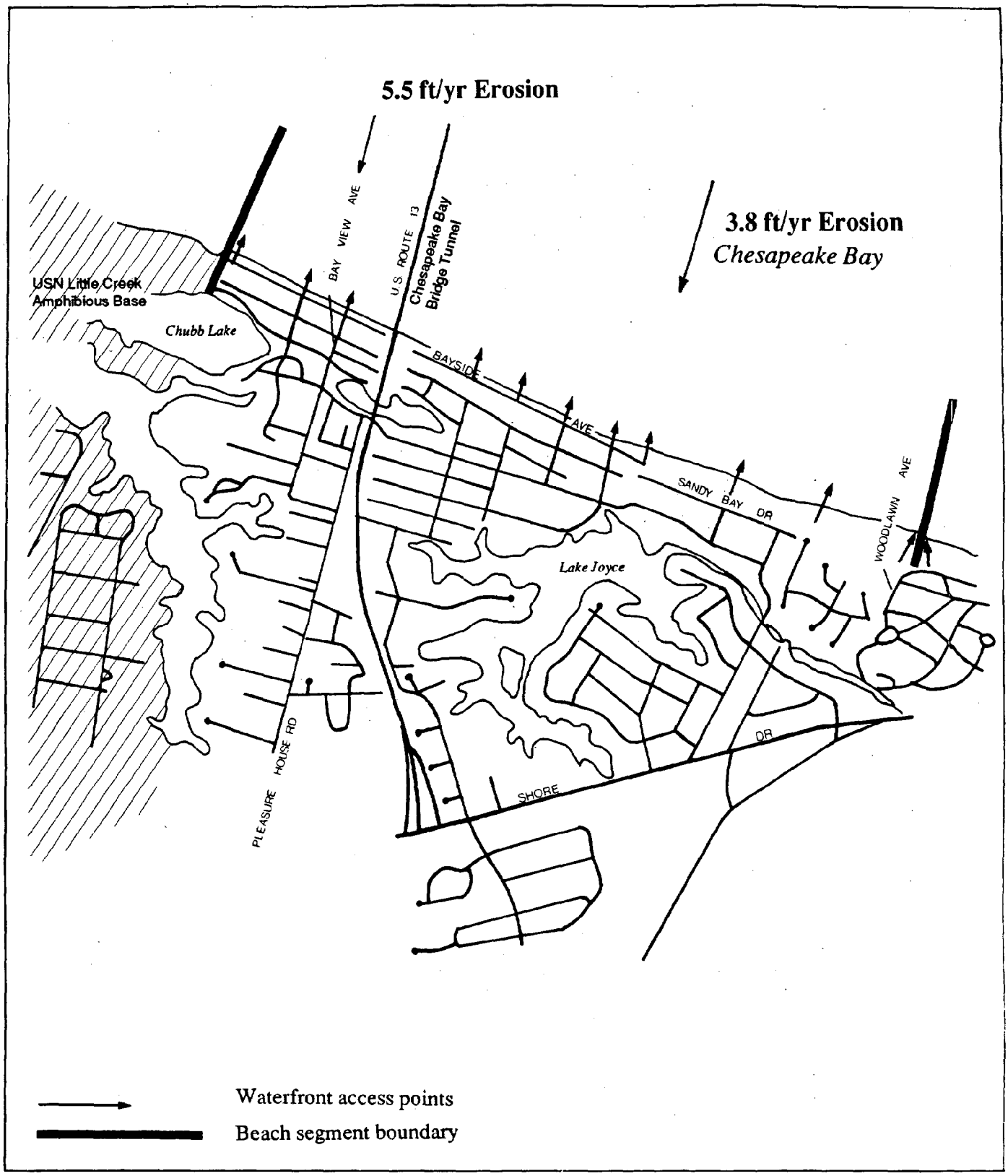


FIGURE 2-1

Shoreline Erosion Rates

Chesapeake Beach

0 750' 1500'

RGH

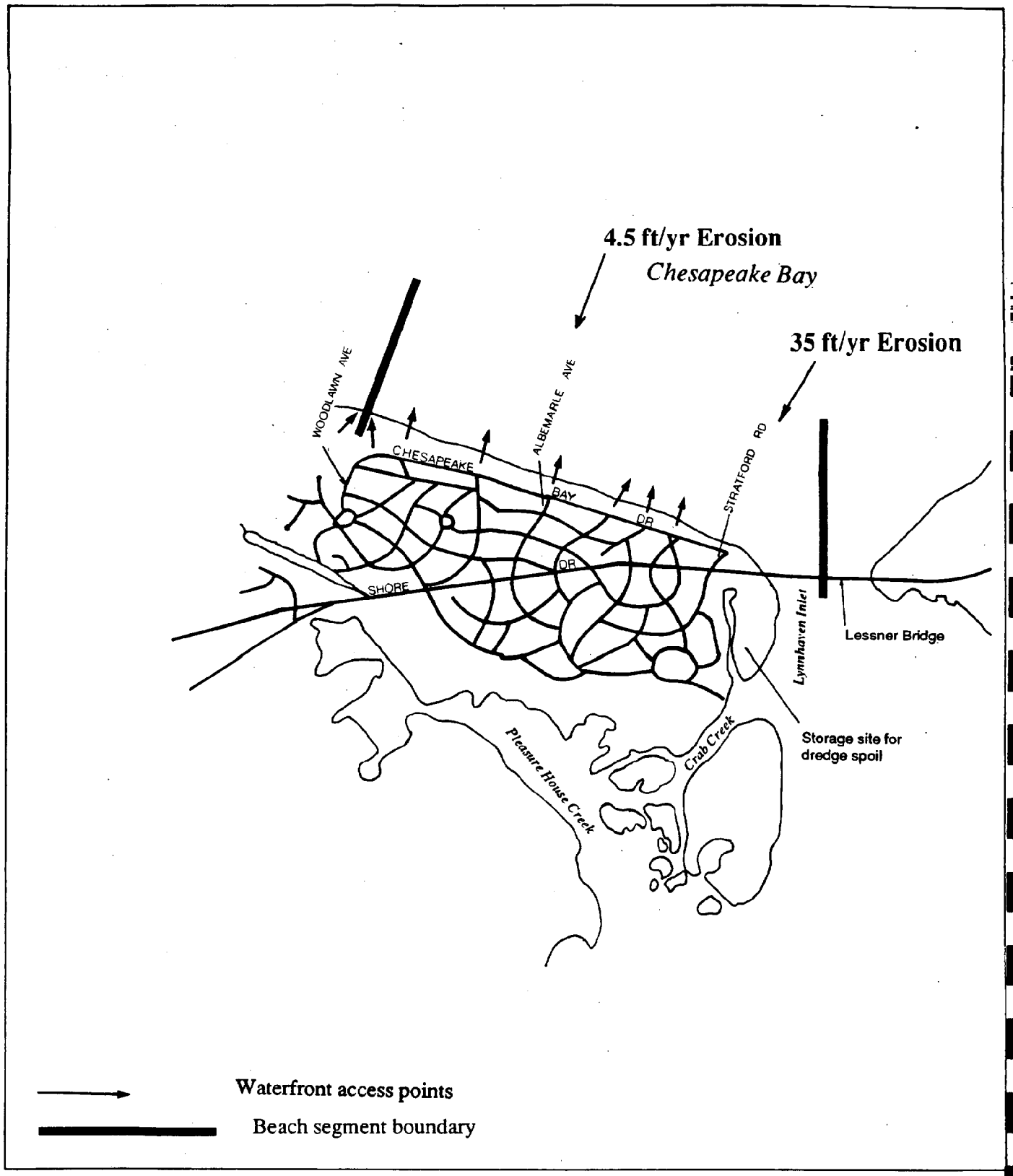


FIGURE 2-2

Shoreline Erosion Rates

Ocean Park Beach

0 750' 1500'

RGH

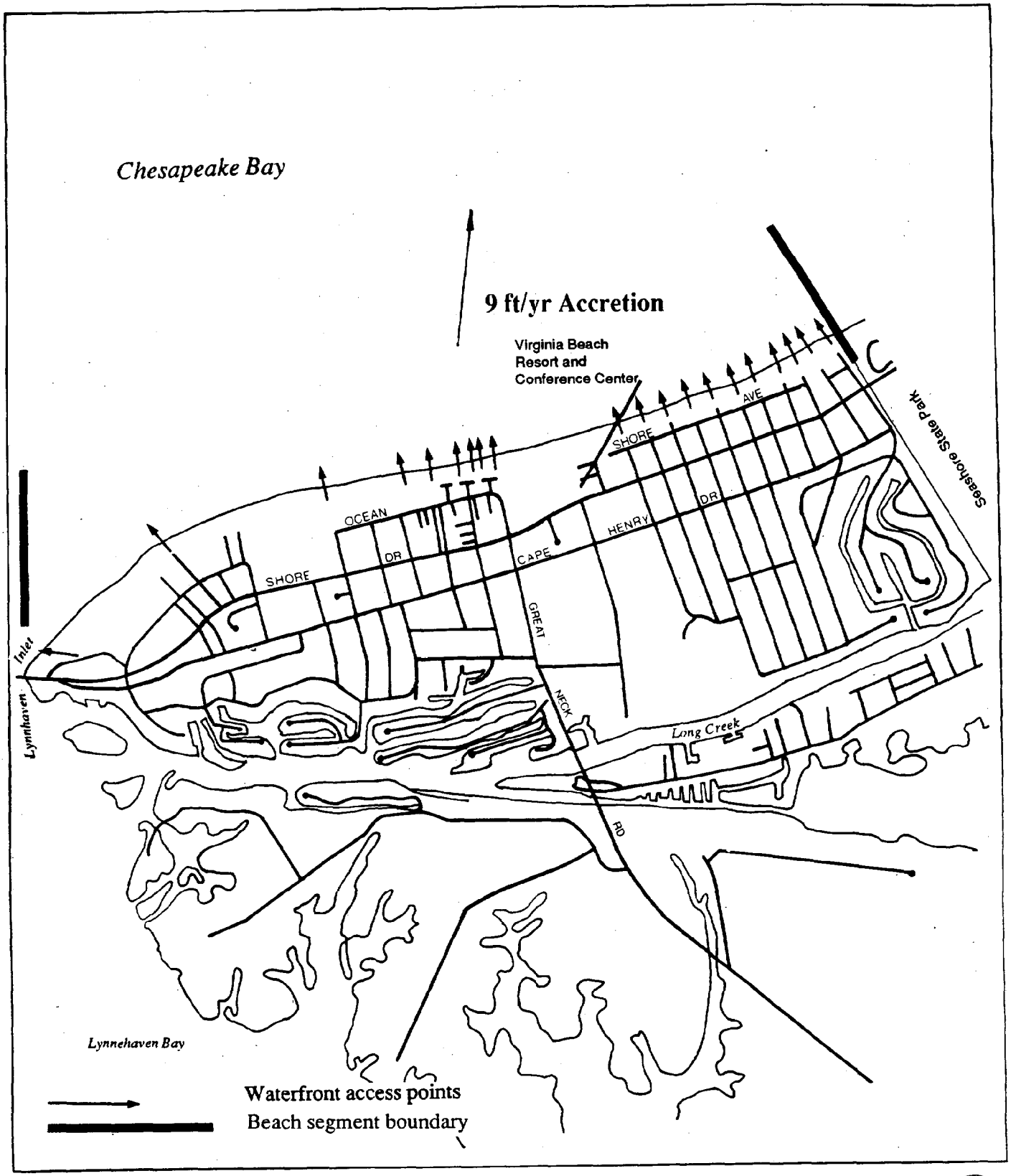


FIGURE 2-3

Shoreline Erosion Rates

Cape Henry Beach

0 750' 1500'

RGH

2.4.4 North Beach

North Beach is a stable beach area located between the accretional area of Cape Henry to the north and the erosional area of the resort beach to the south. The long term average trend is accretional at an average rate of 0.4 ft/yr as shown in Figure 2-4.

2.4.5 Resort Area

The Resort beach has experienced erosion even before the jetties were constructed at Rudee Inlet. Between 1932 and 1946, profile studies done by Harrison and Wagner (1964) showed that the south resort beach shoreline had receded approximately 80 ft while the north shoreline had accreted approximately 9 ft. Erosion rates are shown on Figure 2-5.

Beach nourishment of the resort area has been occurring since 1954 when the Rudee Inlet jetties were first constructed. Approximately 300,000 cy/yr of nourishment has been determined necessary to maintain an adequate beach width (Waterway Survey and Engineering, 1987).

2.4.6 Croatan Beach

Croatan Beach, which is located just south of Rudee Inlet, appears to be prograding as a result of lost sand from Sandbridge Beach. The approximate net shoreline change for Croatan Beach between 1980 and 1985 was +11.9 ft/yr (Byrnes and Oertel, 1986). The long term average shoreline change is accretional but the magnitude is significantly smaller than the recent rates. The long term shoreline advance occurs at an average rate of 1 ft/yr. The long-term erosion rate is shown in Figure 2-6.

2.4.7 Sandbridge Beach

Sandbridge Beach experienced erosion at the net rate of -3.25 ft/yr between 1980 and 1985 (Byrnes and Oertel, 1986). Dolan (1985) estimated that Sandbridge Beach eroded at the rate of 4 to 8 ft/yr between 1937 and 1984 with some areas eroding at the rate of 10 ft/yr. The long term shoreline data show a consistent erosional trend since 1859. The long term average rate of shoreline recession ranges from about 3.4 ft/yr at the northern end of Sandbridge to a maximum of about 9.6 ft/yr at about one mile north of Little Island Park. The recession rate drops back down to about 5.7 ft/yr in the park area. These are shown in Figure 2-7.

The Back Bay shoreline has also eroded over the past 140 yrs. and today the distance between the ocean and the bay is only 720 ft (Dolan, 1985). The rate of convergence of the bay and ocean shorelines at the narrowest places has been greater than 15 ft/yr (Dolan, 1985). Recent installation of bulkheads on the bay shoreline has reduced shoreline regression.

Breaching of a new inlet along Sandbridge Beach and False Cape has been a distinct possibility which may occur as a result of another severe storm (Dolan, 1985). It has been suggested also that about once every four years, a very severe storm will produce high enough waves and surge to transport significant amounts of sand inland. In fact, with the current beach and land characteristics, the minimum conditions for an inlet to form at Sandbridge would be expected to occur within a decade (Resio and Hayden, 1973).

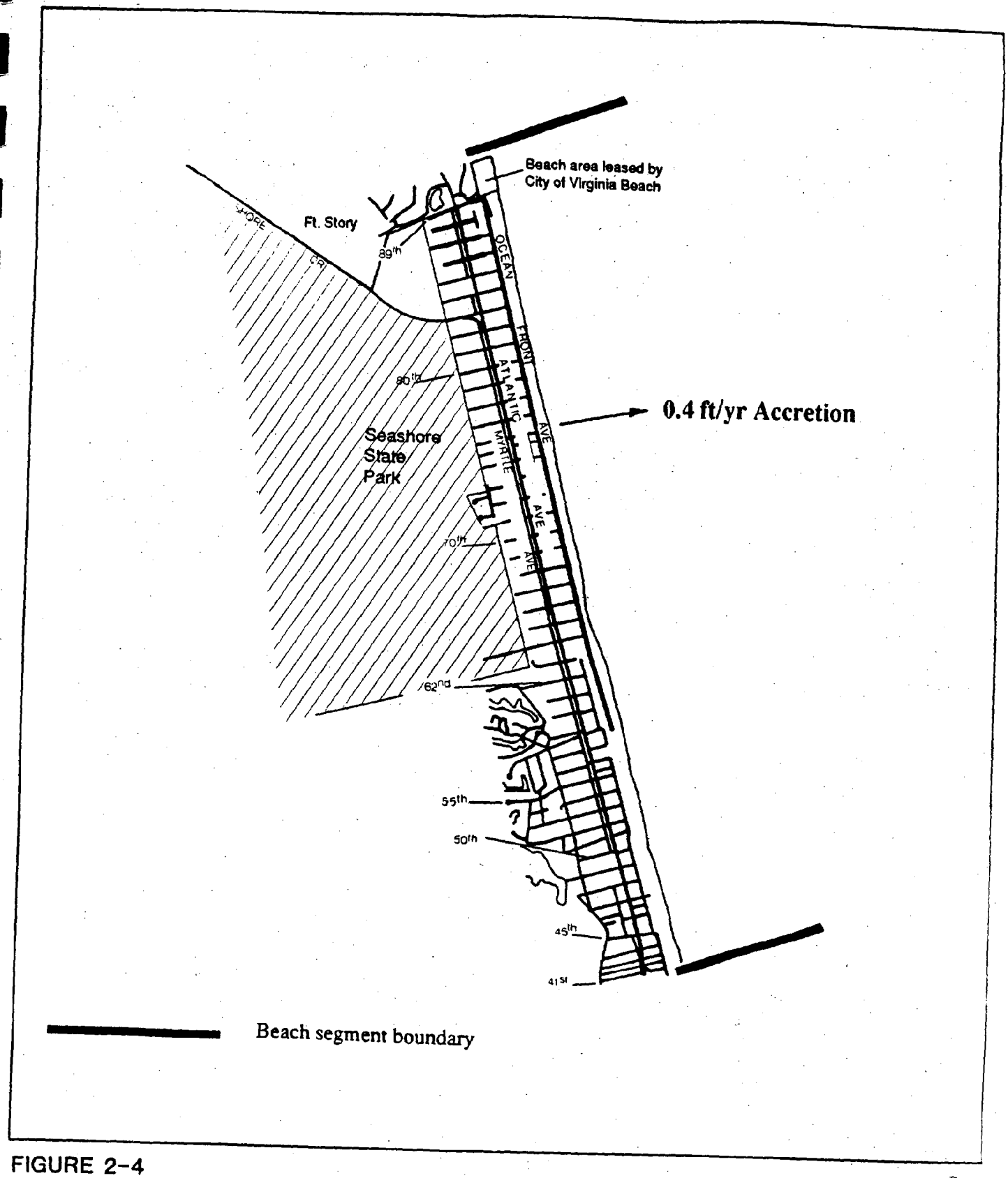


FIGURE 2-4

Shoreline Erosion Rates

North Beach

0 1320' 2640'

RGH

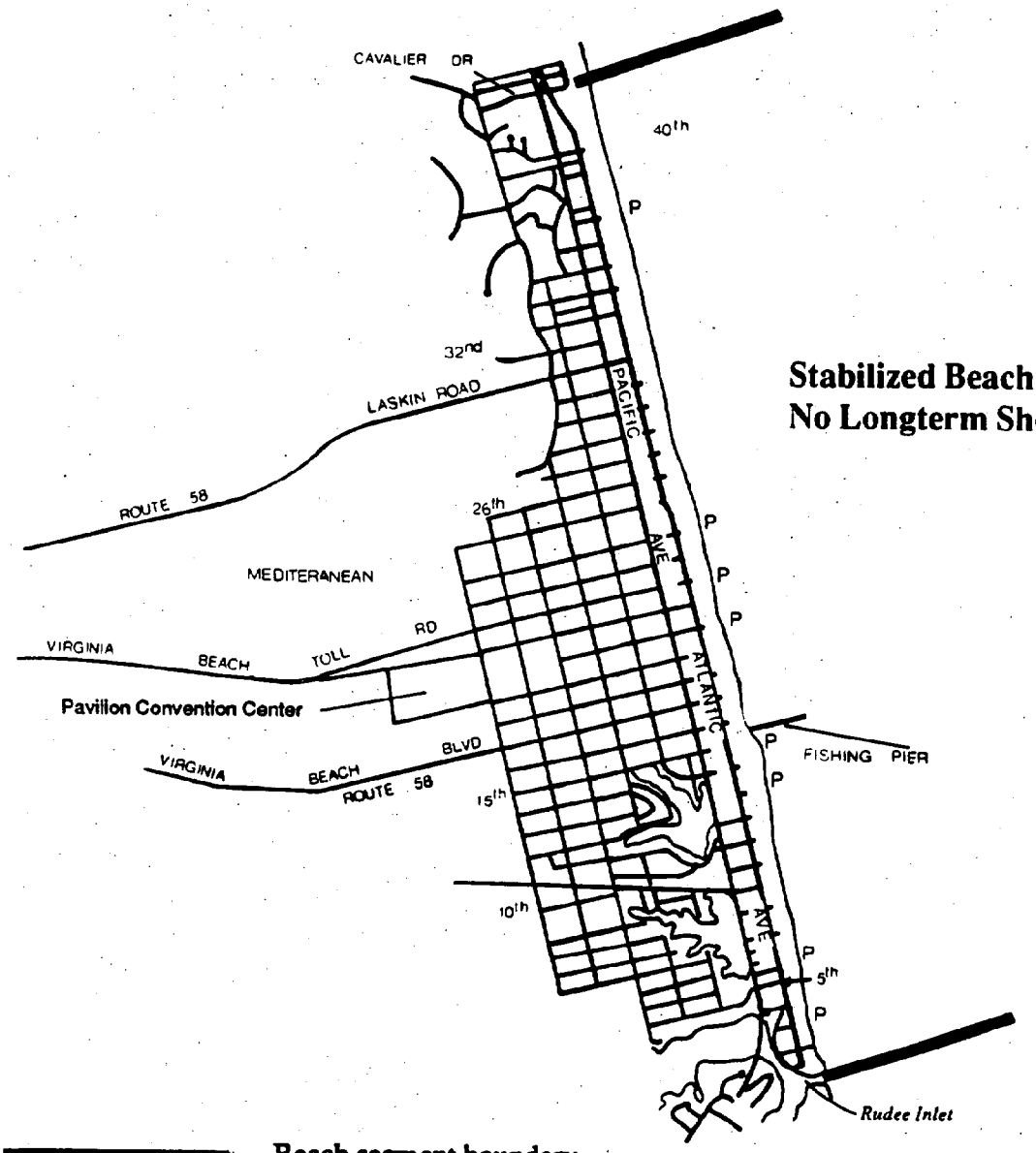


FIGURE 2-5

Shoreline Erosion Rates

Resort Beach

0 1320' 2640'

RGH

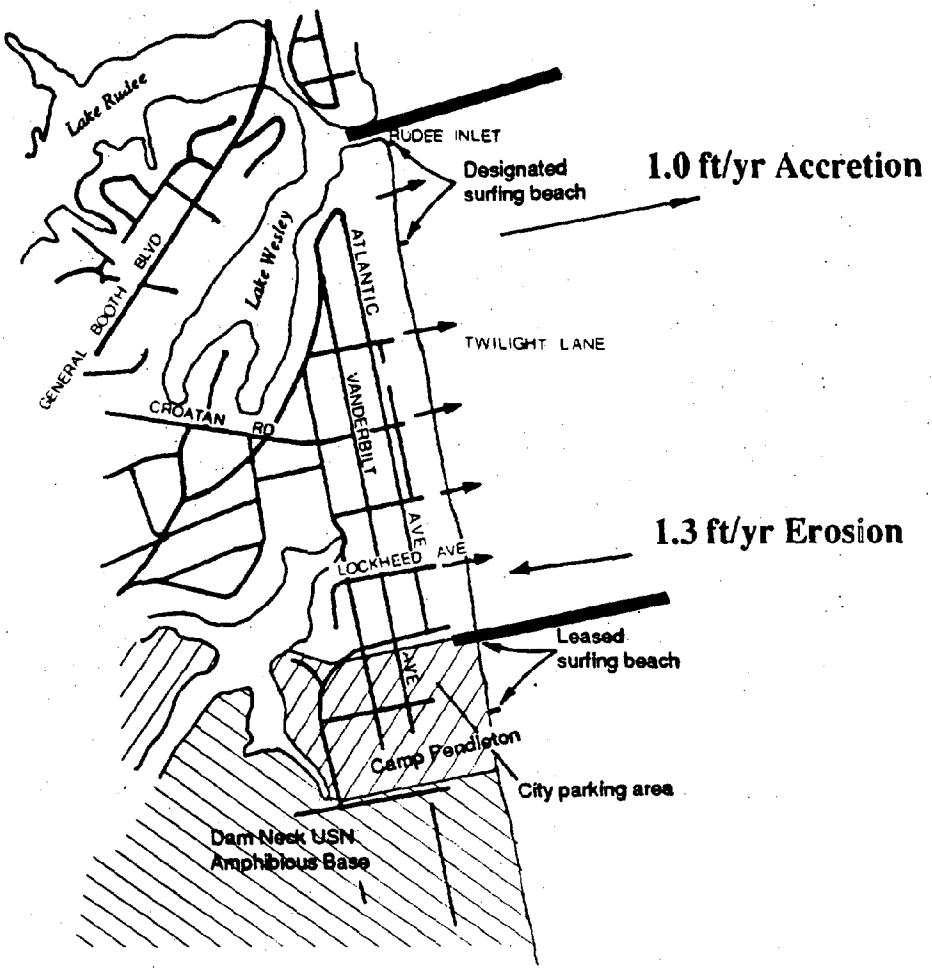


FIGURE 2-6

Shoreline Erosion Rates

Croatan Beach

0 750' 1500'

RGH

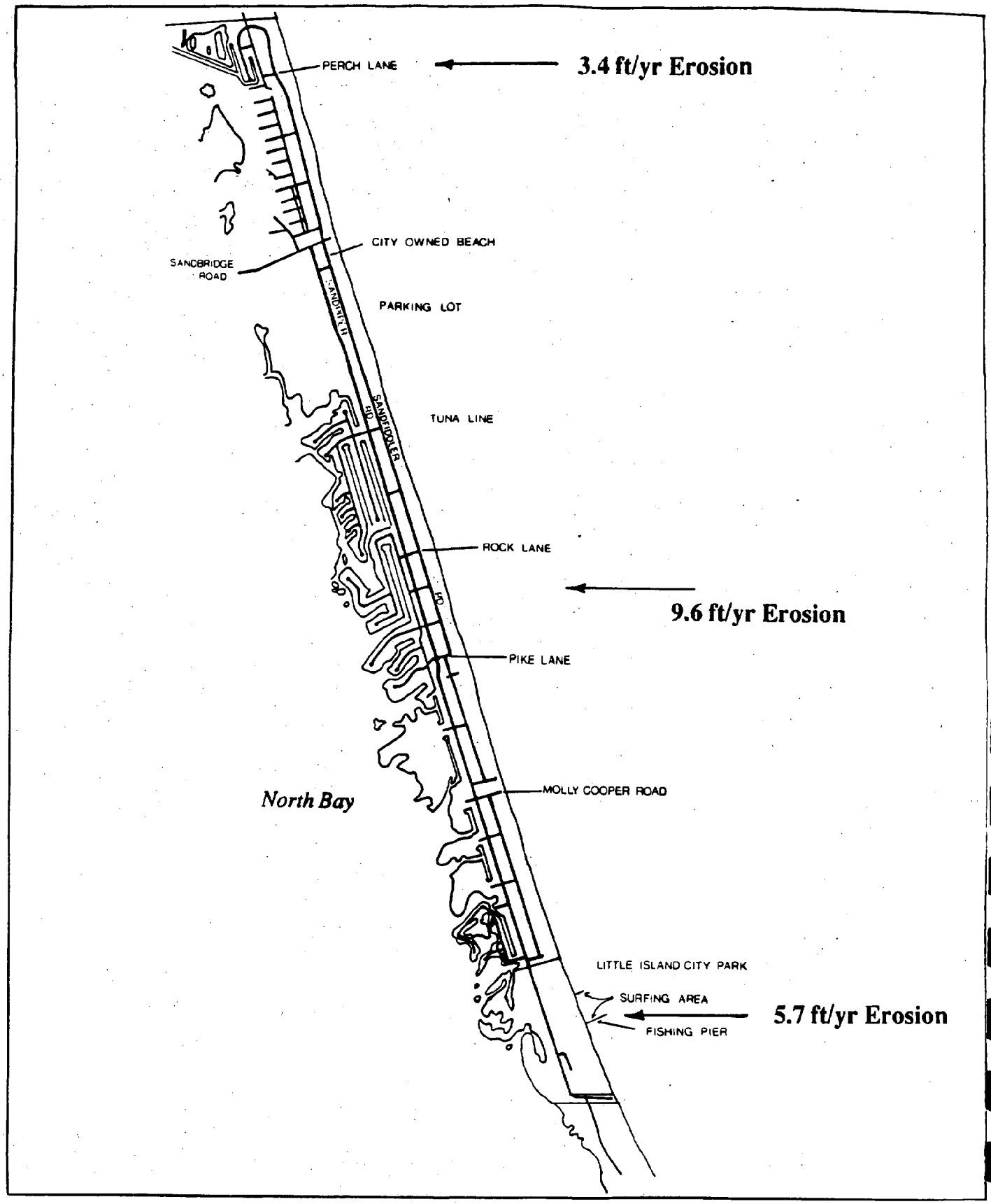


FIGURE 2-7

Shoreline Erosion Rates

Sandbridge Beach

0 1600 3200 feet

RGH

Final280\01\rpt-090788

2.5 Storms

The storms which have significantly affected the shoreline regions of Virginia Beach within the past 60 years were the Ash Wednesday Storm of 1962 and the Hurricanes of 1933. These storms caused severe damage to protective dunes, beaches, and coastal structures as well as to commercial buildings, private homes, and property. Other storms have also caused damage to the Virginia shoreline, however, none have been as considerable as the previously mentioned. Storms have occurred on the average of every seven years this century, totalling eleven.

2.5.1 Ash Wednesday Storm of 1962.

The hardest hit areas in the Virginia Beach region were Ocean Park, North Beach, Town of Virginia Beach, and Sandbridge Beach. The estimated cost of damages for the entire State of Virginia was $34 million, all of which was funded by the Federal Assistance provisions of Public Law 81-875.

Ocean Park beach experienced severe erosion of the protective dune and beach. Restoration was performed by placing 60,000 cy of sand on the shoreline which was dredged from the Lynnhaven Inlet on the shoreline. A 50 ft berm was placed +7 ft above mean low water (MLW) with a foreshore having a slope of 1:15. The linear extent of the restoration was 4,500 ft from Lynnhaven Inlet westward.

The amount of damage which Virginia Beach experienced was nearly $9 million. Restoration of the seawalls, bulkheads, boardwalk, protective dunes, and beaches was performed shortly after the storm. Construction of a new timber bulkhead between 46th and 48th Streets and repair of 5,500 ft of timber bulkhead was performed. Repairs were also made to 4,800 ft of the two mile long boardwalk.

It should also be pointed out that the amount of damage caused by a storm is not necessarily directly related to the severity of the storm, but rather to the amount of development which exists on the shoreline. For example, the amount of damage to shoreline development today by the same March 1962 storm would cause almost twice as much damage today because of extensive development which has occurred along Virginia Beach. Damages are estimated at well over $20 million at 1987 price levels.

Approximately 50% of the dune was eroded at the northern end of the resort beach. Nourishment of the protective dunes and beach of Virginia Beach was done with approximately 300,000 cy of sand taken from borrow sites. The basic shoreline profile which the Corps of Engineers used for 10-year storm protection was a 20 ft wide dune at elevation +12 MLW. A 5:1 slope extended down to a 50 ft wide berm at +10 MLW, which extended seaward at a slope of 1:20.

The Rudee Inlet bypassing plant, located at the south end of the Resort beach, was also destroyed by the storm. Small dredges operated periodically thereafter to maintain the inlet channel.

Sandbridge Beach also experienced severe erosion of the protective dune and beach along nearly two miles of its shoreline. The storm drove water and sediment clear across the beach and into the Back Bay. Emergency post-storm restoration of the beach and dunes in Sandbridge was completed by the Corps of Engineers between July and November 1962.

Approximately 11,000 feet of beach and 4,800 feet of dunes were restored through the placement of about 262,000 cy of sand. The restoration plan called for the restoration of a 50 ft wide berm at elevation +10 ft MLW and 20 ft dune at elevation +12 ft MLW. The restoration work began at the naval station property line and ran south to about the Princess Anne borough line. The sand was obtained by excavating an onshore borrow pit. The triangular-shaped water body at the northern limit of Sandbridge is the remnant of this borrow pit.

2.5.2 Hurricanes of 1933

Limited information was recorded on the hurricanes of 1933 which hit the coast of Virginia Beach. However, the tide level and wind speed recordings taken suggest that these two hurricanes were of considerable magnitude. Both the August 23 and September 16 hurricanes caused phenomenal tides which were the highest ever recorded this century.

Virginia Beach experienced severe dune erosion averaging a recession of 60 ft. The storm of 23 August either destroyed or undercut all structures located on the foredunes within the zone of erosion and all light bulkheads and other structures in front of the dunes.

One fortunate aspect of both storms was that the water level rose so rapidly and to such a height that the storm waves had only limited time to impinge directly on the base of the seawall. Had this not been the case, it is almost certain that a large part of the seawall backfill would have been lost and the seawall partially destroyed (U.S. Army Corps of Engineers, 1984).

In both of these severe storms, the beach was not scoured in front of the seawall or along unprotected sections of the shore. The high sustained water level and the large volume of sand eroded from the dunes (estimated at about 100,000 cubic yards per mile) are believed responsible for the unusual lack of beach erosion.

2.6 Water Levels

The astronomical tides which affect Chesapeake Bay and Virginia Beach are semidiurnal. At Virginia Beach, the mean tidal range is 3.4 ft and the mean spring tidal range is 4.1 ft (Byrnes and Oertel, 1986). In the Chesapeake Bay entrance, the mean tidal range is 2.8 ft and the spring range is 3.4 ft (U.S. Dept. of Commerce, 1987).

At Sandbridge Beach, storm surge heights can exceed approximately 2.1 ft four times a year and 3.5 ft once per decade (Dolan et al., 1985). Also, the less frequent hurricanes produce the largest storm surges than do winter northeasters which generate larger waves (Resio & Hayden, 1973). Storm surges of 10 to 12 ft could occur along a 30 mile stretch of coast with a hurricane landfall on the North Carolina-Virginia coast (Dolan, 1985). The return period for a hurricane landfall at this location is about 42 years, or a 36% chance that a hurricane will cross that section of the Atlantic Coast within the next 15 years (Dolan, 1985).

Recently several studies have projected increases in the rate of eustatic (global) sea level rise. Some climatologists and oceanographers believe that this rise may accelerate due to a future warming of the atmosphere associated with the "greenhouse effect" produced

by increases of carbon dioxide and other gases in the atmosphere. The National Research Council (1987) investigated the engineering implications of rising sea levels and concluded that the risk of accelerated mean sea level is sufficiently established to warrant consideration in the planning and design of coastal facilities. Although there is substantial local variability and statistical uncertainty, average relative sea level over the past century appears to have risen about 30 centimeters (cm) (about 1 foot) relative to the East Coast of the U.S. Over the next 25 years, the highest rate of sea level rise recommended by the National Research Council for planning consideration would produce a 10 cm (4 inch) rise.

Beach areas are particularly sensitive to sea level rise. Bruun (1983a) suggested that as sea level rose, the beach and upper shoreface profile would erode and the lower part of the shoreface profile would acquire an equal volume of sediment. A sea level rise of one centimeter could translate into a horizontal shoreline regression of a meter or more.

Everts (1985) presented a sediment budget approach which encompasses and extends beyond the Bruun Rule. The method was applied to Smith Island, Virginia and a 50 mile segment of the Outer Banks of North Carolina to determine the portion of the shoreline retreat which was attributable to sea level rise. Everts found that 55% and 88% of the measured shoreline retreat was explainable by sea level rise at Smith Island and the Outer Banks. The remaining portions were interpreted to be due to gradients in longshore transport.

About 40% of the sand removed from the Sandbridge area is unaccounted for in typical sediment budgets. Everts (1983) evaluated sea level rise as a possible mechanism of loss. It was found that about 34,000 cy or about 20% of the unaccounted for sand could be related to static sea level rise effects. Rising sea level may have had an additional, unquantifiable effect on the dynamics of the system.

2.7 Beach Characteristics

2.7.1 Profile Shape

Goldsmith et al. (1977) note that there are two basic beach morphologic types along the Virginia Beach ocean shore. The area in the vicinity of Cape Henry is a wide beach which may be very active, either accreting or eroding from one month to the next. The second type is the narrow, inactive beach. Based upon a 27 month survey program, Goldsmith et al. (1977) generally found that the narrower beaches tend to show more extensive changes after storms and are usually slower to recover from storm effects. The profiles in the Sandbridge area are representative of the narrow beach type. The wider beaches have flatter offshore bottom slopes than the narrower beaches. These beaches are better able to dissipate storm wave energy and demonstrate a quicker recovery after storms.

Presently, the Bayfront Beach is characterized by a wide berm and gently sloping foreshore.

2.7.2 Sand Grain Characteristics

Generally, sediment sizes increase in the northward direction along the Virginia Beach resort area. The beach profile zone at which this occurs is from the foreshore seaward

out to the 6 ft depth contour. The average material size ranges from 0.25 millimeters (mm) to 0.75 mm. The sand composing the beach and dunes south of Rudee Inlet is relatively uniform with a mean grain size of 0.25 to 0.5 mm along the berm and 0.7 mm in the dunes (Goldsmith et al., 1977).

2.8 Shoreline Segment Needs Assessment

2.8.1 Chesapeake Beach

The Chesapeake Beach area suffers an erosion loss averaging 3.8 ft/yr. If allowed to continue, the recreational beach will eventually be lost. Approximately 31% of the beach length is protected by bulkheads (Byrne and Oertel, 1986). Therefore loss of the recreational beach would not imply that major property loss would also occur. Some beach restoration is therefore appropriate if current conditions are to maintained.

2.8.2 Ocean Park Beach

A beach fill of about 137,000 cy was placed on the Ocean Park shore in May 1987. The fill was obtained from the Corps of Engineers dredging of Lynnhaven Inlet. This fill should have a useful project life of about four years at the present erosion rates. A previously proposed beach plan (Byrne and Oertel, 1986) calls for a total of 180,000 cy over a 6,000 ft length of shore. This proposed plan provides for a greater initial beach berm width and a longer project life if some renourishment is not provided in the future.

The critical need in Ocean Park is in the vicinity of the inlet. Beach fills alone will not provide any meaningful solution to the problem. Waves and current conditions in the inlet area will simply redistribute any protective fill in a matter of months.

Byrne and Oertel (1986) proposed the stabilization of Lynnhaven Inlet as a means of providing long term protection to the western shore of Ocean Park. The project would consist of a high profile jetty to be constructed adjacent to the west bank of Lynnhaven Inlet. Benefits in terms significantly reduced beach nourishment requirements in Ocean Park as well as a reduction in the maintenance dredging requirements in the inlet could be expected.

The Corps of Engineers are not currently considering any form of inlet stabilization. The Corps have not experienced any significant inlet maintenance problems which would lead them to consider means to reduce the sand trapping characteristics of Lynnhaven Inlet. No requests have been submitted to the Corps by local interests for an inlet improvement feasibility study.

2.8.3 Cape Henry Beach

The Cape Henry Beach area has been accretional since 1935. The beach is expected to continue to build in the future. No specific restoration needs for this area have been identified.

2.8.4 North Beach

The North Beach area is a stable one. The Corps of Engineers Beach Erosion Control and Hurricane Protection Project (Corps of Engineers, 1984) extends the full length of the North Beach area up to the government property line above 89th Street. This Plan is currently moving through the advanced engineering design stage of development. The Corps' restoration design provides for a beach berm of 100 feet in width at an elevation of 5.4 ft National Geodetic Vertical Datum (NGVD). The beach berm is backed up by a dune fill having a 25 ft crest width at an elevation of 22.2 ft NGVD.

The proposed Corps of Engineers program includes elements which address beach restoration needs of the North Beach area. The objectives of the Corps program also include hurricane protection. In as much as this plan seeks to optimize the hurricane protection objective, it necessarily includes features which place recreational usage and beach maintenance in a position of secondary importance. Thus the overall Corps program may not be in the best interests of the City of Virginia Beach.

2.8.5 Resort Beach

The resort beach area has been the recipient of continuous beach nourishment under the recently expired Corps restoration and maintenance program. The Corps Beach Erosion Control and Hurricane Protection Plan (Corps of Engineers, 1984) which is in the advanced engineering design stage provides for the establishment and maintenance of a beach berm of 100 ft in width at an elevation of 5.4 ft NGVD. The beach is backed by a concrete seawall extending up to elevation 15.7 ft NGVD. The project with the seawall backing runs between Rudee Inlet and 57th Street where the beach berm continues in the same cross-section and the seawall is replaced by dune section (see description under 2.8.4 North Beach).

The proposed Corps of Engineers program includes elements which address beach restoration needs of the Resort Beach area. The objectives of the Corps program also include hurricane protection. In as much as this plan seeks to optimize the hurricane protection objective, it necessarily includes features which place recreational usage and beach maintenance in a position of secondary importance. Thus the overall Corps program may not be in the best interests of the City of Virginia Beach.

2.8.6 Croatan Beach

The Croatan Beach area is generally stable. The high sediment transport into the Croatan Beach area from Sandbridge and the sand trapping effects of the Rudee Inlet will continue to maintain a stable beach berm with good capability for rebuilding itself after storm damage. Long term erosion rates of 1.3 to 2.0 ft/yr near the southern end of the Croatan Beach segment could provide a potential threat to private property if these rates continue or increase in magnitude. Under these conditions some form of beach restoration would be required in Croatan Beach in the future.

2.8.7 Sandbridge Beach

Sandbridge has the most critical beach erosion conditions in the City of Virginia Beach. It has the narrowest beach berm (65 ft average as of May 1987 aerial photography). The severe storm in the spring of 1988 further diminished the beach and

resulted in significant damage and loss of property. One home was reported to be destroyed and 20 additional homes were sufficiently damaged to be condemned at least temporarily.

The beach restoration plan developed by the Corps of Engineers and endorsed or modified by Byrne and Oertel (1986), and Dolan (1985), essentially calls for a beach fill of 3,000,000 cy of sand to provide an additional 224 ft of beach berm width. The fill would provide erosion protection against a nominal 100-year storm event. The annual beach nourishment requirements to maintain the beach profile would amount to 500,000 cy.

3.0 PREVIOUS EFFORTS TO MANAGE EROSION

3.1 Corps of Engineers Resort Beach Restoration and Maintenance

Very extensive beach fill efforts took place along Virginia Beach where sand has been placed regularly on the beach since 1951. Almost 9.4 million cy of sand has been placed along six miles of shoreline, mostly within the 3.5 mile reach north of Rudee Inlet. Table 3-1 details the beach nourishment history of the resort beach area. Beach nourishment has even dated back to 1946 when approximately 1,563,000 cy of material was placed between Rudee Inlet and 46th Street during the period September 1946 - June 1952 (Watts, 1959). However, 1,313,000 cy of that material had been lost either offshore or to the north beach.

When the Virginia Beach Erosion Council (VBEC) formed in 1952, nourishment of the Resort Beach began. The initial beach restoration was completed in June 1953 with the placement of about 1,400,000 cy of sand shortly after the two jetties were constructed at Rudee Inlet. Yearly beach nourishment amounts ranged from 47,000 to 490,000 cy of sediment depending on the discovery of new sources and techniques used for restoration.

During the next five years after the March storm of 1962, approximately 900,000 cy was dredged from Owl Creek and placed on the resort beach. There was no contribution from the Rudee Inlet by-passing plant since it was destroyed.

Beach nourishment fluctuated for the next few years from 100,000 to 200,000 cy up until 1970 when the total nourishment rates were increased. Dredged material contributions from Owl Creek have occurred from 1956 to late 1974 and since then, no material from the creek has been used for the resort area restoration.

Beach nourishment operations by truck haul from upland borrow areas or sand stockpiles such as the Lynnhaven Inlet Disposal Area began as early as 1954. With the exception of a 113,000 cy truck haul contribution after the Ash Wednesday storm of 1962, truck haul operations were a relatively small part of the nourishment program until 1975. At that time the truck haul contribution increased to roughly half of the volume of sand placed on the Resort Beach. The remainder was derived from the bypassing operations at Rudee Inlet. The anticipated production program for the year ending September 30, 1988 involves a total placement of 300,000 cy with exactly half of it coming from the truck haul operations.

Federal participation in the cost of beach nourishment began on February 6, 1962 with the signing of a Local Cooperative Agreement (LCA). The Government contributed one-half of the cost of the beach nourishment costs under the provisions of the Supplemental Agreement of November, 1963. The federal participation continued until February 1987 when the 25 year period of the agreement expired. Efforts are in progress to bring about a new agreement which would essentially continue this program. In the interim on-going beach nourishment operations are being carried out consistent with the provisions of the original Agreement.

Table 3-1

Historical Sources of Beach Fill Placed on the Resort Beach

(in cubic yards)

Year	Initial Restoration	New Source Truckhaul	Early Inlet By-Passing	Inlet By-Passing	Owl's Creek	P.L. 875 Dredging	Inlet "New Source"	Annual Total
1951	20,000							20,000
1952	1,300,000							1,300,000
1953								0
1954	60,000	34,000	44,000					138,000
1955		30,000		17,500				47,500
1956								0
1957								0
1958				285,000				285,000
1959					418,000			418,000
1960								0
1961								0
1962		113,000		53,000	101,000	205,000		472,000
1963					121,000			121,000
1964					215,000			215,000
1965					218,000			218,000
1966					174,000			174,000
1967					177,500			177,500
1968				139,000	8,400			147,400
1969				100,500				100,500
1970				140,000	143,800			283,800
1971				127,000	103,600			230,600
1972		43,100		114,900	230,500		101,300	489,800
1973		12,000		86,300	260,300			358,600
1974		12,500		103,300	49,700			165,500
1975		112,470		160,960				273,430
1976		98,580		142,630				241,210
1977		123,100		166,388				289,488
1978		100,010		159,982				259,992
1979		91,826		203,214				295,040
1980		107,859		158,291				266,150
1981		152,124		180,370				332,494
1982		150,050		169,528				319,578
1983		170,520		146,875				317,395
1984		169,140		182,259				351,399
1985		146,160		238,293				384,453
1986		150,038		246,028				396,066
1987		150,000		156,682				306,682
Totals	1,380,000	1,966,477	44,000	3,478,000	2,220,800	205,000	101,300	9,395,577
Percent	14.7%	20.9%	0.5%	37.0%	23.6%	2.2%	1.1%	100%

Source: Waterway Survey & Engineering, Ltd., 1987.

3.2 Rudee Inlet Bypassing

Rudee Inlet was a small meandering inlet not more than 18 in. deep up until 1953 when the VBEC constructed two short jetties on either side of the inlet. In 1953, a fixed dredge placed at the south jetty was installed to bypass sand to the north resort beach.

After the March storm of 1962 destroyed the bypassing plant, small dredges operated periodically to maintain the inlet. In 1968, existing jetties were extended north, by 560 ft., and south, by 280 ft., in addition to a 475-ft-long timber weir at the south end where a 100,000 cy sand trap was dredged. The weir jetty system allowed sand to be trapped in the excavated area such that it could be removed and bypassed to the north resort beach.

The U.S. Army Engineer Waterways Experiment Station (WES) installed the test jet-pump bypassing system in 1975 which worked effectively up until May of 1987 when it ceased operation. The 12-inch dredge periodically removed sand from the sand trap and transferred it to the resort beach. Any remaining sand which was deposited in the inlet, possibly as a result of sand entering the inlet during periods of drift reversal, would be removed by a jet pump eductor system.

Since April 1987, a new dredge named the Rudee Inlet II gradually replaced both the eductor system and the old 12-in. dredge as the primary means of bypassing sand across the Rudee Inlet. It was purchased by the City and is currently leased to the VBEC. The COE has agreed to take responsibility for the maintenance of Rudee Inlet as a formal project. The City and COE are currently discussing the details of a revised LCA.

The existing inlet bypassing system and annual truck haul provide adequate sand nourishment for the resort beach (Byrne & Oertel, 1986). Approximately 120,000 to 150,000 cy/yr is provided artificially (bypassing) to the Virginia Beach Resort area (Waterway Survey & Engineering, 1986.). 156,000 cy was reported to be by-passed during the fiscal year of 1987 (Waterway Survey & Engineering, 1987). The necessary requirements for adequate nourishment are approximately 300,000 cy/yr for the resort beach.

3.3 Lynnhaven Inlet Maintenance Dredging

The primary concern of the federal maintenance dredging program of Lynnhaven Inlet since 1965 is to maintain a channel with fixed boundaries since a bridge was constructed across the inlet. The dredging of Lynnhaven Inlet provides sand suitable for beach nourishment as a byproduct of the channel dredging program.

A beach fill project by the Corps of Engineers was planned for the fall of 1986. Sand from the dredging of the inlet would be used for sand fill on Ocean Park Beach as described on page 2-18. The beach fill called for approximately 112,000 cy over 4,400 feet of shore (Waterway Surveys and Engineering Ltd., 1987). Byrne and Oertel (1986) called for approximately 180,000 cy over 6,000 ft. of shore.

Lynnhaven Inlet disposal site, located on the west bank of the inlet, had approximately 160,000 cy available during the months of May and June of 1987.

CHAPTER 4.0 EXISTING MANAGEMENT SYSTEM

The management and nourishment of the City's beaches involves the participation and decision-making authority of a number of governmental agencies at the local, state and federal levels. The participation by a particular agency or group of agencies depends on the nature of the project and the source of the funding. Presented below is a description of the agencies that have some level of involvement in the beach nourishment process.

4.1 City of Virginia Beach Agencies

4.1.1 Office of Environmental Management

The Office of Environmental Management (OEM) is the department within Virginia Beach city government with the responsibility for coordinating and managing environmental protection programs. Under this authority, the OEM has overall coordinating and planning responsibility for coastal management programs. The OEM works closely with other City agencies, particularly the Division of Engineering, Department of Public Works on coastal erosion efforts and issues such as beach nourishment.

4.1.2 Virginia Beach Erosion Advisory Commission

The Virginia Beach Erosion Advisory Commission's (VBEAC) primary purpose is to determine the extent of erosion problems on the City's beaches, suggest erosion control strategies, assess program implementation (City Code, Article VIII, Section 6-161 to 6-164. Its major function is to endorse the annual request made by the City to the Public Beach Board (see section 4.2.2 below) for the funding of beach nourishment projects. Virginia law (10-222, Code of Virginia) requires that municipalities have local Beach Erosion Advisory Commissions in order to receive state beach nourishment and management funds. The Commission consists of 5 members appointed by City Council.

The annual request made by the City to Public Beach Board for state funds for the beach nourishment programs performed by the Virginia Beach Erosion Council must be approved and endorsed by the VBEAC. The VBEAC does not perform or fund any actual local beach nourishment activities or projects.

4.1.3 Division of Engineering, Department of Public Works

The Division of Engineering's major involvement in beach nourishment has been in providing engineering design services and technical support. Another important function of the Division of Engineering is working with the COE in providing comments and recommendations on the design of proposed coastal engineering and beach nourishment projects in the city. Most recently, the City's Engineer has been working directly with the Corps on the design of the hurricane protection project, and on the Cape Henry Channel beach nourishment project. The Division also provides engineering support to the Virginia Beach Erosion Council.

Interaction between the Division of Engineering and the Office of Intergovernmental Coordination (OIC) on beach nourishment projects has generally been done on an as-needed basis. In many cases, once the OIC has established the initial contact and obtained

program approval or funding, discussions concerning design standards and technical program content take place directly between the sponsoring agency (e.g., Army Corps of Engineers, Public Beach Board, etc.) and the Division of Engineering.

4.1.4 Office of Intergovernmental Coordination

The principal responsibilities of the OIC are to coordinate requests by City of Virginia Beach agencies for funding, permit approval and program eligibility from state and federal governments, and to act as a lobbyist at the state level for Virginia Beach. The OIC's efforts at coordinating requests for beach nourishment projects between the various levels of government therefore comprises only one part of their overall responsibilities. Communications, permit requests, funding approvals, etc. between city agencies and state and federal offices are to be directed through the OIC.

The OIC also performs preliminary research on nourishment opportunities (i.e., federal or state programs or fundings sources for nourishment, what sand will be available, what are other municipalities doing, and upcoming dredging projects). The OIC informs city agencies such as the Office of Environmental Management and the Division of Engineering about these nourishment opportunities and about the procedures and criteria for participation.

The OIC is currently representing the City in negotiations to obtain up to 1.2 million cy of sand for Virginia Beach that is being dredged in Cape Henry Channel dredging project. The availability of this sand will depend upon the specific details of an agreement between Virginia and Maryland concerning the disposition of the dredge spoil produced as part the Cape Henry dredging project.

4.1.5 The Resort Programs Office

The Resort Programs Office functions as a clearinghouse for requests or concerns from business or citizen groups and the Resort Area Advisory Commission (RAAC). The Office Director, communicates the concerns from these groups to the City management. These concerns which relate to maintaining the economic viability of the Resort Area include issues such as: shore protection, traffic, signage, beach access, promotion, economic development, etc.

The Resort Program Office does not have a direct role in beach management and nourishment. It does provide a means for communicating concerns to the City from Resort Area interests whose economic viability is directly determined by the condition of the resort area beach. These interests perceive the beach as the City's major natural resource and the driving force behind the resort-based economy for the resort area. Therefore, resort area businesses remain very interested in actions affecting the beach and communicate their concerns through the Resort Programs Office.

4.1.6 Resort Area Advisory Commission-RAAC

The RAAC consists of the hotel/motel association, the restaurant association, and the retail association. These groups united three years ago to form RAAC. Their purpose is to promote the interests of the resort area. Thus, they have the same interest in beach nourishment projects as the Resorts Program Office.

4.2 State of Virginia Agencies

4.2.1 Virginia Beach Erosion Council

This agency provides services for, and is composed of representatives from, the City of Virginia Beach. However, it is technically and legally a state organization and is described in this section.

The VBEC consists of five council members and a staff of 20. The Council's members are appointed by the Governor. The Council is charged with maintaining the Resort area beaches (Rudee Inlet north to 49th Street) on a year to year basis. Their general purpose is defined in the Code of Virginia, Chapter 12 62.1-153 & 154 is "... stop, impede or correct erosion along the Atlantic coast in the City of Virginia Beach, and maintain jetties, groins, seawalls, to pump or otherwise place sand or any kind of material upon the beach for the purpose of correcting or controlling erosion;".

The Council was established in 1953, and funded until recently by City, state, and federal (Corps') funds. The funding for the Council now comes from the Commonwealth (the Public Beach Board-see below) and the City, which supplies approximately 80-90% of its annual budget. The Council's annual budget is $2,000,000 and is devoted primarily to it's major responsibility -- the on-going nourishment of the Resort Area beaches. This nourishment effort has two major components: the sand bypassing operation at Rudee Inlet, and the trucking of sand from the Lynnhaven Inlet stockpile to the Resort Area beach.

The major part of the bypassing operation is the operation of the dredge Rudee Inlet II, which is owned by the City and leased to the VBEC. Sand from the bypassing is sent through pipes which extend as far north as the 16th Street pier. North of this point VBEC's nourishment efforts rely on the placement of sand which is trucked from the Lynnhaven Inlet stockpile and other inland sources.

Since 1964 the nourishment program operated by the VBEC has placed approximately 9,395,000 cubic yards of sand on the beach between Rudee Inlet and 49th Street. Over this period the primary sources of sand have been Inlet Bypassing - 37%; Owl Creek - 23.6%; and truckhauling from the Lynnhaven Inlet disposal area - 21%. Since 1975 the only the first two sources of sand have been used, with an average of 177,800 cubic yards/year from the Rudee Inlet Bypassing program, and 132,000 cubic yards/year from Lynnhaven Inlet.

The City has no direct control over the VBEC, even though providing a large share of their annual budget. The City and the VBEC do keep each other informed of their plans with regard to the resort beach, and the VBEC does work closely with the Division of Engineering.

The City may introduce legislation to have the VBEC abolished. The Council has outlived its original purpose as the City now has the full range of capabilities assigned to the Council.

The VBEC did not have a direct role in the planning of the Hurricane Protection project. This is because their charter limits the council's jurisdiction to only the dredging and depositing of sand from Rudee Inlet. They have no role in any other beach nourishment scenario.

4.2.2 Public Beach Board

The Public Beach Board (also known as the Board on Conservation and Development of Public Beaches) was established in 1980. The Board's primary responsibility, as outlined in the Code of Virginia Chapter 21, 10-215 through 10-222 is to:

- o Review the financial needs of localities for implementation of the Public Beach Conservation and Development Act;
- o Determine successful applicants and the equitable allocation of funds among participating localities; and
- o Oversee the local implementation of approved projects.

The Public Beach Board supplies 30% of the funds availabe in a fiscal year to Virginia municipalities. Under the Shoreline Programs Office of the Commonwealth, the Public Beach Board supplies part of the funding of the VBEC. In 1988, the VBEC will receive $210,000 from the Public Beach Board. The City of Virginia Beach supplies approximately 80-90% of the annual budget of VBEC.

Municipalities can approach the Board to ask for financial assistance in underwriting 50% of the cost of beach nourishment. A project must be designed to conserve, protect, improve, maintain and develop public beaches in order to receive consideration for funding from the Public Beach Board.

Virginia Beach will not receive any financial assistance from the Public Beach Board for the Beach Erosion Control and Hurricane Protection Project. Neither the cost of constructing the protective seawall nor the beach nourishment will receive state funds. This is because this project was viewed by the Board as a hurricane protection program whose primary benefits were the protection of shorefront real property as opposed to providing recreational benefits generated by a beach nourishment. Engineered structures such as a jetty or groin are more likely to receive funding assistance from the Board. A municipality can directly contact the Virginia General Assembly and make a request to be considered for a Senate appropriation for such a project.

A municipality cannot first secure federal dollars for 50% of a project's cost and then ask the state to match that amount so as to avoid any local cost share. It can contribute a local share, seek the same amount from the state and then seek a 50% match (equal to the sum of the local and state shares) from the federal government for a federal program. This approach results in a 25% cost share for the local government.

The Board will generally vote in favor of the municipality with the smaller beach area when competition exists among two municipalities for the same sand appropriation. Smaller beach area in this context means the municipality with the narrow beach and/or lesser dry sand area.

In addition to providing funding and appropriation services, the Board often provides technical guidance to local governments through the services of the Virginia Institute of Marine Sciences (VIMS). The Board retains VIMS as its technical advisor/consultant when applications for sand appropriations or funding are made.

The Beach Board has the responsibility for allocating the sand from Corps-sponsored projects where the Virginia Port Authority is <u>not</u> the local sponsor of the project. In cases where the Port Authority <u>is</u> the local sponsor, the Public Beach Board and the Port

Authority work closely together in allocating the sand to Virginia local governments seeking it for beach nourishment. Nominally, the Port Authority has the responsibility for allocating the sand, although the Public Beach Board and the authority work closely with each other.

The Public Beach Board currently provides state funding for small beach nourishment projects, with amounts generally no larger than several hundred thousand dollars (Payne, 1988). At present the Public Beach Board does not provide a state share for large beach nourishment projects that seek a federal 50% share under Section 933 (see Section 4.3.1) of the difference between the cost of beach nourishment and the cost of dredging with ocean disposal (Payne, 1988).

The increased ability to provide timely decisions on beach nourishment applications and decisions is due to the fact that Jack Frye of the Public Beach Board is now part of the Port Authority's Dredging Management Staff. This enables both organizations to work together on beach nourishment projects, particularly applications by Virginia municipalities for funding under the COE's 933 beach nourishment funding program.

4.2.3 Virginia Port Authority

The primary goal of the Authority is to operate and promote the use of the Ports of Virginia. Under this mandate the Authority often function as the local sponsor for COE dredging projects which are intended to maintain or enhance the use of navigable waterways falling under the jurisdiction of the Corps. The Port Authority provides the sponsors cost share for these dredging projects and assumes the responsibility for allocating the sand from these projects for local Virginia governments seeking to use it for beach nourishment.

At present, the Virginia Port Authority is the agency with responsibility for allocating the sand from several on-going and soon-to-happen dredging projects for which it is the local sponsor, and which will result in the deepening of channels leading into and out of the Hampton Roads Harbor. The Authority sends out the initial letters of interest to municipalities, and coordinates the allocation of sand with the COE and the Public Beach Board.

4.3 Federal Agencies

4.3.1 United States Army Corps of Engineers (COE), Norfolk District

A primary responsibility of the COE is to maintain the navigable waterways of the United States. The means by which this is accomplished is through dredging to maintain sufficient depth in navigable waterways, and through new dredging to deepen navigable channels to enable them to accommodate larger vessels. A by-product of such dredging can be large volumes of dredge spoil in the form of clean sand which is suitable for beach nourishment. The COE has other responsibilities for the protection of shorefront areas from storm related flooding and coastal erosion. This responsibility is evidenced by the proposed hurricane protection plan for Virginia Beach which will be designed and constructed by the COE.

Beach Nourishment Cost Sharing Under Section 933 of the Water Resources Development Act of 1986. This is the primary vehicle through which the COE is involved in beach nourishment projects where sand is placed on a beach by the COE. This legislation specifies the criteria and cost sharing percentages for COE involvement in beach nourishment projects using the spoil produced by dredging. Under this law, the COE will pay 50% of the increment between the cost of placing sand on the proposed beach and the cost of placing the dredge spoil in the designated disposal site.

The 50% cost share will be paid by the COE if a beach nourishment project is determined to be in the federal interest. The interpretation by the COE of Section 933 is that a project is in the federal interest if it provides storm protection benefits. Recreation benefits provided by a wider, nourished beach are not considered.

As an example of a 933 project, if a project is shown to be in the federal interest, and if the normal cost of disposal is $3/cy, and would be $4 with beach nourishment, the COE will pay 50% of the differential, or $.50/cy. A Virginia municipality pays the remainder of the cost. The Public Beach Board will pay part of a 933 project if requested by the municipality. Municipalities have always had the option of getting sand from a COE project if they were willing to pay the full cost of the difference between normal disposal and placement on a beach.

Whenever the COE has a dredging project that will produce sand suitable for beach nourishment they notify the local contact, usually the local sponsor. In the case of the Norfolk channel projects this is the Virginia Port Authority. For other projects, it is Jack Frye of the Shoreline Programs Office of the Public Beach Board. The local contact then has the responsibility to inform local municipalities and to get requests from them for the sand. The local contact then submits these requests to the COE. If a local government is willing to pay the full delta (i.e., the cost differential between putting the sand on a beach and the normal disposal option), then no action is taken by the COE other than to do a preliminary estimate of what the municipality's cost share will be.

A COE spokesman (Ogle, 1988) noted that the first thing the municipalities had requested, prior to the preparation of a 933 study (which municipalities must agree to pay for), is an estimate of the costs of providing the sand. This presumably lets the requesting municipalities know whether their potential cost share is something they can afford.

If a municipality is requesting the COE to fund half of the cost increment then the 933 study process is begun. The municipality must then agree to pay half the cost of the 933 study if a project results from the study. The COE performs this study to determine if the project is in the federal interest and estimate what it will cost the municipality. The Corps will not participate in a project that is not environmentally sound. If the 933 study deems a beach nourishment project to be in the federal interest, then the municipality must obtain funding for their 50% share of the cost increment.

The COE then decides which of these requests they will prepare 933 studies on. The COE does not have to prepare 933 studies for all requests.

The only beach nourishment project approved to receive sand from the Cape Henry Channel dredging project under Section 933 is the Virginia Beach beach nourishment plan. The location of the Cape Henry Channel, and other navigation channels in the region, is shown in Figure 4-1. The 933 study done for the Virginia Beach request for sand from the

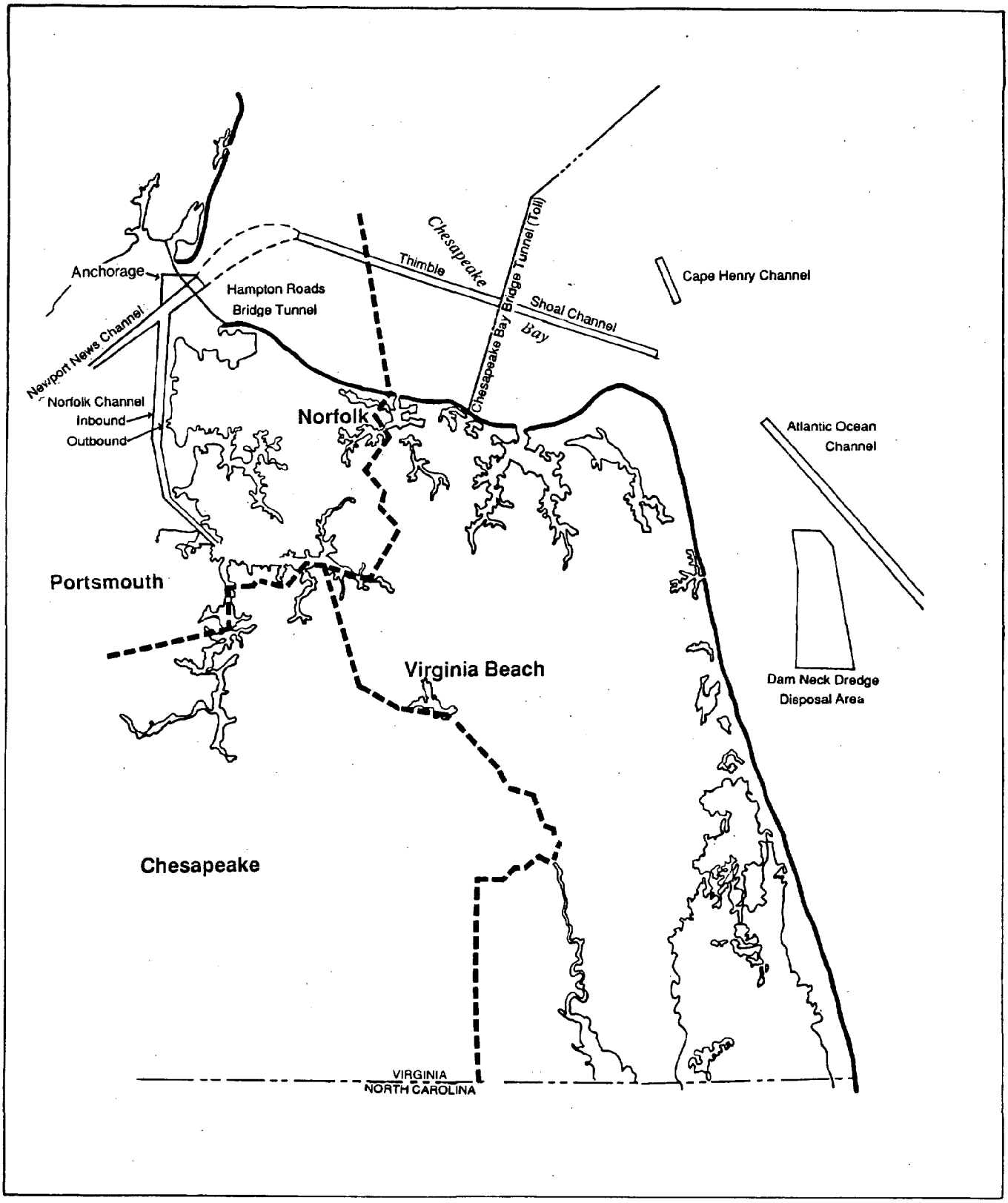


FIGURE 4-1

Navigation Channels in the Norfolk/Virginia Beach Region

0 2.5 5miles

RGH

Cape Henry dredging project has determined that it is in the federal interest to provide 964,000 cy of sand at a cost of $5,221,000 ($5.42/cy) (Pezza, 1988). This is very fine sand and an overfill ratio of 2.67:1 has been assumed. This sand will result in a beach 100 ft. wide, 20:1 slope, and the height of the beach will be 9.5 ft. above MLW. Placement of sand on the East Ocean View beach in Norfolk was found not to be in the federal interest. The normal disposal area for the Cape Henry sand, if not used for beach nourishment, would be the Dam Neck disposal area, an open water disposal area located four miles offshore from Virginia Beach.

The COE has already received 15 requests from Virginia municipalities for sand from the deepening of the Norfolk channel to 55 ft., scheduled to begin in 1990. This project has received congressional authorization and will proceed. Their preliminary analysis shows that probably 12 of these are potentially fundable requests.

Annual Beach Nourishment Under Section 934 of the Water Resources and Development Act of 1986. There was a Federal Assistance Agreement between the COE and the City for the nourishment of the Resort Area beaches between Rudee Inlet and 49th Street (the northern boundary of the old City of Virginia Beach). The two components of this nourishment program were (and are) the Rudee Inlet sand bypassing operation (which placed sand on the beach up to 16th Street), and the trucking of sand from the Lynnhaven Inlet stockpile. Under this agreement the Corps paid 50% of the cost of nourishment. This agreement began in 1962 and ended in 1987.

Section 934 provides for establishment of an LCA between a local government and the COE for continuing authority to nourish beaches and maintain them at a specified design standard (e.g., width of berm, height of berm above mean low water). The Act establishes a 50% cost sharing between the Corps of Engineers and the local municipality. The Act calls for a 25 year agreement, although the COE is currently approving only 10 year agreements. Sand used for nourishment under this Act can come from a variety of sources, and is not limited to sand from dredging projects.

Maintaining Navigable Waterways. The other vehicle for COE involvement in beach nourishment at the local level is through Local Cooperative Agreement's (LCA) between the COE and local municipalities that define the COE responsibility for maintaining local navigable waterways, including inlets. These are projects authorized under Section 107 of the Rivers and Harbors Act of 1960.

An LCA between the Corps and the City of Virginia Beach concerning Rudee Inlet was reached in March, 1986. A revised LCA is being drafted at the present time (August, 1988). Under this LCA, the primary responsibility of the COE will be to maintain the navigability of the inlet, and not to provide sand for beach nourishment. The COE will contribute 75% of the initial construction costs and 100% of the annual maintenance costs for maintaining the inlet. The total contribution by the Corps is limited to $4,500,000. This funding is provided under a Section 107 Continuing Authority project. The City will supply their own funds to make the federal funds last as long as possible.

Even with the COE assuming responsibility for maintaining the navigability of Rudee Inlet, the VBEC will still have their responsibility for nourishing the Resort Area beaches. Communication between the City, VBEC and the COE will have to be maintained to ensure that the various dredging activities conducted in and around Rudee Inlet do not conflict with one another.

The involvement with beach nourishment is indirect under this type of LCA as their primary objective is the maintenance of navigation. The sand generated by the maintenance dredging needed to maintain navigability can often be used for beach nourishment. A noteworthy example is the Lynnhaven Inlet LCA where sand from the inlet has been placed on the City's resort beaches for many years. As noted above, a new LCA between the City and COE for Lynnhaven Inlet has recently been signed and the COE will be assuming responsibility for the maintenance dredging of Rudee Inlet this fall. In Virginia Beach, sand from the dredging of Lynnhaven Inlet has been stored at a site immediately south of the Lessner bridge over the Inlet.

Coastal Engineering. The final type of COE involvement in beach nourishment is the construction by the COE of engineered structures, including seawalls, groins, or jetties. Usually a local government, with possible assistance from the state, proposes a project to the COE. However, it is possible that the COE may propose a project based on needs assessments conducted by the COE. As an example, the Beach Erosion Control and Hurricane Protection Project for Virginia Beach grew out of a study by the COE.

4.4 Existing Proposals for Beach Nourishment

This section describes existing proposals for beach nourishment and management that are being considered for implementation in Virginia Beach. These include proposals to use sand from Army Corps of Engineers dredging projects. Figure 4-1 shows the location of the different navigation channels in the lower Chesapeake Bay area that are currently being dredged, or are proposed for dredging, that will produce sand for beach nourishment.

4.4.1 Cape Henry Channel Dredging Project

A prior analysis showed that there was not enough sand economically recoverable from the Thimble Shoals 50' Outbound Channel dredging project to warrant using it for beach nourishment. The Cape Henry 50' Channel dredging project is slated to start in the Fall of 1988. A 1981 agreement between Virginia and Maryland specified that sand from Cape Henry dredging would go to a stockpile at Fort Story having a storage capacity of 600,000 cy, with Maryland paying all costs. The agreement was later modified so that sand from the Cape Henry Channel dredging would go to only two locations for beach nourishment: the Resort Beach in Virginia Beach and East Ocean View beach in Norfolk. Maryland will pay all costs for putting sand at these two locations. This will be a one-time agreement covering just the dredging of Cape Henry Channel.

Virginia Beach will receive up to 1.2 million cy of sand from the Cape Henry Channel dredging project which is to be placed on the Resort Beach at no cost to the City under the above agreement. The Corps determined that this project was in the federal interest and would be eligible for a 50% cost share under Section 933. However, Maryland will be paying the full cost of putting this sand on the Resort Beach. For future maintenance dredging of the Baltimore channels Virginia will have the option of getting this sand at their (Virginia's) cost.

Sand from Cape Henry dredging project may be ready for placement on the resort beach early this winter. This sand is felt to be only temporary measure that will provide only a modest benefit for Virginia Beach until more sand begins to be placed on the beach in

1990. The placement this winter of the Cape Henry sand on the City's beaches will not interfere with the subsequent hurricane protection study as much of this sand will likely not stay on the beaches. This is because the Cape Henry sand has a smaller grain size than the sand on the Resort and North Beach segments. A significant proportion of this smaller-grained sand will wash off the beaches. An overfill ratio of 2.67 to 1 has been assumed for this project.

A major issue is the need for the state, the city and the COE to be talking about coordinating the availability of sand from future Norfolk dredging projects with the need for sand for the Beach Erosion Control and Hurricane Protection project.

4.4.2 Beach Erosion Control and Hurricane Protection Project for Virginia Beach

The COE has designed a Beach Erosion Control and Hurricane Protection Project for the City of Virginia Beach. A draft of the design memorandum is expected to be released in October, 1988. This project has two main components: 1) a protective seawall extending between Rudee Inlet and 58th Street; and 2) a one-time beach nourishment project. The project as originally designed provides protection against the 54 year storm, with the design of both the seawall and beach interacting to provide this level of protection. The cost of this project will be split 65/35 between the Federal Government and the City.

The COE estimates that construction of the seawall component of this project will begin in 1990, and that the beach nourishment component will begin the following year. The entire project is slated to be completed by 1992.

A final agreement between the COE and City with regard to the design of the protective seawall is being worked toward. The two primary concerns of the City are related to the seawall: 1) the elevation of the seawall above the boardwalk, and 2) the location of the seawall relative to the boardwalk (be landward or seaward of the boardwalk).

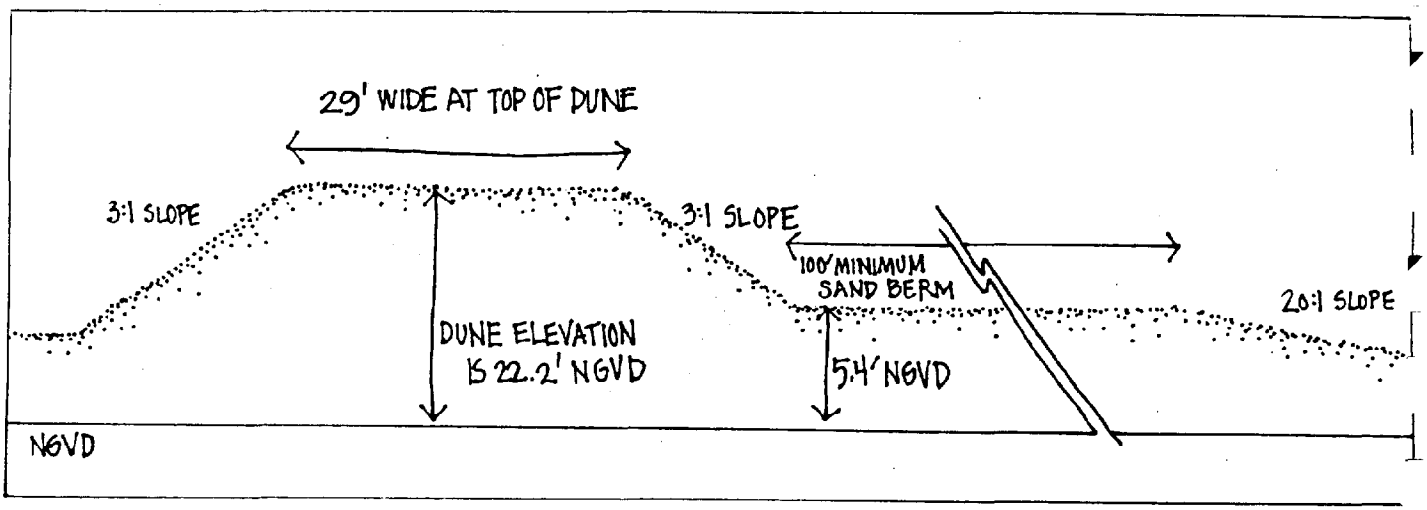
The elevation of the top of the seawall is proposed at 15.7 ft. NGVD as shown in Figure 4-2. This elevation would constant along the entire length of the seawall. The major design issue of concern to the City is the height of the seawall above the boardwalk. The boardwalk ranges in elevation from 13.5 ft. NGVD on the north to 10.5 ft. NGVD at Rudee Inlet. The average elevation is 11.5 ft. NGVD. Thus, the top of the seawall would be, on average, 4.2 ft. above the boardwalk, varying from as much as 5.2 ft. higher near Rudee Inlet to as little as 2.2 ft. higher where the ends at 57th Street.

The City is also working with the Corps on the location of the seawall relative to the position of the boardwalk. Placing the seawall landward of the boardwalk would allow for unrestricted access to the beach for boardwalk users such as walkers, swimmers, joggers, and bicyclists. This location would also provide an unobstructed view of the ocean from the boardwalk. It is possible that placing the seawall further inland could result in a lower design elevation.

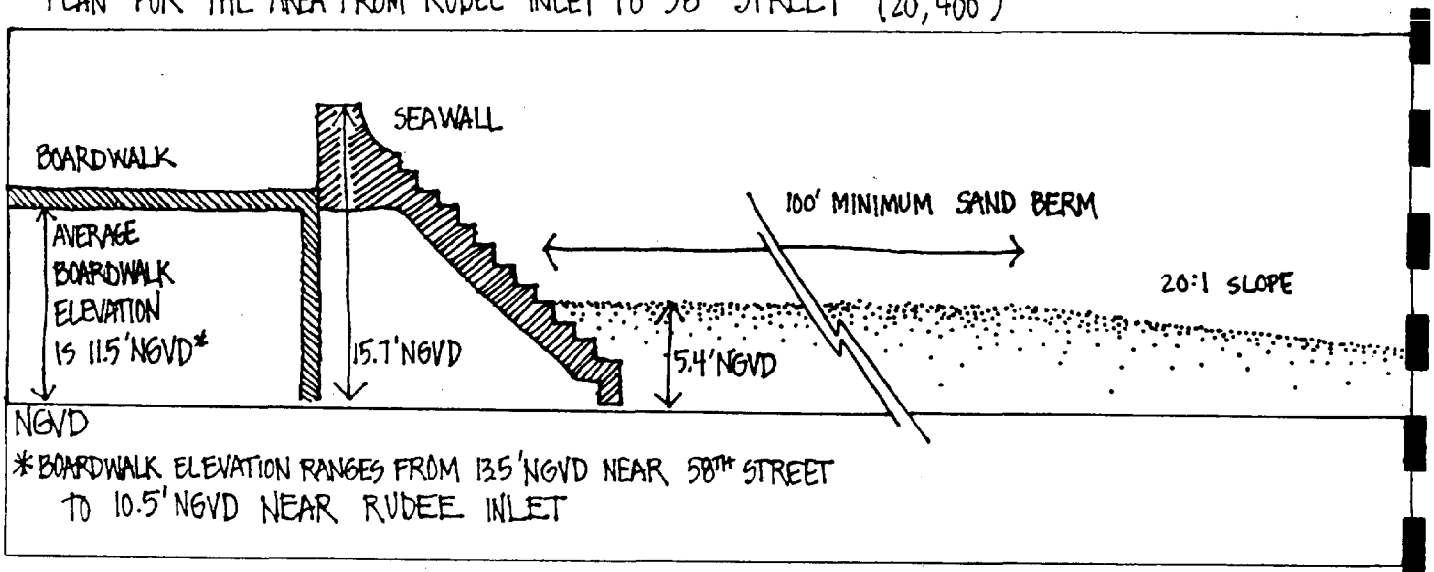
The City is concerned that the seawall may obstruct the view of the beach from the adjacent boardwalk and hotels/motels fronting on the boardwalk to such an extent that tourists would find the Resort Area less desirable, and ultimately choose to visit other locations. Another concern of the City is to provide the necessary design amenities for the seawall in order to mitigate its potential adverse impacts. These amenities could include benches, planters, use of color, landscaping, etc. These features would most likely not be covered under the cost sharing agreement for the seawall.

FIGURE 4-2 PROPOSED PRELIMINARY DESIGN OF THE BEACH EROSION CONTROL AND HURRICANE PROTECTION PLAN FOR VIRGINIA BEACH

PLAN FOR THE AREA FROM 58TH TO 89TH STREETS (11,400')



PLAN FOR THE AREA FROM RUDEE INLET TO 58TH STREET (20,400')



*BOARDWALK ELEVATION RANGES FROM 13.5' NGVD NEAR 58TH STREET TO 10.5' NGVD NEAR RUDEE INLET

SOURCE: US ARMY CORPS OF ENGINEERS, NORFOLK DISTRICT, 1988.

The COE indicated to the City that the level of protection would decline so dramatically by reducing the height of the wall the requested 2.2 ft. that the project would no longer be cost beneficial. The City would incur substantial increases in maintenance dredging costs to maintain a wider beach, coupled with the wall only providing protection against a 20 year storm.

The dimensions of the beach as originally proposed would consist of a 100 ft.-wide beach berm at 5.4 ft. NGVD with a 20:1 slope. This dimension would apply to both the section of the beach in front of the seawall and the beach between 57th and 89th Streets. North of 57th Street, sand dunes with an elevation 22.2 NGVD would provide protection. The Corps estimates that the initial dimension of the beach would be 200' wide at an elevation of 6.4 ft. NGVD. After erosion losses, the beach would stabilize at dimensions of a 100' wide berm and an elevation of 5.4 ft. NGVD (equivalent to approximately 7' above MLW). The COE has further estimated that a total of 1,227,000 cubic yards of sand in-place will needed to achieve the desired final beach dimension. Substantially more sand than this will need to be dredged due to losses during handling and erosion losses from the beach. The COE is assuming an overfill ratio of 1.55 (Pezza, 1988).

Once the beach has stabilized, approximately 150,000 cubic yards per year of sand will be needed to maintain the beach (Pezza, 1988). The periodic beach nourishment will be performed under a new Section 934 Agreement covering the Resort Area and North Beach segments. Under this act, beach nourishment costs would be split 50-50 between the COE and Virginia Beach.

The COE is assuming a borrow source located near the proposed Norfolk Channel deepening project at Thimble Shoals, and that no sand would be available from a dredging project. This would mean that they would have to mine the sand from this deposit and put it on the beach using a hopper dredge. If sand becomes available from a dredging project this would decrease the COE costs for the Beach Erosion Control and Hurricane Protection Project. The timing of the Norfolk channel deepening may dovetail nicely with the Virginia Beach Hurricane Protection project, providing the source of sand from close to the same area that the COE is considering mining it from.

4.4.3 Annual Nourishment of the Resort Area Beaches

The City is currently attempting to establish a new beach nourishment agreement with COE under Section 934 of the Water Resources Development Act of 1986. The agreement which lasted for 25 years and expired February 6, 1987. The proposed LCA between the City and the COE has been approved, but not yet signed, as nourishment of the beaches between Rudee Inlet and 49th Street has been found to be in the federal interest. The City's intent is to have this agreement begin after the completion of the Beach Erosion Control and Hurricane Protection project. Under this program the cost of nourishing City beaches between Rudee Inlet and 49th Street would split 50/50 between the Corps and the City.

The COE estimates that 150,000 cubic yards of sand per year, not including the sand available from Lynnhaven Inlet, would be needed to maintain the beaches at the dimensions noted above in the discussion of the Beach Erosion Control and Hurricane Protection Project.

4.4.4 Longer-Term Beach Nourishment Projects

Offshore Berms, or the Murdens Mound Project The Public Beach Board, with input from Virginia Beach officials, has requested the Corps of Engineers to investigate the feasibility of offshore feeder berms and stabilizing berms as a technique for beach nourishment. Under this approach, sand would be placed in berms located offshore. The feeder berm would rely on tidal action and littoral drift to move sand shoreward and naturally replenish the beaches. The stabilizing berm would be located seaward of the feeder berm. Its purpose would be to protect the feeder berm erosion and storm impacts so that it (the feeder berm) can continue to serve as a sand source for beach nourishment.

Ocean Mining Ocean mining may prove to be an adequate source for beach fill since a limited number of borrow pits remain. Due to current development, the location of sites left for use as borrow pits will become more remote. As a result, hauling costs will increase and it will soon be uneconomical to utilize sand material from land reserves. However, obtaining sand from ocean mining may prove to be costly and difficult should the areas be too remote for dredging and pumping.

A recently published document, A Summary of Sediment Characteristics of the York Spit and Cape Henry Channels by Dr. Suzette Kimble of VIMS, discusses potential offshore borrow sources in lower Chesapeake Bay.

Beach Nourishment from Major Dredging Projects Future plans for the dredging of navigation channels leading from the Lower Chesapeake Bay into the Atlantic Ocean are currently under evaluation and are listed in Table 4-1.

Additional sand for beach nourishment will be available when the deepening of the outbound navigation channels to 55' or 60' begins. These include the Norfolk, Atlantic Ocean, Thimble Shoals and Newport News outbound channels. These projects are currently unscheduled, and the earliest of them -- the Newport News outbound channel -- would not begin before late 1990 (McGee, 1988). These projects could supply millions of cubic yards of sand. However, the funding for these projects are uncertain, thus the availability of and timing of sands from them is also unknown.

Table 4-1

CURRENT AND PLANNED FEDERAL DREDGING PROJECTS

CHANNEL	DEPTH (FT)	VOLUME (CY)
Norfolk	55 outbound	4,300,000
Atlantic Ocean	60 outbound	9,600,000
Newport News	55	4,500,000
Thimble Shoals	55 outbound	7,400,000
Anchorage	55	800,000
Cape Henry*	50	2,900,000
York Spit**	50	10,500,000

Notes:

1. Sands in the Cape Henry project are estimated to have overfill ratios of 2.3 to 2.6

2. Sands in the York Spit project are estimated to be of excellent quality for beach nourishment with an overfill ratio of 1.2

Source: McGee, 1988.

5.0 BEACH NOURISHMENT ALTERNATIVES

This chapter presents the different management alternatives for beach nourishment. A brief description of structural and non-structural methods for placing more sand on a beach are presented. Then the sand resources available in the Norfolk/Virginia Beach region for use in beach nourishment are presented. The two primary types of resources are sand from proposed dredging projects, and off-shore sand deposits.

5.1 Introduction to Management Alternatives

Up to this point, this report has discussed the existing and anticipated coastal environment in the area of interest in order to provide a setting for the planning process. This section opens the direct discussion of beach management planning by presenting an overview of the many alternative approaches to beach management planning.

5.1.1 Objectives and Procedures

In general, the objectives of a beach management program or, more specifically, an erosion protection plan may be classified into two general categories:

- o amelioration of erosional processes;
- o recreation enhancement.

Erosional processes are related to long-term trends in the prevailing coastal environment or to storms. Planning for these two types of erosion usually takes much different forms. In the study area, storm protection may be affected for moderate hurricanes or northeasters through either engineering or land management techniques while engineering protection from extreme hurricanes appears to be infeasible.

Recreation is meant here to be broadly inclusive of the many types of beach uses ranging from the traditional beach visitor through appreciation of the beach for its aesthetic value (the latter does not even require that the "user" physically be at the shore). Recreational enhancement, then, can range from maintaining a narrow strand for private use, through maintaining a wide beach to accommodate a larger public demand, to simply preserving the beach in its natural state (which may limit or prescribe public and private use). The stated objective desired for a particular reach will determine the alternatives available to achieve it.

A wide range of techniques have been implemented by nearly all levels of government, and by individual and private shore front property owners to adjust to coastal erosion processes. Two basic approaches to shore protection are suggested. First 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. Second, 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 private property owners and the general public where erosion is occurring.

5.1.2 Engineering Alternatives

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 non-structural methods such as beach nourishment, intertidal vegetation, and dune stabilization.

The application of any 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 evaluations.

Properly applied, the methods summarized in this section have the potential to mitigate erosion of the beaches in the study area. However, improperly used, the methods may accelerate or aggravate existing erosion conditions and increase the short-term erosion damage associated with storms. Even proper use may not be appropriate after a careful weighing of costs and benefits.

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 wave attack. 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 ocean front, bulkheads are normally located above the high water level so that they are not brought under direct wave attack except during storms or at times of very unusual tides. Revetments are flexible sloping structures designed to protect shorelines against erosion by currents or wave action. The degree of protection afforded depends on the materials used and the method of construction.

Bulkheads and revetments are commonly seen in the City of Virginia Beach. They appear to have all been privately constructed for the protection of individual homes and lots. Their state of design, construction, and repair vary considerably. For example, the structures range from what appears to be Christmas trees placed to increase the primary dune height by interrupting eolian sand transport to armor stone revetment/wooden bulkhead combinations that are an integral part of the basic structure.

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 updrift shoreline erosion. 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.

Seawalls, bulkheads, and revetments can also have an effect on seaward beach profiles. Scour can be expected 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 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. These structures are not effective in reducing loss of the seaward beach and, in fact, may accelerate erosional effects.

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 some desired portion of the littoral drift. 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 uneconomic (USACOE, CERC, 1984).

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 sand and the prevailing wave climate. At some 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, groins affect the normal movement of beach sands for some distance downdrift. 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 used 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 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 (Surf zone is defined as the area between the outermost breaker and the limit of wave uprush (Corps of Engineers, 1984). In the case of high profile groins, some of the littoral material can be 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 groin 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 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, 1984).

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.

Offshore Breakwaters. Offshore breakwaters are structures designed to protect shore areas from direct wave action. 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 behind the breakwater. 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, 1984).

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.

Beach Nourishment. Beach nourishment can range from the periodic replacement of sand lost by erosion to the extensive placement of sand to the construction of 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. Typically beach nourishment projects are designed for a specific project life. After that design period, the project has to be rebuilt. A permanent commitment to funding period beach nourishment is required if it is adopted as a beach preservation technique.

The retrieval and use 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; and
- 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 angle of wave attack (such changes may affect the rate of littoral drift along the shoreline, which can change erosion or accretion patterns).

Sand Scraping. Beach scraping is the removal of material from the lower part of the beach for deposition on the higher part of the beach or at the dune toe. Beach

scraping is usually performed by a scraper pan which removes or skims the uppermost layer of the beach. Bulldozers are used on narrow beaches which do not provide sufficient maneuvering room for a scraper.

Beach scraping is different from artificial nourishment. Artificial nourishment is replacement of eroded material by new material generally borrowed from a remote source. Scraping is the redistribution of the available beach material in a manner which improves the coastal protection capabilities of the overall beach profile without providing any new beach material.

Bruun (1983b) examines the advisability of beach scraping and concludes that:

- Beach scraping by skimming thin surface layers where surplus material is available in the profile is beneficial as protection for eroding dunes;
- Technically responsible beach scraping does not have an adverse effect on adjacent beaches; and
- Beach scraping is a method of arranging the available beach material in a more sensible manner on a short term basis. It is a temporary procedure which does not replace artificial nourishment.

It is also concluded that beach scraping should only be done where surplus beach material is available in the profile. This will usually occur in the area of active fluctuation of the profile where ridges build up by swell activity following a storm or during the spring and summer seasons. The material which comprises the beach ridge comes from the near shore bottom. The scraped beach material should be used to protect the dune by placing it at the dune toe. A judicious scraping program will skim no more than about one foot of the upper surface of the beach.

Sand Bypassing. Sand bypassing involves the mechanical transfer of sand around littoral barriers such as jetties and breakwaters. The basic methods of sand bypassing are by means of permanent bypassing plants, floating bypassing plants, and land-based mobile equipment.

Sand bypassing schemes are designed to relieve the erosion conditions which occur downdrift of littoral barriers. Sand from an accretion area updrift of the barrier is used to nourish the eroded downdrift beaches. In other situations, sand traps are excavated in inlet areas. These traps are periodically dredged to remove the sand which is deposited there by the tidal currents in the inlet. Effective bypassing is accomplished when the dredged sands are deposited on the downdrift beaches.

Dune Stabilization. Dunes that form just behind the beach perform a vital role in littoral processes. The foredunes function as reservoirs of sand to nourish eroding beaches during high water conditions and as levees of sand to prevent wave damage to backshore areas. As such, they are valuable non-rigid natural shore protection features. Well-stabilized inland dune ridges are a second line of defense against erosion if the foredunes are destroyed by storms.

Sand fences slow sand movement by reducing wind velocity in their immediate vicinity. When properly designed and installed, they can be very efficient sand-trapping devices. Where optimum conditions of blowing sand occur, dune accumulations in excess of 12 cubic yards of sand per year per yard of beach have occurred.

While fences are effective in trapping windblown sand, they have little or no effect on sand movement once they are filled. Fence built dunes must be stabilized or the fence will deteriorate and release the sand. Vegetation is generally the only feasible long term means of stabilizing sand dunes (Woodhouse, 1978). Although some fence built dunes become vegetated naturally under very favorable circumstances, the planting of vegetation on fence-built dunes is usually essential to their survival.

Fences have two initial advantages over planting which warrant their use before or with planting: a) sand fences can be installed during any season; and b) the fence is fully effective as soon as the fence is installed (Woodhouse, 1978).

5.2 Available Sand Resources

5.2.1 Channel Dredging

The dominant surficial sediment of the Chesapeake Bay entrance is a homogeneous gray, fine to very fine quartzose sand. This fine sand mantles the bottom almost everywhere, except the channels and Lynnhaven Bay area where gray silt is the dominant sediment type. Medium and coarse sand is rare; the only sizable concentration at the surface occurs in Thimble Shoals Channel where a light brown coarse sand with streaks and patches of gravelly sand occur in outcrops. Some concentrations occur in thin patches on the southwest rim of Chesapeake Channel (Corps 1972).

Significant deposits of suitable sand, which has nearly the same size characteristics of the native beach and is composed of hard inorganic material, can be found in the Thimble Shoals Channel and along a re-entrant in the south flank of Tail of the Horseshoe-which lies between Chesapeake Channel and Thimble Shoal Channel. It was estimated back in 1972 that 19.4 million cy of suitable sand can be obtained from Thimble Shoal Channel either in direct exposure or under less than five ft. of overburden (Corps 1972). Grain sizes ranged from 0.15 mm (fine) to 1.00 mm (coarse) for typical samples of Thimble Shoals Channel. Also gradation plots indicate material is well or densely graded. According to Wright et al. (1987), the median grain size of the fill material should be 0.25 mm or larger for uses of sand nourishment.

Section 4.4 above (pages 4-8 through 4-11) discussed the proposed COE channel deepening and maintenance projects that would produce significant quantities of beach nourishment quality sand.

5.2.2 Borrow Pits

The City of Virginia Beach purchased 72+ acres of land in the South Birdneck Road (VBEC Borrow Pit "A"). The reported median grain size of the sand ranges from 0.2 mm to 0.4 mm, with an average value of 0.24 mm. Evaluations of the sand quality was conducted by the COE using soil boring data. One of four discernible soil layers was found to be suitable. However, sand placed on the beach from this site proved to be somewhat less

than suitable. Further evaluation of the sand resources in Borrow Pit "A" are required before the site can be considered as a source for beach nourishment operations (Waterway Survey and Engineering, Ltd., 1987).

The VBEC purchased mineral rights to an 11 acre site on Oceana Boulevard (VBEC Borrow Pit "B") for use as a borrow pit. Soil borings indicate the presence of a 26 ft minimum thickness layer of beach nourishment quality fine to medium sand. The grain sizes range from 0.25 mm to 2.75 mm, averaging 0.95 mm. The total volume of sand available was estimated at 310,000 cy. Approximately 150,000 cy of sand was excavated and placed on the Resort Area beach during the 1987 truck haul program. The remaining 160,000 cy would provide enough sand for one additional annual truck haul program (Waterway Survey and Engineering, Ltd., 1987).

5.2.3 Inlet Dredging

The sand trap and navigation channel dredging of Rudee Inlet can yield between 80,000 and 250,000 cy of sand per year. As of 1987, the yield was estimated at 155,000 cy, of which nearly all is considered suitable (Waterway Survey and Engineering, Ltd., 1987).

Dredging of the federal project channel in Lynnhaven Inlet produces about 200,000 cy of clean beach quality sand. The dredging operations typically occur on a 2 to 3 year cycle. The sand is stockpiled at the Lynnhaven Disposal site adjacent to Lessner Bridge (see Figure 1-4). Spring truck haul operations transfer this sand to the Resort Area beach. Approximately 160,000 cy of sand was dredged from Lynnhaven Inlet and stockpiled in 1987. This sand was placed on the beach in 1988 (Waterway Survey and Engineering, Ltd., 1987).

The VBEC has a permit to conduct dredging operations in the Lynnhaven Channel and turning basin for the purpose of mining and stockpiling sand. The sand would be stockpiled in the Lynnhaven Inlet disposal site. This sand mining operation would have to be scheduled so that stockpiling would not interfere with the periodic federal dredging operations to maintain navigability of the Inlet. To date (August, 1988), this sand mining option has not been exercised.

5.2.4 Offshore Sand Deposits

VIMS is currently investigating the possibility of offshore sand deposits which may have the volume and sand quality characteristics to make them potentially feasible sources of beach nourishment sands. Recent studies identified a body of course grain sand with an apparent volume of 12 - 14 million cy. The site is located offshore of Sandbridge to the south of the Dam Neck disposal site.

A recently published document, A Summary of Sediment Characteristics of the York Spit and Cape Henry Channels by Dr. Suzette Kimble of VIMS discusses the potential offshore borrow sources in lower Chesapeake Bay.

6.0 BEACH MANAGEMENT AND RESTORATION PLAN

This section presents the proposed Beach Management and Restoration Plan for the City of Virginia Beach. The plan is presented as a series of recommendations in four distinct areas for each of the seven beach segments addressed by this study. The five components of the Plan are:

- o Proposed Beach Nourishment Programs, Section 6.1 The amount and timing of sand for beach nourishment, and the dimensions of engineering structures that are required.
- o Recreational Use and Planning Recommendations, Section 6.2. These recommendations describe actions, programs, etc. that should be undertaken in each segment to improve or maintain its recreational use.
- o Modifications in the Local Management System, Section 6.3. This section presents proposed changes on how the City should manage and plan for its beaches.
- o Modifications in the State Beach Management System, Section 6.4. This section describes organizational or programmatic changes that should occur at the state level.
- o Other Studies, Section 6.5. Recommendations are presented of future studies that should be performed, or data gathering programs that should be initiated, to fill in information gaps discovered in the process of this study.

6.1 Proposed Beach Nourishment Programs

6.1.1 Chesapeake Beach

A beach maintenance plan is recommended for adoption in the Chesapeake Beach segment. The proposed plan involves the permanent maintenance of a 50 ft wide beach berm along the Chesapeake Beach shoreline. The average beach width (March, 1986 aerial photos) is about 76 ft. Therefore the proposed program would not include any initial sand placement to restore the beach.

Periodic beach nourishment under this recommended plan would begin once the beach erodes to the 50 ft design berm width. All of the beach fill for the proposed plan would be in the form of periodic nourishment to compensate for erosion losses. A fill of 50,000 cy would represent an nourishment equivalent to approximately three years of erosion losses. Additional beach fills of 50,000 cy would be placed at three year intervals in the future so as to maintain to 50 ft. minimum plan beach width.

6.1.2 Ocean Park Beach

A beach maintenance plan is recommended for adoption in the Ocean Park Beach segment. This plan has two principal elements. The first proposed plan element involves the permanent maintenance of a 50 ft. wide beach berm along the Ocean Park Beach shoreline. The average beach width (March, 1986 aerial photos) is about 82 feet. Therefore the

proposed program would not include any initial sand placement to restore the beach. All of the beach fill for the proposed plan would be in the form of periodic nourishment to compensate for erosion losses. A fill of 33,000 cy would represent nourishment equivalent to approximately three years of erosion losses. Additional beach fills of 33,000 cy would be placed at three year intervals in the future so as to maintain to 50 ft. minimum plan beach.

A second element of the recommended plan for Ocean Park attempts to deal with the critical erosion which is occurring in the vicinity of Lynnhaven Inlet. Previous studies have suggested that inlet stabilization in the form of jetties would be important in the alleviation of this erosion condition. A study investigating the feasibility of such inlet stabilization should be conducted. A formal request for the investigation of the impact of the federal maintenance project at Lynnhaven Inlet and the feasibility of its possible remedies should be developed and transmitted to the Corps of Engineers.

6.1.3 Cape Henry Beach

A beach maintenance plan is recommended for adoption in the Cape Henry Beach segment. The proposed plan involves the permanent maintenance of a 50 ft. wide beach berm along the Cape Henry Beach shoreline. The average beach width (March, 1986 aerial photos) is about 131 ft. Therefore, the proposed program would not initially include any sand placement to restore the beach.

Periodic monitoring of the beach condition should be continued to verify that the Cape Henry Beach segment continues to be an accretional area as it has been since 1935. As long as the accretional trend continues, there is no need for periodic beach nourishment.

Section 6.2.3 below presents recommendations on increasing the use of Cape Henry Beach.

6.1.4 North Beach

The North Beach area is included in the Beach Erosion Control and Hurricane Protection Project for Virginia Beach. Recommendations of this plan with regard to that project are discussed in the section below.

6.1.5 Resort Beach

This study recommends for adoption as the management plan for Resort Beach the Beach Erosion Control and Hurricane Protection project once a design acceptable to both the Corps of Engineers and the City of Virginia Beach has been agreed upon. RGH and Cubit Engineering have assumed that a project similar to one that has been proposed will be developed along the Resort Beach and North Beach segments sometime during the next 2-5 years. We have further assumed that the project will consist of a protective seawall and beach nourishment. We concur with the Corps that both components are necessary to provide both: 1) protection for shorefront real property from erosion and storms, and 2) a beach of sufficient width that will continue to be the City's major recreational asset.

RGH and Cubit Engineering did <u>not</u> undertake the very substantial effort required to confirm the Corps of Engineers proposed design (August, 1988) of the Beach Erosion Control and Hurricane Protection Project for Virginia Beach that was presented in detail in

Section 4.4.2 on page 4-9. Therefore, we are not in a position to either support the seawall as presently (August, 1988) designed, or to recommend an alternative design.

6.1.6 Croatan Beach

A beach maintenance plan is recommended for adoption in the Croatan Beach segment. The proposed plan involves the permanent maintenance of a 100-ft. wide beach berm along the Croatan Beach shoreline. The average beach width (March, 1986 aerial photos) is about 146 ft. Therefore, the proposed program would not include any initial sand placement to restore the beach. The northern portion of Croatan beach segment has been an accretional area as a result of the sand trapping effects of the Rudee Inlet jetties. As long as the accretional trend continues, there is no need for periodic beach nourishment into this area.

The southern portion of Croatan Beach has a long term erosion rate which could, if it continues unchanged, impact a significant amount of property. The implementation of a major beach restoration project at Sandbridge to the south would contribute to an additional movement of sand into the Croatan Beach area. This would benefit the area and could potentially defer or reduce any future nourishment needs. A beach monitoring program should be continued to determine if and when periodic beach nourishment is required in southern Croatan Beach. Should the area continue to erode as projected, periodic nourishment of about 27,000 cy per year would be required. The nourishment program should commence once the beach narrows down to the 100 ft maintenance plan width.

6.1.7 Sandbridge

A beach restoration and maintenance plan is recommended for adoption in the Sandbridge Beach segment. The proposed plan involves the permanent maintenance of a 100-ft. wide beach berm along the Sandbridge Beach shoreline. The average beach width (March 1986 aerial photos) is about 75 ft. Therefore, the proposed program would include an initial sand placement to restore the beach to a minimum berm width of 100 ft. An estimated 1,210,000 cy of beach fill would be required to restore the beach as proposed. An additional 990,000 cy of sand would also be placed initially as advance nourishment. This would represent an advance nourishment equivalent to approximately three years of erosion losses. Additional beach fills of 990,000 cy would be placed at three year intervals in the future so as to maintain the 100 ft. minimum plan beach width.

6.1.8 Recommended Project Cost Estimates

This section presents the estimated costs of the recommended projects. All costs are presented in 1988 dollars.

One of the most significant factors influencing the cost of a proposed project is the cost of the sand. If a beach nourishment project must be bid as a separate contract not in conjunction with any other dredging programs, the cost of the sand may range between $4/cy to as high as $10/cy. The key factor in this case is the requirement of specialty dredging equipment. If the project characteristics are such as to allow bidding by several dredging contractors, the competitive market forces will generally result in bids at the low end of the range. Projects requiring specialty equipment or projects having low dredging volumes will generally attract fewer bidders and yield higher bids than would projects which are open and attractive to all. A recent small dredging project in the Virginia Beach area was let at a $10/cy rate because of such unfavorable bidding conditions.

The most attractive situation for the City is to be able to participate in a channel maintenance project where the dredged sand would otherwise be disposed of in a designated ocean disposal area. In such cases, the sand may become available for beach nourishment purposes by payment of the incremental costs associated with placing the sand on the beach versus open water or upland disposal. The incremental costs would be related to such factors as increased dredging cycle time, engineering and design of the fill project, mobilization, placement and maintenance of dredge pipe and related equipment such as booster pumps and buoy systems, and mechanical placement of the sand on the beach. The actual costs incurred would be project specific. However, the expected range of costs under such a cooperative dredging-beach fill project arrangement could incremental be from about $1.60 to $5.00 per gross cubic yards (i.e., the total volume of sand dredged for nourishment).

The total cost of a beach nourishment project is also dependent upon the quality of the sand relative to the native beach sand at the project site. A suitability analysis is a comparative procedure which estimates the erosion losses of the borrow sand resulting from grain size variations from the native beach sand. The results are typically expressed in terms of an overfill ratio. This ratio indicates how much additional borrow sand is required to yield the amount of sand desired in place on the beach after the fill project is completed. Quality coarse grain sand such as the York Spit sands have overfill ratios of 1.2 indicating that about 20% additional borrow yardage is required to compensate for erosion losses. Finer grain sands such as the Cape Henry dredging project sands have overfill ratios of 2.3 to 2.6. These overfill ratios indicate that the borrow sand volumes may be 2.3 to 2.6 times larger than the actual beach fill volume requirements.

Table 6-1 provides a breakdown of the cost components of beach fill project. Comparative costs for a separate beach fill project and a cooperative dredging-beach fill project. As can be seen from the table values, the cost per cubic yard of beach fill in place (i.e., net cubic yard) can range from about $3.00/cy to $16.25/cy depending on the project type and sand quality. As a point of comparison, the VBEC's estimate of the expenses of its truck haul program for the period ending September, 30, 1988 is $1,012,000. This program involved the placement of 150,000 cy of sand. Depending upon the overfill ratio of the sand placed on the beach, the equivalent cost of the sand in place or net cubic yards could range from $10.12/cy to $17.54/cy (overfill ratios of 1.5 and 2.6 respectively).

Using the range of in-place sand costs from Table 6-1, the costs of the recommended projects outlined in the proceeding paragraphs are listed in Table 6-2. The costs for an initial beach fill placement consisting of a beach restoration quantity and an advance nourishment quantity are listed where appropriate. Periodic nourishment volumes and costs are based upon a three year interval between sand placement.

It is important to note that the costs presented in Table 6-2 are the estimated <u>total</u> costs of performing the recommended projects. Viewed in another way, they represent estimates of what a private contractor would likely bid for these jobs under current 1988 economic conditions. The estimates include mobilization & demobilization, engineering and design, and labor and materials. Most importantly, these estimates assumes placement of sand on the proposed beach as opposed to disposal of sand at the Dam Neck dredge disposal site. For this reason, the cost estimates in Table 6-2 are somewhat higher than they would be if the sand was being disposed of at Dam Neck.

Table 6-1

BEACH NOURISHMENT COST FACTORS

Fill Quantity	50,000 cy	50,000 cy	50,000 cy	50,000 cy
Project Type	Combination Beach Fill and Channel Dredging	Beach Fill Only	Combination Beach Fill and Channel Dredging	Beach Fill Only
Overfill Factor	1.5	1.5	2.6	2.6
Overfill Volume (cy)	75,000 cy	75,000 cy	130,000 cy	130,000 cy
Sand Unit Cost	$1.60	$5.00	$1.60	$5.00
Sand Cost	$120,000	$375,000	$200,000	$650,000
Contingency Allowance (10%)	$12,000	$37,500	$20,000	$65,000
Engineering, Design Design Supervision & Contract Administration (15%)	$18,000	$56,250	$31,200	$97,500
Total Project Cost	$150,000	$468,750	$260,000	$812,500
Equivalent Cost per cy in place	$3.00	$9.38	$5.20	$16.25

Table 6-2

RECOMMENDED PROJECT COST

Beach	Initial Fill Volumes: Recommended Program	Restoration	Advance Nourish	Total	Cost	Renourishment (3 Yr Interval): Volume	Cost
Chesapeake	Maintenance	0	50,000 cy	50,000 cy	$150,000 to 469,000	50,000 cy	$150,000 to $469,000
Ocean Park[1]	Maintenance	0	33,000 cy	33,000 cy	$99,000 to 309,000	33,000 cy	$99,000 to $309,000
Cape Henry	Maintenance	0	0	0	$ 0	0	$ 0
North Beach	EC&HP[2]						
Resort Beach	EC&HP[3]						
Croatan	Maintenance	0	0	0	$ 0	27,000	$102,000 to $253,000
Sandbridge	Restoration	1,210,000 cy	990,000 cy	2,200,000 cy	$6,600,000 to 20,625,000	990,000 cy	$2,970,000 to $9,286,000

Notes:

1. Program includes construction of high profile jetty to control erosion losses to inlet. At a nominal length of 1,000 ft. and cost of $1,500,000
2. Hurricane Protection and Erosion Program includes 100 ft. beach berm maintained to +5.4 NGVD and dunes to +22.2 ft. NGVD.
3. Hurricane Protection and Erosion Program includes 100 ft. beach berm maintained to +5.4 ft. NGVD and concrete stepped face seawall.

The above costs represent the total cost of placing sand on the beach. These estimates include mobilization and demobilization, engineering and design, labor, and materials. The costs can be viewed as estimates of bids that would be submitted by contractors bidding on the projects. These estimates do not represent the potential 50% cost share of the increment between beach nourishment and open water disposal to Virginia Beach under an approved Section 933 project. The cost share incurred by the City, if any of the above were Section 933 projects, would be less than the amounts shown. How much less would depend on the amount of difference between the costs shown above and the cost of open water disposal.

The costs in Table 6-2 do not represent the potential 50% cost share to Virginia Beach under an Act 933 beach nourishment program. For example, the periodic nourishment cost under the low cost option for Sandbridge is estimated at $6,600,000. If the cost of disposing of this sand was estimated to be $5,000,000, the total differential cost between open water disposal and beach nourishment would be $1,600,000. The cost to Virginia Beach if this nourishment was an approved Act 933 project would be $800,000. In sum, the proposed cost to Virginia Beach if the projects in Table 6-2 were approved Act 933 nourishment projects would be substantially less than the amounts shown. These estimates do, however, represent the total cost that would be incurred by all governmental agencies (e.g., Corps of Engineers, State of Virginia, and/or the City of Virginia Beach) in funding these projects.

The total cost of $6,600,000 would be used by the COE in determing the economic feasibility of the proposed project.

6.1.9 Property Protection Benefits

The nourishment programs recommended above in Sections 6.1-6.7 propose only two significant projects: the ongoing nourishment of Sandbridge Beach and a feasibility study for a jetty at the west side of Lynnhaven inlet. Small continuing nourishment projects are proposed for Croatan, Chesapeake and Cape Henry beaches.

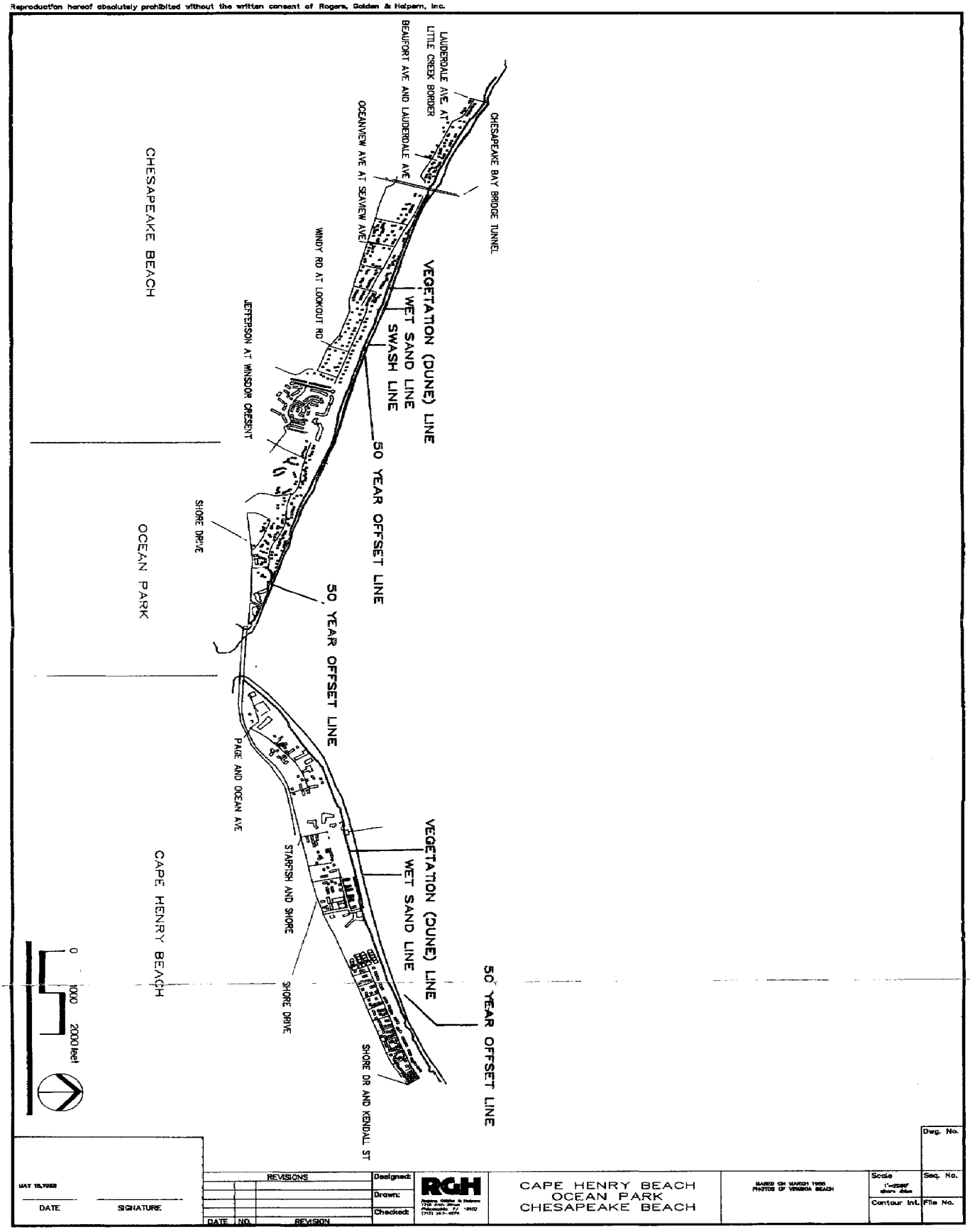
Prior to the formation of the recommended measures for each segment, RGH began developing data on the property that was potentially at risk from erosion in each of the seven segments. This was done because we knew that from prior experience and from other Corps cost benefit studies that property protection benefits usually comprise the majority of benefits from beach nourishment projects. Presented below is a discussion of how estimates of the real property at risk from erosion were estimated for each segment.

The first step in estimating property protection benefits was to determine the value of existing real property and infrastructure that would be affected by erosion over the next 50 years. Figures 6-1, 6-2 and 6-3 present plotted maps that were drawn using a Computer Assisted Design (CAD) program. Figure 6-1 shows the three Chesapeake Bay segments, 6-2 the North Beach, Resort and Croatan segments, and 6-3 Sandbridge. These maps were drawn from the 1986 aerial photos of Virginia Beach. Indicated on each map are the following:

Swash line. Indicating the line along the beach where the waves break. This line is shown in red.

Wet sand line. Shows the inland extent of the area that is covered by water at some point during the tidal cycle, and is therefore not usable beach area (i.e., for sunbathing, or for placing a towel). This line is shown in blue.

Vegetation/dune/structure line. This shows the inland extent of the beach area. Depending on the characteristics and development patterns along a particular segment, the inland extent of beach is defined by the presence of one of these three features. This line is shown in green. The area between the wet sand and vegetation/dune/structure line is defined to be the existing beach area.



MAY 15,1982
DATE SIGNATURE

REVISIONS		
DATE	NO.	REVISION

Designed:
Drawn:
Checked:

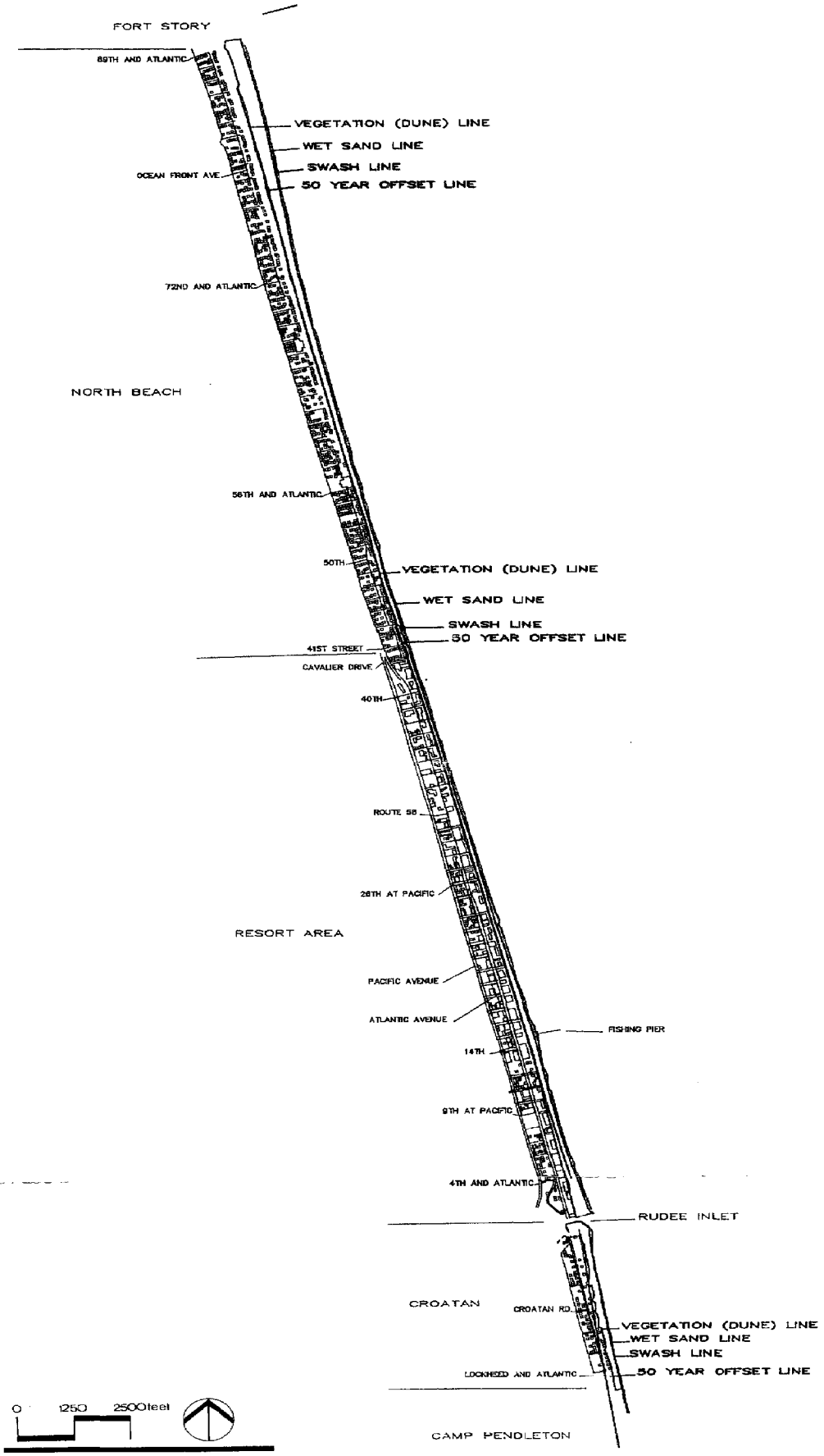
RGH
Rogers, Golden & Halpern
1750 Kraft Drive
Blacksburg, VA 24060
(703) 552-4076

CAPE HENRY BEACH
OCEAN PARK
CHESAPEAKE BEACH

BASED ON MARCH 1980 PHOTOS OF VIRGINIA BEACH

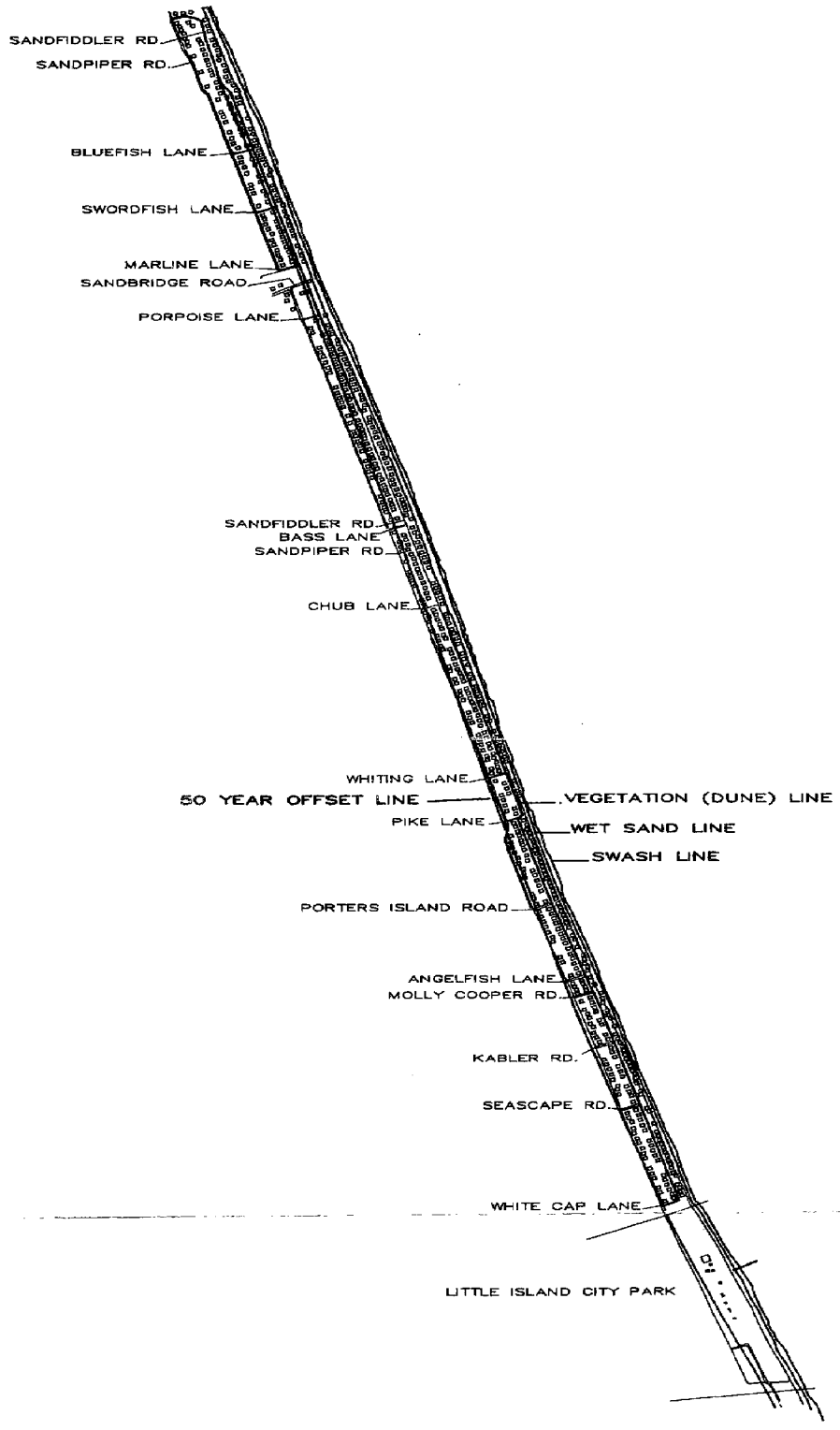
Scale 1"=2000' short dist.
Contour Int.
Dwg. No.
Seq. No.
File No.

Figure 6-1



MAY 17, 1988 DATE SIGNATURE	REVISIONS DATE NO. REVISION	Designed: Drawn: Checked:	RGH Rogers, Golden & Halpern 148 Anapo Street Philadelphia PA 19107 (215) 563-4220	CROATAN, RESOPT AREA, & NORTH BEACH	BASED ON MARCH, 1986 PHOTOS OF VIRGINIA BEACH	Scale "=2500' Contour Int.	Dwg. No Seq. No File No.

Figure 6-2



MAY 1988 DATE	SIGNATURE	REVISIONS DATE / NO. / REVISION	Designed: / Drawn: / Checked:	RGH Rogers, Golden & Halpern 1216 Arch Street Philadelphia PA 19107 (215) 563-4220	SANDBRIDGE & LITTLE ISLAND PARK	BASED ON MARCH 1988 AERIAL PHOTOS OF VIRGINIA BEACH	Scale 1"=2000' / Contour Int.	Dwg. No. / Seq. No. / File No.

Figure 6-3

50 year offset line. This is where the vegetation line will be in 50 years if historical rates of erosion hold true over the next 50 years. This line is shown in purple. It assumes that no additional measures, beyond those already existing, are undertaken to prevent erosion (i.e., construction of bulkheads, jetties, or groins; beach nourishment). All existing land, homes, structures, infrastructure (e.g., roads, water & sewer lines, public facilities) located between the green and purple lines is assumed to be completely lost due to erosion. The only additional losses that would occur would be additional buildings that would be constructed between the purple and green lines at some point during the 50 year period. This development could consist either of infill development of remaining undeveloped parcels, or a transition from low intensity to higher intensity uses on developed. This latter type of growth would be dependent upon the applicable Master Plan and Zoning Ordinance provisions.

The locations of all existing structures and roads were digitized from the aerial photos onto the CAD system, and are presented on the maps. The number of structures and roads between the purple and green lines gives a clear visual indication of the potential losses of property that could occur within a given beach segment. The most prominent example is Figure 6-3, which indicates that at Sandbridge a large number of structures and a large acreage of land is currently at risk from erosion over the next 50 years.

It should be clearly noted that the projected position of the 50 year offset line (in purple) assumes that the historically determined erosion rates will continue over the next 50 years. This represents a worst case scenario in which nothing is done to halt erosion and the natural erosion rate continues throughout the 50 planning period.

The value of existing shorefront real property at risk from erosion was determined from data supplied by the Virginia Beach Tax Assessors Office. Blocks and lots potentially at risk from erosion were identified by RGH and the Assessors Office performed computer runs to determine the market value of properties at risk. The assessors office noted that they attempt to assess at market value, and that the values on the books average 90-95% of true market value.

Table 6-3 presents a summary of beach characteristics and potential property and infrastructure losses. Based on the potential erosion losses (and assuming the existence of the proposed Shore Erosion Control and Hurricane Protection Project along the Resort Beach and North Beach segments), Sandbridge and Croatan are the only beach segments where there is a significant value of property at risk from erosion.

A comparison of benefits and costs for the three Chesapeake Bay beach segments is not provided due to the following factors: 1) the low losses of land and property from erosion over the next 50 years (i.e., the 50 year erosion line and the existing vegetation/dune/structure line are very close together), and 2) all 3 segments appear not to be used by beachgoers to their recreational capacity. In essence, there is very little in the way of public benefits to be gained by beach nourishment along the Chesapeake Bay beaches.

Benefits from Beach Nourishment at Sandbridge. Based on the interpretation of aerial photos, the CAD maps, and data provided by the Virginia Beach Tax Assessor office, erosion over the next 50 years would result in the following losses of property at Sandbridge:

TABLE 6-3

RECREATIONAL CHARACTERISTICS AND POTENTIAL EROSION LOSSES and POTENTIAL EROSION LOSSES BY BEACH SEGMENT

Beach Segment	Beach Area (ft2)	Beach Length	Average Width [1]	Beach Area (acres)	Total Daily Beach User Capacity	Peak Day Beach Use Capacity [2]	Annual Beach Capacity	Annual Peak Day Beach Capacity
Chesapeake Beach	639,033	8,760	76	14.7	11,503	6,390	1,150,259	191,710
Ocean Park	403,037	4,920	82	9.3	7,255	4,030	725,467	120,911
Cape Henry	1,353,717	10,335	131	31.1	24,367	13,537	2,436,691	406,115
North Beach	2,825,647	16,165	175	64.9	50,862	28,256	5,086,165	847,694
Resort Area	1,806,784	15,565	116	41.5	32,522	18,068	3,252,211	542,035
Croatan	656,445	4,510	146	15.1	11,816	6,564	1,181,601	196,934
Sandbridge (excludes Little Island City Park)	1,816,859	24,165	75	41.7	32,703	18,169	3,270,346	545,058
TOTALS	9,501,522	84,420	797	218	171,027	95,015	17,102,740	2,850,457

VARIABLES

Area per User (sq. ft.)	100
Length of Season (days)	100
Turnover Factor	1.8
% of Weekend days/season	0.3

Beach Segment	Areas Affected by 50 Years of Erosion
Chesapeake Beach	No areas affected by erosion behind 50 yr. line. 16 houses currently are on or seaware of vegetation line.
Ocean Park	No areas affected.
Cape Henry	1 area of 12,478 square feet near bridge, no structures affected. 1 area of 31,687 square feet west of Starfish Lane & Ocean Drive; one high-rise potentially affected.
North Beach	31,355 square feet, no houses. Impact around 86th street.
Resort Area	82,617 square feet, Impact around 41,4243 & 44 streets.
Croatan	89,297 square feet at northeast end of beach. 243,984 square feet from mid beach to border at Atlantic and Lockheed. 13 houses + 2 on edge or erosion line; total value $6,385,311, includes land-$5,059500 + structures-$1,325,811.
Sandbridge	8,228,760 square feet through entire length, 203 houses and 39 lots east of Sandfiddler Road. 315 houses and 65 lots west of Sandfiddler Road. 7 miles of secondary roads, 7 miles of water lines. Total value of potenitally affected property is $99,965,273.

Notes:

1. Beach width is the distance between the wet sand line and the vegetation/property/dune line. It was determined from 1986 aerial photos.
2. Peak Use is between 12 and 2 PM on a summer weekend day.

- o 203 developed ocean-front residential parcels and 39 undeveloped residential parcels east of Sandfiddler Road; 315 developed inland residential parcels and 65 undeveloped parcels; total current market value of these parcels is $86,601,600. Assuming that all of the undeveloped parcels are developed, the total value of the private property losses would be $95,349,000.

- o Slightly over 7 linear miles of water pipe, ranging in diameter from 6" to 12". Total estimated replacement cost of these lines is $793,600. Note that there are no sewer lines in Sandbridge.

- o Slightly over 7 linear miles of secondary roads; total estimated replacement cost $3,822,700.

- o Loss of the public structures at Little Island City Park.

The total estimated erosion losses of public and private real property at Sand Bridge of the next 50 years are estimated to be $99,965,300. The average annual losses would depend on when properties are lost to erosion. At an average erosion rate of 6-6.5 ft./yr., ocean front lots that are 150' deep would be largely lost to erosion by year 15 (i.e., the vegetation/dune line would be 90' inland).

RGH has assumed that all of the properties that lie wholly or partially within the 50 year erosion line would be lost to erosion over the next 50 years. This results in an average annual erosion property loss of $2,156,447, assuming a discount rate of 8.625% (the current rate used by the Corps of Engineers in evaluating water resources projects). This compares to the estimate of $2,124,731 made by Coastal Research Associates in 1985 (using a discount rate of 8.125%).

The other direct benefits calculated by Coastal Research Associates are generally applicable, with some modification. The benefit for preventing the formation of the new inlet depends on two factors: 1) the probability of such an event occurring, and 2) the property damages associated with such an event. The product of these factors is the expected value of the damages, which we feel is the more proper measure of this benefit. For example, if the 50 year storm could form a new inlet, and the damages as calculated by Coastal Research Association are accurate, the expected average annual benefit for any year throughout the 50 year planning period would be would be $78,176 (.02 x $3,908,830). In contrast, if a 100 year storm would produce a new inlet, the average annual benefit would be $39,088.

Storm protection from beach nourishment is also a proper direct benefit. The Corps estimated that in 1985 approximately $61,600,000 worth of real property was at <u>risk</u> for being damaged by a storm, not that this is amount of actual <u>damage</u> that would occur. The level of actual damages would be a function of the return frequency of the storm, its associated inundation levels, and the resulting damage to structures. Damage from a storm at Sandbridge needs to be related to a particular year storm event. RGH feels that using the total value of property at risk from storms results in an over estimate of potential storm damage. In order to minimize this overestimate, RGH has assumed that storm protection benefits are 75% of those calculated in the Coastal Research study. Using the present worth amount in the Coastal Research Study, the annual average storm protection benefit at 8.625% is $817,700.

RGH agrees that property enhancement benefit of $777,653 is also a proper direct benefit from nourishment. A conservative assumption was made that this benefit has not increased over the last three years. This was done so as to not over-estimate this benefit. Property owners would be more willing to make investments in ocean front properties if there was an established program to maintain the beach so as to prevent erosion. Note that such a nourishment plan would not eliminate the potential for storm related damages, so that investing in shorefront property would still be a somewhat risky proposition. For a theoretical discussion of investment decision-making in shorefront areas readers are referred to Armstrong and Denuyl, "An Investment Decision Model for Shoreland Protection and Management," Coastal Zone Management Journal, Vol. 3, No. 3, 1977.

A development trend occurring in some coastal areas is that due to the value and desirability of shorefront locations, existing older structures are being substantially renovated and improved, or in some cases, torn down and replaced by significantly more expensive structures. Note that this does not lead to a change in development intensity, but a replacement of older, less expensive structures by new, more expensive ones. The establishment of beach nourishment program at Sandbridge could be expected to increase the amount of this activity there. The ultimate result would be a higher property protection benefit due to the increase in value of structures located seaward of the 50 year erosion line. The magnitude of this effect is difficult to predict, but we feel the property enhancement benefit calculated by Coastal Research Associates does pick up some of this effect.

RGH disagrees with the sand loss benefit calculated by Coastal Research. Sand will continue to be lost each year with or without beach nourishment. The key point is that periodic nourishment as recommended in this study will offset these losses, and maintain the beach in existing location at the proposed dimensions.

The final benefit is recreation, which in most studies of this type comprises the smallest annual benefit. As a point of reference, the recreation benefit provided by the hurricane protection project along the Resort Beach comprise less than 5% of the total annual benefits (Mansfield, 1988). Based on discussions with city officials, realtors, etc., Sandbridge is not used to capacity, except at Little Island during peak weekend and holiday periods. There are no accurate statistics for beach use at Sandbridge outside of the parking statistics for Little Island. RGH performed some calculations which indicate that the existing beach area is sufficient to accommodate the demand, even during peak periods, from the adjacent residents and visitors to Little Island. It is possible that the beach could be near capacity at Sandbridge Road and Little Island park during peak periods, but away from these areas there is more than sufficient capacity to accommodate the adjacent residents.

A key issue is whether under the no-action alternative the amount of beach available for recreation will decrease because of continuing erosion, or whether the beach profile will shift inland as erosion proceeds. In the short-run, particularly in areas where there are engineering structures such as bulkheads and groins, the beach would likely become narrower. Over the 50 planning period the beach would be expected to remain at the same width, but migrate inland.

For these reasons, RGH feels that there is not a significant recreational benefit to be gained from the proposed beach nourishment project at Sandbridge. However, it should be noted that this conclusion is reached without the existence of reliable survey data which would indicate the actual level of demand for beach space at Sandbridge.

The total direct benefits estimated by RGH for the proposed Sandbridge Beach Nourishment project are presented below.

o	Property Protection:	$2,156,500
o	Inlet Prevention:	$78,176
o	Property Enhancement	$777,653
o	Storm Protection	$ 817,700
	Total Direct Benefit	$3,830,029

Property Protection Benefits at Croatan Beach. The other beach segment where a nourishment project would produce substantial property protection benefits is Croatan. As shown in Table 6-3, approximately $6,385,300 of property could be loss to erosion over the next 50 years. These properties are located in the southern portion of Croatan as shown on Figure 6-2.

It is estimated that the average annual property protection benefit (in 1988$ over 50 years using a discount rate 8.625%) from the proposed beach nourishment project at Croatan is approximately $175,300. This assumes that the properties identified on Figure 6-2 as being located seaward of the 50 year offset line would be lost due to erosion.

6.1.10 Average Annual Project Costs.

The average annual costs for each project, assuming a discount factor 8.625% are presented below:

	Low Cost Option	High Cost Option
Chesapeake Beach	$58,900	$184,300
Ocean Park		
Nourishment Only	$38,900	$121,400
Nourishment & Jetty	$170,400	$252,900
Croatan	$31,100	$77,200
Sandbridge	$1,485,153	$4,611,000

These numbers indicate the average annual cost (in 1988$) that would be incurred for each year of the 50 year project life.

These costs are expressed in the same basis as those in Table 6-2. They represent the total estimated average annual costs of performing the recommended projects. The costs to Virginia Beach could be substantially less if any of the projects were approved Act 933 beach nourishment projects.

6.1.11 Benefit Cost Ratio of the Sandbridge Project.

Combining the results of the above two sections produces the following Benefit Cost ratios for Sandbridge:

Low Cost Option	2.57 ($3,830,029/$1,485,153)
High Cost Option	0.83 ($3,830,029/$4,611,000)

The implication of these results are that beach nourishment at Sandbridge is cost beneficial if the sand is available relatively cheaply (i.e., the incremental cost of putting it on the beach as compared to the cost of disposing it at the Dam Neck disposal site is low). However, if the incremental cost of nourishment is high, then beach nourishment at Sandbridge would not be cost beneficial. The levelized annual cost for the low cost option above would be $3.00/cubic yard, and $9.38/cubic yard for the high cost option. It should be remembered that these are costs for cubic yards in place (i.e., sand that remains on the beach). The break even point appears to approximately $7.70/cubic yard in place.

The proposed Sandbridge beach nourishment project provides primarily prevention against property losses due to erosion, with some modest storm protection benefits also provided. The value of Sandbridge property along the oceanfront is not sufficiently high to warrant expensive structural methods or very wide beaches designed to provide storm protection benefits. The property protection benefits, given the current state of development along Sandbridge's oceanfront, would not be large enough to offset the high project costs of alternatives providing protection against storm damage.

6.1.12 Croatan Beach Benefit Cost Analysis

A preliminary comparison of the average annual property protection benefit and the average annual costs yields the following ratios:

Low Cost Option	5.6	($175,355/$31,138)
High Cost Option	2.2	($175,355/$77,234)

It appears from this preliminary analysis that a beach nourishment project as the southern end of Croatan Beach could be in the federal interest (i.e., provide property protection benefits), and could be eligible for funding under Act 933. This would have to be definitively determined by the COE.

6.1.13 Other Considerations

The proposed nourishment projects at Sandbridge and Croatan are consistent with the future development mix as presented in the Comprehensive Plan. The policy articulated in the Plan is to maintain Sandbridge and Croatan as a single family, resort oriented residential area correlates with the emphasis of the proposed beach nourishment plan. The continuation of current residential development patterns in both areas confirms that there will not be enough intense, high value development there (i.e., ocean front hotels/motels and condominiums) to warrant nourishment options that provide significant storm protection benefits. In other words, adherence to the Comprehensive Plan will limit amount of property protection benefits that can be obtained to projects that protect primarily against erosion.

Accessibility is an issue at Sandbridge, both in terms of its distance and travel time from the remainder of Virginia Beach, and in terms of the ability of the public to have access to areas outside of the city-operated Sandbridge Road and Little Island beaches. If there are no major changes in accessibility to Sandbridge from elsewhere in Virginia Beach, use of the beaches will continue to be primarily limited to people who live or rent there. Thus, there does not appear to be at present a need to provide additional offstreet parking in Sandbridge away from the two publicly operated beach areas in order to encourage additional use of these areas. Continued residential development in the

Courthouse area will likely result in an increase in use of the Sandbridge Road and Little Island beaches. However, the recent declines in the annual number of vehicles using the Little Island parking lot does not indicate that such a trend has begun.

6.1.14 Recommended Projects

The results of the Benefit Cost analysis indicate that beach nourishment at Sandbridge is cost beneficial and should be undertaken if sand can be obtained at a reasonable cost per cubic yard. The scope of such a program should consist of initial fill amount of 2.2 million cubic yards, followed by a regular program of periodic nourishment. The plan recommends that nourishment occur every three years with a volume of approximately 990,000 cubic yards.

It appears very likely that a beach nourishment plan at Croatan Beach would also be cost beneficial. This program would consist of nourishment every three years of approximately 27,000 cy.

It is economically essential that beach nourishment projects be evaluated on the basis of the actual costs required to provide the desired in place volume of sand on the beach. Fine grain sands may be available on a cost share bases as a result of some of the channel dredging operations. On a per yard basis, the fine grain sands may appear to be inexpensive. However, such high volumes of sand are required to obtain a reasonable residual volume after the beach fill operation that the effective cost per cubic yard in place becomes prohibitively high. The discussions in the preceding section details how some fine grain sand can have in place costs as high as $16.25 per yard or more.

6.2 Use Recommendations

The City's beaches serve a number of different types of user subgroups, all with distinct needs concerning proximity to support facilities, transportation accessibility, proximity to lodging, etc. Major subgroups include:

- Tourists who come to Virginia Beach on their principal annual vacation because of the beaches. These visitors require overnight accommodations and desire to stay within walking distance of the beaches. Their primary rental accommodations are hotel and motel rooms, and seasonal homes.

- Tourists coming to Virginia Beach who do not desire walking proximity to the beach but do want easy auto access to beaches. These include persons staying in Campgrounds.

- Residents of the southeastern Virginia Tidewater region that use the beaches on a day-trip basis. They require easy transportation access to the beaches, and support services such as lifeguards, showers, medical services. Immediate proximity to resort retail, entertainment and restaurants establishments is not essential.

- Residents of non-shorefront areas of Virginia Beach who use the beaches on a day trip basis, and who require easy transportation access to the beaches. These consist of residents who do not live within walking distance of the beach. They

require support services such as lifeguards, showers, medical services. Immediate proximity to resort retail, eating & drinking establishments is not essential.

- Year round residents of shorefront areas that live within walking distance of the beaches. These include residents of all the beach segments outside of the Resort Beach. Beach use in these areas includes the residents and their quests, and to a much lesser extent, persons driving into these areas, parking on the street and using the public access points to get to the beaches.

The continuing high-level of economic development and population growth of Virginia Beach and the surrounding southeastern Virginia tidewater area indicates that the demand for City's beaches by subgroups three and four above will continue to grow. At the present the primary options for these persons desiring to use the City's beaches on a day-trip basis are the resort area, and to a lesser extent, the publicly-operated beaches at Ft. Story, Camp Pendleton, Sandbridge Road, and Little Island City Park where parking is available. Some use of this type also occurs along the Cape Henry Beach where day users park along Shore Drive and in restaurant parking lots.

The following use recommendations for each beach segment suggest measures that should be considered in either maintaining or improving the recreational use of each segment. They are based on the existing conditions in each segment (as described in Chapter 1), the proposed beach nourishment projects, and the types of recreational users described above.

Prior to presenting specific recommendations for each segment, the issue of increasing public access to the Chesapeake Bay beaches is discussed.

6.2.1 Increase Public Access to and Use of the Chesapeake Bay Beaches

The Chesapeake Bay beaches appear to be underutilized recreational resources. The primary reason is that access to these beaches by persons not living immediately adjacent to them (i.e., within walking distance) is very limited. Beach goers coming by car from other parts of Virginia Beach or the Tidewater region will find relatively few parking spaces available. While there are a number of public right of ways between adjacent streets and the beach (see Figures 1-3 through 1-5), there is little if any parking available at these access points. Use of the Chesapeake Bay beaches has been primarily by residents of the adjacent neighborhoods and their guests. There are no city-owned and operated public beaches along the Chesapeake Bay.

The Chesapeake Bay beaches, particularly west of Lynnhaven Inlet, are bordered by well-established residential neighborhoods with little tourism-related uses (i.e., little seasonal rental housing). These areas are, for the most part, recommended in the Virginia Beach Comprehensive Plan to remain as residential areas. Tourism-related retail and commercial development has occurred along Shore Drive, particularly east of Lynnhaven Inlet.

A conscious policy by the City of Virginia Beach to increase recreational use of the Chesapeake Bay beaches would require the City to resolve a number of potential issues, including:

- Increasing use of these beaches would mean increasing the daily flow of non-residents through residential areas, which would conflict with the recommendations of the City's Comprehensive Plan in some areas, such as Chesapeake and Ocean Park.

- It is possible that residents of adjacent areas may not be amenable to having either an increased number of beach goers passing through their neighborhoods, increased on-street parking, or increased use of adjacent beaches.
- The City would need to establish and operate a public beach along Chesapeake Bay, along with necessary support facilities such as concessions, changing areas, bath houses, lifeguards, and first aid services.
- Public access would have to provided in the form of parking lots, shuttle buses between satellite lots and the beach, and mass transit.
- The legal status of Chesapeake Bay beaches as publicly accessible facilities would have to be established. This includes ownership of the beaches, and the ability of the public to use them. An expansive concept of public access and use of these beaches would require the City to establish the ability of beach goers to move freely along the entire length, such as users are currently able to do along the Resort Area and North Beaches.
- Encouraging use at a particular point through establishment of a city-owned and operated beach would require the OEM to coordinate with other City agencies in terms of the presence of infrastructure and transportation access.
- To what extent the Chesapeake Bay beaches have characteristics that make them more or less attractive than ocean beaches in terms of the quality of the recreational experience and the types of activities that can be enjoyed.

The overall recommendation of this plan is that the City adopt policy of increasing public use of and accessibility to the Chesapeake Bay beaches. By this, we mean guaranteeing the ability of the public to use these beaches and move unrestricted along them. This policy should be targeted toward attracting day users from other areas of Virginia Beach and throughout the Tidewater region in terms of the types of access and facilities provided. One necessary component of increasing access to and use of the these beaches is the establishment of public beaches in several areas. These are noted in the recommendations below.

This recommended policy does <u>not</u> imply a need to provide increase support facilities and parking along all areas of the Chesapeake, nor an increase in the number of beach goers coming into the residential areas. Within this overall recommendation, specific suggestions for increasing access, establishing public beaches, etc. at particular points are presented below under the individual beach segments.

6.2.2 Chesapeake Beach

Maintain the Existing Access to Chesapeake Beach. The accessibility to Chesapeake Beach should remain unchanged. No additional facilities, including parking and access routes to the beach, should be provided. Chesapeake Beach is a residential area, and is designated to remain so under the Virginia Beach Comprehensive Plan. Under the overall recommendation made above, some increase in the use Chesapeake Beach by non-residents of adjacent shorefront areas would occur. However, these would be from persons moving westward along the beach instead of beach goers coming into and passing through the Chesapeake Beach neighborhood on their way to the beach.

6.2.3 Ocean Park

Maintain the Existing Access to Ocean Park Beach. Ocean Park is very similar in the character of adjacent shorefront areas and in recreational use patterns to Chesapeake Beach. It is also proposed in the Comprehensive Plan that Ocean Park remain as a residential neighborhood. For these reasons, it is also recommended that no additional facilities be provided that would increase the daily flow of non-residents through the Ocean Park community to the beach.

Assess the Feasibility of Establishing a Public Beach Just West of Lessner Bridge. The City should investigate the feasibility of establishing a public beach at the eastern end of Ocean Park beach between Dupont Circle and Lessner Bridge. A public beach at this location would be designed to attract day users from elsewhere in Virginia Beach and the Tidewater region. Facilities and services that should be provided include showers, restrooms, changing areas, concession stand, lifeguards, and public parking. The City would have to provide additional parking in this area, or at least a satellite parking area.

A public beach as used in this context denotes an area where public services and facilities are available. Users of this beach should be informed that they can proceed west if they so desire, but that no public facilities are available there. The location of a public beach west of Lynnhaven Inlet would be essential to providing beach goers with access to the remaining beach areas located to the west.

This beach segment possesses characteristics that give it potential for use by non-residents. It does not have the exclusively single family detached residential character of the rest of Ocean Park as the dominant land uses here include single family residential, two high rise apartments/condo structures just west of Lessner Bridge, and some commercial/retail use is found along Shore Drive. Its proximity to Shore Drive gives it excellent regional transportation accessibility.

6.2.4 Cape Henry Beach

Establish A Secondary Resort Area and Public Beach. It is recommended that the City consider developing a smaller resort activity center in Cape Henry Beach that would serve primarily day trip users from elsewhere in the City and from the surrounding tidewater region. This area should be located between Great Neck Road west to Lynnhaven Inlet. Such an area would not require a concentration of high intensity hotels and motels which should still be confined to the Resort Area. Enough resort retail, restaurant, and entertainment establishments are present in the area to serve day user needs. The OEM should talk with the Department of Planning about designating the area near the intersection of Shore Drive and Great Neck Road as an RT-3 Resort Tourist District.

Development trends and accessibility factors indicate that this would be a logical place to promote the growth of a smaller resort activity center. The Cape Henry Beach has excellent transportation access and proximity to Seashore State park already draws a lot of people into the area. The Comprehensive Plan designates the proposed land use for this area as multi-family residential, with commercial development along Shore Drive. Mixed use development is a suitable future use for this area in the Plan. Encouragement of additional resort activity between Great Neck Road and the inlet would be more compatible with the existing and proposed land uses here than anywhere else along the Chesapeake Bay beaches.

Establish a Public Beach Near Great Neck Road. A public beach should also be established near Great Neck Road and the Virginia Beach Resort and Conference Center Hotel. The City would have to provide lifeguard services and public restrooms and showers in this area. Scheduled improvements to Great Neck Road will expedite intra-Virginia Beach automobile travel from south to this area and make the proposed beach area easily accessible.

Ensure Public Access to Cape Henry Beach. One potential issue that may require resolution is the ownership of the beaches in this area and the right of the public to use them. Private beaches are present in front of several of the high rise condominiums close to the inlet which would restrict unimpeded public access along the beaches. It is highly likely that public ownership of the proposed public beach near Great Neck Road would be required.

One method of ensuring use of a public beach would be to reserve some or all of it for specialized recreational uses such as the launching of hobbie cats or sailboats, surfing or surf fishing, volleyball, etc. (assuming conditions are present for any of these uses) that are incompatible with swimming and sunbathing. Participants in these sports may only be concerned about the availability of designated beach area to undertake their sports, and not whether a beach is close to support facilities and resort retail/restaurant establishments.

Provide Additional Parking Capacity in Cape Henry Beach. An essential part of increasing the day use of Cape Henry Beach must be the provision of additional public parking, particularly off-street parking. At the present time day users do park along Shore Drive and in restaurant parking lots. This is not a desirable situation as pedestrians should be discouraged from attempting to cross Shore Drive on foot. The optimal solution would be the construction of a public parking lot on the north side of Shore Drive immediately adjacent to the proposed beach. Another option would be to develop a public parking lot nearby and provide a shuttle bus to the beach.

Provide Mass Transit Access to the Cape Henry Resort Area and Public Beach. The City should ensure that direct mass transit access to the above two areas exists. Bus stops should be established at Great Neck Road and Shore Drive. For example, a stop on the 33 North Seashore Trolley should be established at Great Neck Road and Shore Drive.

6.2.5 North Beach

Maintain the Existing Use of North Beach. The City should not provide additional facilities such as parking to increase the access to North Beach. The existing residential character of North Beach would be adversely affected by encouraging additional users to drive to and park in the adjacent residential neighborhoods so as to use the beach. Substantial use of the southern part of North Beach by persons walking or jogging up from the Resort Beach already occurs.

Promote the Increased Use of the Ft. Story Beach. Discussions with the Virginia Beach Department of Parks & Recreation (Jeavons, 1988) indicated that Ft. Story is somewhat underutilized. Increasing use this facility should include a number of strategies such as publicity, mass transit access, and additional parking. The Ft. Story Beach appears to be well suited for use by day visitors who do not need many supporting facilities. The establishment of permanent restroom, showers, and changing facilities should be considered, along with the development of a concession area.

6.2.6 Resort Area

The following recommendations for the Resort Area assume the eventual construction of a Beach Erosion Control and Hurricane Protection Project, comprised of a seawall along the entire length of the Resort Beach (i.e., as far north as 58th Street), and beach nourishment. It is further assumed that the top of the seawall will be above the existing boardwalk elevation.

Assess with the COE the Feasibility of Constructing the Seawall along the Landward Side of the Boardwalk. If a seawall is constructed whose elevation is above the boardwalk, the City is faced with the difficult choice of either 1) maintaining to the maximum extent possible access between the shorefront areas, the boardwalk, and the beach; or 2) maintaining as much visibility as possible of the ocean from adjacent shorefront areas (e.g., boardwalk-level restaurants, eye-level ocean view of persons walking along the the boardwalk). It is inevitable that the view of the ocean and beach from adjacent shorefront areas inland from the boardwalk will be partially obstructed. If this is the case, it would seem desirable to maintain unrestricted access between the boardwalk and the beach by placing the seawall on the inland side of the boardwalk.

This is largely a perceptual issue based on whether shorefront users have a preference for unrestricted access between the boardwalk and the beach, as opposed to a lesser visual obstruction that would occur if the seawall were on the oceanward side of the boardwalk. It would be useful to the City to question visitors on their preference using a visual sketch of alternative boardwalk locations.

Ensure that the Seawall is as Aesthetically Pleasing and Functional as Possible. The aesthetic appearance of the seawall could be enhanced through the use of pleasing colors, plantings and other landscaping features, textured surface, street art, attractive street furniture and ornamental lighting, etc. The worst possible scenario would be a 58 block long, stark grey concrete seawall unadorned by any visual amenities.

Enhancing the functionality of the seawall would be to convert it from simply serving as a barrier to providing opportunities for people to gather, stop and view the ocean, receive information from kiosks, etc. Design features for doing so include the installation of benches, construction of outcrops projecting out onto the beach where persons can stop, installation of shelters or information kiosks, etc. If the seawall was constructed on the seaward side of the boardwalk, provision should be made for as many access points to the beach as possible without compromising the structural integrity of the seawall.

Assess the Feasibility of Constructing A Raised Boardwalk. The Division of Engineering should assess the feasibility and cost of constructing a raised boardwalk between Rudee Inlet and 41st Street. If it appears important to maintain an unrestricted view of the ocean from the boardwalk (and given that views will unavoidably be restricted at the current level of the boardwalk) a raised boardwalk might provide an alternative solution.

Monitor Visitation to the Resort Area After Construction of a Seawall. The City, along with the RAAC, the Resort Programs Office, and the Tourist Development Division, should undertake an active monitoring program of visitation to the Resort Area immediately after completion of the seawall. They should track occupancy rates in hotels and motels, receipts by shorefront businesses, and beach use. Visitors should be interviewed about

their origin, length of stay, perceptions of their visits, whether they intend to return, what impact the presence of the seawall had, etc.

A key of concern of the City and Resort Area merchants will be whether potential visitors to Virginia Beach are being diverted to other similar competing resort areas such as Ocean City Maryland, Myrtle Beach, and Rehoboth Beach, Delaware. The monitoring process should attempt to measure whether the origin of visitors to the Resort Beach changes significantly after the construction of the seawall, particularly if the proportion of out-of-state visitors coming from a significant distance begin to decline. This could indicate that these visitors are going to other resort areas.

Undertake a Public Education Program About the Seawall. Once it is determined that a seawall will be built, the City of Virginia Beach should begin to educate both residents and visitors about the project. This program can take the form of an explanatory brochure that explains the project, a slide available to community groups and advertisements. Public meetings (if not required as part of a scoping process for an Environmental Impact Statement) hosted jointly by the City and the Corps of Engineers should be held to explain the details of the project and to receive input on perceived impacts.

This education program should address: 1) the need for the project, including the level of protection provided; 2) the fact that the project consists of both a seawall and beach nourishment; 3) project schedule (i.e., when certain blocks will be affected, seasonal timing of major construction phases, etc.); 4) measures that will be undertaken to enhance the appearance and functionality of the seawall and boardwalk; and 5) assurances that accessibility to the beach and use of the boardwalk will be maintained.

6.2.7 Croatan Beach

Maintain the Existing Use of Croatan. Croatan appears to have a greater proportion of use by non-residents than either Chesapeake Beach or Ocean Park Beach. This is due to its proximity to the Resort Beach, and the presence of Camp Pendleton and the designated surfing beach immediately south of Rudee Inlet. This non-residential use conflicts with the residential character of Croatan, particularly during summer weekends. In order not to exacerbate the competition between residents and non-residents for scarce beach space, we do not recommend any use changes or development of supporting facilities for Croatan.

6.2.8 Sandbridge

Establish Summer Mass Transit from the Resort Area. Increased use of these facilities could be promoted by the existence of a bus route between the Resort Area and Sandbridge. The distance of Sandbridge from the rest of Virginia Beach, both in terms of distance and travel time, has clearly limited its use. A bus route to Little Island Park, supported by promotional materials, could substantially increase its day use by visitors staying in the Resort Area who desire a less intense recreational setting.

Such a bus route may become increasingly necessary if the planned expansion in use of False Cape State Park occurs and a roadway to the Park through the Back Bay National Wildlife Refuge is constructed. The City and State should consider the development of remote parking lot on the mainland for visitors to either of the city beaches, the wildlife refuge, or False Cape State Park. A shuttle bus would leave from this lot and provide service to all four destinations.

6.3 Improvements to the Existing Local Management System

6.3.1 Consolidate the Decision-making Authority for Long-term Coastal Planning, and Coastal Engineering in One Department

The major problem in the planning and management of the City's beaches is scattered decision-making authority. Responsibility for various components in the beach nourishment process such as planning, design and engineering, etc. are scattered among different agencies and individuals that do not communicate effectively or often enough with each other. They appear at times to be competing for the attention of and approval from the City Manager and the City Council. Long-term planning and needs assessment of the City's coastal areas has been occurring only on an irregular, disjointed basis with no one organization having clearly designated responsibility for performing it.

The OEM is taking the lead in the long-term planning process with the recent hiring of a Coastal Scientist. The intense demands on the City's Division of Engineering just keep up with pace of new development in Virginia Beach has meant that long range effective planning for beach nourishment has received less attention than it should have. As a result, giving planning responsibility to the OEM is a step in the right direction. Consideration should be given to enhancing the design & engineering capabilities of the OEM by hiring a coastal engineer. An alternative approach could be for the Division of Engineering to hire a coastal engineer, with specific provisions in the position's job description that a major proportion of time must be allocated to coastal engineering issues such as beach nourishment, erosion control, and hurricane protection.

The reason for giving planning and design responsibility for beach nourishment and other coastal planning issues to one agency is that the City's beaches are its most unique and valuable natural and economic resources. As such, they involve considerations in a number of different areas, including land use planning, transportation access, economic development, environmental management, etc. The comprehensive focus required for the planning and management of the city's beach front areas should be placed in an organization such as the Department of Environmental Management that can give it the attention it deserves.

6.3.2 Establish a Coastal Planning Committee

A committee should be established consisting of a representative from the following city agencies: the Division of Engineering, the Office of Environmental Management, Planning, the Resort Area Advisory Committee, the Intergovernmental Coordinator, the City Manager's Office and a member of City Council. The purpose of this group would be to provide a structured mechanism for regular communication and problem solving among the various department of city government having some responsibility for coastal planning. The responsibilities of this group would be to develop a consensus among City agencies on various coastal planning and engineering issues, identify and research long-range coastal planning issues, and provide a forum for regular structured communication between city agencies. Technical services would be provided by each of the city departments with a representative on the committee. The Committee should be chaired by a representative of the OEM.

A corollary purpose of the Committee would be to prevent the current situation where there are a number of departments all competing to promote their ideas and agendas on

coastal issues to the City Manager and the Council. The committee would be advisory in nature and empowered to make official consensus recommendations to the City Manager and the Council. The City Manager and the Council would have the responsibility of viewing any recommendation from the committee as a consensus position of all city agencies. It would be important to remove the temptation for individual departments to avoid the Committee and take their concerns directly to the City Manager or the Council.

6.3.3 Abolish the Virginia Beach Erosion Council and Consolidate Its Responsibilities into the Division of Engineering

The VBEC was originally formed to provide a local, municipal-level agency capable of receiving state funds and operating a local beach nourishment program. The Division of Engineering now has the capabilities to assume all of the functions currently being provided by the Erosion Council.

The City currently provides a large share of the Council's budget, leases them a dredge, and yet has no official control over their decisions. The potential clearly exists for a conflict in policies and decision-making. This is not to say that the Erosion Council has been working at cross purposes with the City, our discussions indicate that the Council and the City Engineer do work closely with one another. It is not in the City's best interests to continue a situation where they pay the bill but have no official control over how their money is being spent when the City is capable of performing all of the original and current responsibilities of the VBEC.

6.3.4 Identify the Users of the City's Beaches

One the major data gaps that was present throughout this study was reliable and recent information about the use of the city beaches outside of the resort beaches. On an annual basis the city surveys visitors to the resort area to determine such data as their place of residence, length of stay, number in party, etc. The primary use of this data is to increase the effectiveness of the City in tourist marketing and advertising. This data is only indirectly useful for beach nourishment planning purposes as it doesn't focus directly on how the beaches are being used. A basic question that needs answering is the demand for use of the City's beaches in all areas, and whether beaches are below, at, or above capacity during certain peak use periods. A related issue are the number and types of uses that take place in different segments.

It is recommended that the City undertake a user survey of all its beaches during peak summer periods. Information could be obtained in a number of different ways, including:

- Survey forms that can be returned in the mail by beach users.
- A fly over of the beaches during peak periods to determine how many persons are present on the beach.
- The use of college students to walk the beaches and conduct brief surveys of beach users.
- Soliciting the assistance of civic organizations in ocean front areas outside of the resort beach to conduct regular beach counts and to describe the types and locations of activities.

6.3.5 Revise the Coastal Primary Sand Dune Zoning Ordinance

A review of the Coastal Primary Sand Dune Zoning Ordinance, Article 16 of the Virginia Beach Zoning Ordinance raises several concerns. Our primary concern is that Section 1602 (h) does not limit or prohibit outdoor recreational activities on coastal primary sand dunes. It is our recommendation that this section be revised to prohibit any outdoor recreational activities on coastal primary sand dunes.

A related concern is that "Governmental Activity" in Section 1602 (l) is undefined, and could potentially allow the state or any of its subdivisions to undertake potentially destructive activities on coastal primary sand dunes. We recommend that this term be more carefully defined.

6.4 State-wide Recommendations

6.4.1 Establish a Long range Planning Capability in the Public Beach Board

It appears that the primary determinant of where and when large-scale beach nourishment has occurred in Virginia has been the scheduling and size of major channel dredging projects. Small scale nourishment has historically been handled by local governments through such groups as the Virginia Beach Erosion Council. There has been recent movement toward establishing a long range planning function by the coordinated actions of the Virginia Port Authority and the Public Beach Board. Given that the Port Authority's primary function is the promotion of the state's port, the long-range planning role for beach nourishment is probably better entrusted to the Public Beach Board where it would be more consistent with their primary objective.

A long range planning program should encompass the following elements:

- A comprehensive needs assessment of the state's shorefront areas in terms of the current erosion problems and beach conditions.
- A technical education effort which informs local municipalities on different techniques for nourishment, assesses the availability of off shore sand sources, and provides engineering support in terms of preliminary designs and cost information to local governments.
- Requiring shorefront municipalities to submit long range coastal plans on a regular basis which contain their proposed nourishment project lists.
- A ranking process by which the state can evaluate and rate for funding purposes the projects submitted by local governments.
- Tracking and advance notice of major dredging projects so that the state can submit to the Corps an already-evaluated project list for 933 funding which is consistent with the location and characteristics of the sand that will be produced.
- An increased state commitment to funding large scale beach nourishment projects.

6.5 Information Needs and Future Studies

6.5.1 Prepare Routine Profile Studies

The City of Virginia Beach has conducted a program of quarterly beach profile surveys since 1980. Such surveys provide important data regarding shoreline changes and response of the shorefront to storm events. The City currently completes the surveys at established, monumented stations, plots the beach profiles and files the drawings. The data is available to various researchers including the Virginia Institute of Marine Science (VIMS). However, there is no systematic analysis of the profile data on a continuing basis.

The following is a list of suggested actions to improve the data collection and utilization:

- Develop cooperative agreements necessary to have one consistent profile survey program throughout the City of Virginia Beach. This would involve merging the profiling efforts of the VBEC in the Resort Beach area with the efforts of the City in the remaining shorefront segments.

- Develop the profile data base in a digital format. Modern survey equipment collect data in a digital format which can be transferred to permanent data base storage very conveniently. The digital data base is also very convenient for subsequent analysis or plotting of the data by computer. Reliance upon graphical profile plots as the principal data recording and storage format for the monitoring program greatly inhibits its use in effectively using the data in analysis and planning which are the reasons the data was collected.

- Develop a routine profile data analysis program to determine volume changes and movement patterns of MHW and MLW shorelines and other contour elevations of significance. The results of each profile survey should be analyzed and summarized within a reasonable time after the completion of the field work.

6.5.2 Sand Source Investigation

A comprehensive sand source investigation to determine the anticipated volume and quality of sand for potential use in beach nourishment projects should be supported. Such an effort might best be accomplished at the State level. An accurate quantification of the sand resources would be very valuable in the development of practical and fair sand allocations to the various competing communities.

6.5.3 Near Shore Dredge Spoil Disposal

Conventional dredged material disposal from the channel maintenance operations in Chesapeake Bay utilized ocean disposal of disposal into dike containment areas such as Craney Island. Recent implementation of the COE's 933 program now provides some cost sharing of the incremental cost to place sand on the beach versus a conventional disposal site. However, even the cost sharing possibility may preclude the implementation of some needed beach restoration projects.

The incremental costs of placing sand on the beach are related to such factors as increased dredging cycle time, engineering and design of the fill project, mobilization, placement and maintenance of dredge pipe and related equipment such as booster pumps and buoy systems, and mechanical placement of the sand on the beach. Some or all of these costs could be eliminated with near shore disposal where sand is placed in water depths where profiles undergo active changes under the influence of waves and currents (generally 30 ft. of water and shallower). A study to evaluate the feasibility of such nearshore disposal of clean fine grain sand should be considered. The Sandbridge area has a steeper offshore profile than the areas offshore of the northern ocean beaches. Placement of large quantities of sand in that area may produce a positive effect on shoreline erosion by flattening the profile.

There has been considerable interest in this concept which is known as the "underwater stable berm" or "Murden's Mound." The City of Virginia Beach has made a request for a feasibility study of the concept. The Virginia Department of Conservation and Historic Resources, Shoreline Programs Office is seeking the support of the Virginia Port Authority in its effort to have the Corps of Engineers perform the feasibility study. In its letter of July 26, 1988, the Shoreline Programs Office outlines the course of action in investigating this concept. The steps to be followed are:

- Request the Norfolk District Corps to assess the economic impact of the concept on the long-term dredging costs associated with the development and maintenance of Virginia's navigational channels.

- Convene a meeting of the resource agencies to determine the environmental concerns and how they can be investigated.

- Estimate the cost of the research needed to investigate the concerns raised by the resource agencies.

- Decide if the benefit/cost ratio of the concept is still sufficiently strong to justify continuing on with the research effort.

The underwater berm concept appears to offer significant beach nourishment merits which should be investigated as outlined above in an expeditious manner.

Appendix A

Listing of Zoning Classifications

City Zoning Ordinance
Virginia Beach, Virginia
Adopted April 18, 1988

ARTICLE 3. PRESERVATION DISTRICT

Sec. 300. Legislative intent.

It is the intent of the City of Virginia Beach to protect its atmosphere, lands and waters from pollution, impairment or destruction for the benefit, enjoyment and general welfare of the public. Critical areas of special concern include parklands, wilderness areas, open spaces, greenbelts, beach reserves, scenic areas, wetlands, floodplains, floodways, watersheds and water supplies; and to conserve fish and wildlife. The boundaries of these areas of critical concern shall be identified and delineated in order to provide a means of protecting and preserving them.

ARTICLE 4. AGRICULTURAL DISTRICTS

Sec. 400. Legislative intent.

The purpose of the AG-1 and AG-2 Agricultural Districts is to protect and preserve agricultural lands for agricultural functions. The AG-1 District is not intended to accommodate residential development. The AG-2 District is intended to accommodate rural residential development.

ARTICLE 5. RESIDENTIAL DISTRICTS

Sec. 500. Legislative intent.

The purpose of the Residential Districts is to provide areas for residential housing types at a variety of densities, provide for harmonious neighborhoods located so as to create compatibility and to provide for certain other necessary and related uses within residential communities but limited as to maintain neighborhood compatibility. The R-40, R-30 and R-20 Residential Districts provide for larger minimum lot sizes for use in areas where lower residential densities are necessary to address environmental and public facilities constraints as recommended by the Comprehensive Plan. The R-15, R-10 and R-7.5 Residential Districts provided for medium density single family residential development in areas where these densities are recommended by the Comprehensive Plan. The R-5D Residential Duplex District is created in recognition of the existence of developed areas where single family and semi-detached dwellings exist on lots averaging 5,000 square feet in area and where duplexes exists on lots of 10,000 square feet in area. It is not the intention to create additional R-5D Districts or to enlarge the limits of existing R-5D Districts. The R-5R Residential Resort District is created in recognition of the existence of developed areas where single family and duplex dwellings exist on lots of less than 7,500 square feet of area and where the character of the neighborhood includes both permanent year round residents as well as seasonal residents. It is not the intention to create additional R-5R Districts or to enlarge the limits of existing R-5R Districts. The R-5S Residential Single Family District is created in recognition of the existence of developed areas where single family dwellings exist on lots with fifty and sixty foot frontages. It is not the intention to create additional R-5S Districts or to enlarge the limits of existing R-5S Districts. The R-2.5 Residential Townhouse District provides for the development of residential townhouses in areas where such development is recommended by the Comprehensive Plan.

ARTICLE 6. APARTMENT DISTRICTS

Sec. 600. Legislative intent.

The purpose of the A-12 and A-18 Apartment Districts is to provide areas for various multiple-family housing types at a variety of densities, in areas where public facilities are adequate to support these densities, and to provide for certain other necessary and related uses within multi-family communities but limited as to maintain compatibility with residential uses. The A-24 and A-36 Apartment Districts are created in recognition of the existence of developed areas where multi-family dwellings exist at densities between 24 and 36 dwelling units per acre. It is not the intention to create additional A-24 or A-36 Districts or to enlarge the limits of existing A-24 or A-36 Districts except in cases to promote infilling in areas that are already zoned or developed at densities between 24 and 36 dwelling units per acre.

ARTICLE 7. HOTEL DISTRICT

Sec. 700. Legislative intent.

The purpose of the H-1 Hotel District is to provide medium density hotel areas for general application in the city where such uses are desirable and where public facilities are available to meet their needs.

ARTICLE 8. OFFICE DISTRICTS

Sec. 800. Legislative intent.

The O-1 Office District is intended primarily for office and institutional uses. Within this district, it is intended to provide an environment appropriate to office or institutional character and compatible with residential uses which may adjoin and where public facilities are available to meet their needs. The O-2 Office District is intended for larger scale office and institutional structures and uses in areas where public facilities are available and where conflicts with residential neighborhoods can be avoided.

ARTICLE 9. BUSINESS DISTRICTS

Sec. 900. Legislative intent.

The purpose of the B-1 Neighborhood Business District is to provide areas where a limited range of business establishments that can be located near or adjacent to residential development without adversely impacting the adjacent residential area. The purpose of the B-1A Limited Community Business District is to provide areas where limited commercial development can be dispersed to support the needs of nearby residential neighborhoods. The purpose of the B-2 Community Business District is to provide land needed for community-wide business establishments. This district is intended for general application in the city. It is intended that, by the creation of this district, business uses will be geographically concentrated. The purpose of the B-3 Central Business District is to set apart that portion of the city which forms the metropolitan center for financial, commercial, professional and cultural activities. It is intended that any uses likely to create friction with these proposed types of activities will be discouraged. This district is not intended for general application throughout the city. The purpose of the B-4 Resort Commercial District is to provide for retail and commercial service facilities to serve the needs of visitors to existing resort areas and residents living in or adjacent to such area. It is not the intent to create additional B-4 Districts or enlarge the limits of existing B-4 Districts.

ARTICLE 10. INDUSTRIAL DISTRICTS

Sec. 1000. Legislative intent.

The purpose of the I-1 Light Industrial District is to permit light industrial uses, wholesaling, storage, packaging, distribution, and retailing restricted primarily to operations requiring bulk deliveries by truck or van in locations served by major transportation networks and in areas where employment centers close to residential concentrations will reduce traffic congestion and add to public convenience but moving places of work closer to places of residence. The purpose of the I-2 Heavy Industrial District is to permit industrial operations, wholesaling, warehousing and distribution in areas suitable for these functions.

ARTICLE 11. PLANNED DEVELOPMENT DISTRICTS

Sec. 1100. General legislative intent.

It is the intent not to create additional PD-H1 or PD-H2 Districts, or to enlarge the limits of existing PD-H1 or PD-H2 Districts. It is only the intent of this Article to recognize those areas currently developed, being developed, or proposed for development under planned unit development regulations as zoned PD-H1 or PD-H2.

A. PD-H1 PLANNED UNIT DEVELOPMENT DISTRICT

ARTICLE 15. RESORT TOURIST DISTRICTS

A. RT-1 Resort Tourist District.

Sec. 1500. Legislative intent.

The purpose of the RT-1 Resort Tourist District is to provide areas which can accommodate high density hotels and their related needs and where a high concentration of resort facilities are desirable. This district is not intended for general application but should be limited generally to those properties contiguous to Atlantic Avenue.

Appendix B

Summary of Restrictions on Beach Use

Chapter 6 of the Virginia Beach City Code

Chapter 6

BEACHES, BOATS AND WATERWAYS*

Article I. In General

Article II. Port Advisory Commission

*Cross references—Signs and billboards prohibited on portion of ocean front, § 3-2; amusements, Ch. 4; fires on beaches, § 12-5, license tax for beach equipment rental businesses, §§ 18-59, 18-60; license tax for marinas, § 18-87; license tax for excursion boats and other water transportation services, § 18-114; begging on beaches, § 23-15; injuring, tampering with, etc., boats, § 23-41; fees and rules and regulations for use of lakes of Mount Trashmore Park, §§ 24-4, 24-5; swimming pools, Ch. 34.

State law references—Waters of the state, ports and harbors, Code of Virginia, title 62.1; authority of city to adopt ordinances regulating operation of vessels on waters within its limits, including the marginal ocean adjacent thereto, and the conduct and activity of any person using such waters, § 62.1-182.