THE RICHARD STOCKTON COLLEGE OF NEW JERSEY COASTAL RESEARCH CENTER

Photograph taken May 2, 2005 following erosion of the seaward dune slope during late winter northeast storms. This damage to the dunes was repaired all along the Long Beach Island shoreline using a bulldozer to harvest sand returning to the beach during the following weeks of calm sea conditions.

New Jersey Beach Profile Network Annual Report on Shoreline Changes in New Jersey Coastal Reaches One Through Fifteen Raritan Bay to Delaware Bay Spring of 2004 Through Fall of 2005

Prepared for:
New Jersey Department of Environmental Protection
Division of Construction and Engineering
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December 30, 2006

The Richard Stockton College of New Jersey
Coastal Research Center

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Annual Report
On
Shoreline Changes In New Jersey
Coastal Reaches One Through Fifteen
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EXECUTIVE SUMMARY

The New Jersey Beach Profile Network is 20 years old as of the fall of 2006. These observations on beach changes along the New Jersey coastline have provided a means to determine both rapid seasonal changes and follow long-term trends in shoreline position or beach volume. The 100 sites extend from the lower Raritan Bay, along the four-oceanfront county shorelines and into Delaware Bay along the western shoreline of Cape May County. Each report focuses on shoreline and beach volume changes presented as tables, photographs and topographic profiles for each of the 100 locations between spring 2004 and fall 2005 in this edition. The winter of 2004 to 2005 had a benign start followed by a prolonged interval of minor northeast storms, which culminated in moderate beach erosion and some cutting into the toe of the dunes. These conditions continued into the late spring and frustrated municipal efforts to get the beaches ready for the 2005 summer season. While few communities were forced to bulldoze sand back to the toe of the dunes, there were substantial erosional issues related to the northern end of barrier islands such as Avalon, Absecon Island, and Long Beach Island south of Barnegat Light Borough. Modest winter storms in mid-October 2005 created a fear of a long hard winter, but the weather changed dominated by northwest winds with few storms and mild temperatures.

The fall 2005 hurricane season was one to remember for the Gulf coast as Hurricanes Katrina and Rita demolished entire resort shorelines for several blocks inland. Hurricane Wilma crossed the State of Florida and damaged both coasts. Fortunately the storms missed the Mid-Atlantic coastline, but 28 named tropical depressions, 15 hurricanes and 4 category five events made 2005 the most active Atlantic basin storm season in history and the most expensive in terms of damages (100 billion dollars and 2,280 deaths). After the last hurricane faded to a tropical depression (Tropical Storm Zeta, Jan. 6, 2006), the northeast storm season failed to develop any significant coastal storms sparing the Mid-Atlantic coast further damage following the mid-October events discussed above.

Following the construction of the Seven-Mile Island Storm Protection project in 2002 and northern Absecon Island in 2004, the US Army Corps of Engineers (ACOE) spent the last 18 months developing final details on a 71 million dollar project for Long Beach Island (LBI). The Philadelphia District also completed work on the Cape May Meadows and Borough of Cape May Point project in the late fall, early winter of 2004 to 2005 with over a million cubic yards of sand pumped onto the Cape May Meadows shoreline for environmental restoration purposes, which continued into Cape May Point as a shore protection effort. In early 2006 the relatively small Brigantine Island project finally went to construction after considerable delay. The upsurge in real estate related issues has plagued both the LBI project and is causing problems for the Northern Ocean County effort as well. The problem revolves around private ownership of the beach to the high tide line conflicting with the use of public funds to benefit private land without gaining public access to the beach built with public money. The refusal by many beachfront lot owners to grant access easements to the State and ACOE in perpetuity to manage the project and perform maintenance is the heart of the conflict. This conflict between some property owners and the public agencies must be solved before these projects can move forward. The rising resistance by Congress to fund large-scale shore protection efforts by the ACOE further complicates the drive to gain 100% coverage for the developed NJ shoreline under Federal project supervision.

The Cape May Point 227 experimental project monitoring the performance of "reef" structures in preventing sand loss offshore along Cape May Point will enter its fourth year. The project compares the 6-foot high "Beachsaver" concrete units with the standardized "Double Tee" concrete parking garage floor-beam units, which are only about 30 inches tall. Both types of "reef" structures reduced erosion.

ACKNOWLEDGEMENTS

This research was funded by the State of New Jersey Department of Environmental Protection, Division of Construction and Engineering under the Shore Protection legislation authorizing the stable funding of coastal projects (NJ PL 93 Chap 155). This is the final report under contract #4190-05.

INTRODUCTION:

The New Jersey Beach Profile Network (NJBPN) provides local to regional information on coastal zone changes and is designed to document storm-related damage assessments to the New Jersey shoreline. Several reports have focused on long-term trends at sites to develop statistically meaningful information for State and local coastal zone managers. The database consists of 100 locations between Raritan Bay (three sites in the lower bay), the Atlantic Ocean coastline, and Delaware Bay (four sites on the western shoreline of Cape May County). Each site has been visited annually in the fall since 1986. Semiannual visits, each spring and fall, began in 1994 and have continued since. Information collected consists of photographs of the beach/dune system at each site, a topographic profile of the dune, beach and seafloor to a depth of 12+ feet, and field notes on significant geologic change in progress. Any construction activity is noted and necessary information regarding quantity and duration of such activity is gathered. The field data is used to generate graphical cross section plots, which compare profiles across the width of the active coastal zone, and calculate sand volume and shoreline position changes. Analysis may be performed for any selection of survey dates at any site. This report is the latest in a series of annual reports prepared for the New Jersey Department of Environmental Protection (NJDEP) that began in 1987.

The geomorphology of the New Jersey coastline was defined by Nordstrom, 1977 and has been used to divide the State's coastline into five distinct zones with different characteristics. The variation is most dramatic between the bluff where the upland surface ends at the beach as a cliff in the older sedimentary deposits and the barrier spits or islands. The bays and lagoons are found to the south of Bay Head, NJ where the bluff finally is submerged at the edge of the rising sea level and its Holocene deposits. There are two long sand spits attached at the north end of the bluff (Sandy Hook) and at Bay Head, extending south to Barnegat Inlet. Tidal inlets occur about every 10 miles and number 11 from Shark River to Cold Springs Inlet. Finally, a shore segment of uplands bluff is exposed at Cape May Point where the Cape May County peninsula extends into Delaware Bay. A detailed discussion on the geologic changes and the present-day emergence of the New Jersey coastal plain and coastline has been included for a number of years in previous reports. This information is still found on the website devoted to the New Jersey Beach Profile Network data generated by the Richard Stockton Coastal Research Center (CRC)(page 5, 2002-report).

SHORE PROTECTION IN THE STATE OF NEW JERSEY:

New Jersey is considered the most developed and densely populated shoreline in the country, but out of a 130-mile distance between Sandy Hook and Cape May Point, there are 31.2 miles of shoreline with no human development between the salt marshes and the sea. The Sandy Hook National Seashore was established on the northern spit in Monmouth County, long used for military defense of New York harbor. Continuous development extends from Sea Bright south to Seaside Park in Ocean County. The 10.5-mile Island Beach State Park provides a nearly pristine coastal environment utilized in ever increasing recreational and eco-tourist activities. Long Beach Island has the Holgate unit of the Forsythe National Wildlife Refuge at its southern tip as part of a 10.8-mile gap in development consisting of Holgate, Little Beach Island and the northern part of Brigantine Island. Shorter segments of undeveloped shoreline exist on Pecks Beach (Corson's Inlet State Park), the Two-Mile Beach Unit; Cape May National Wildlife Refuge, and the Cape May Meadows in Cape May County. Seventy six percent of the coast is developed, with intensely crowded public and private land use activities of great economic value to the State and its citizens.

Shore protection is the science and strategy of devising methods, structures, and practices that together, promote the art of living safely within a geologically unstable environment with the constant threat of storm damage. Made of unconsolidated sediments, the New Jersey coastal zone is not able to resist alteration by waves, tides and storms that move sediment from place to place. The total absence of bedrock along the shoreline means that all the oceanfront is vulnerable to be removed and re-deposited elsewhere over relatively short periods of time.

Protection has involved many different structural solutions beginning with timber bulkheads and piles of brush contained inside a double row of cedar pilings (early groins). During the 20th Century truck transportation of large rocks added to the ability of placing large armor stone along erosional shorelines. Concrete came into play to create seawalls and other structural solutions. Finally, the development of large-scale methodology for moving millions of cubic yards of sand from areas of surplus at inlets or offshore to eroded beaches created the beach replenishment "industry". Between 1990 and 2005 over a half billion Federal, State and local dollars were expended at over 50% of the developed shoreline placing 10's of millions of cubic yards of sand on beaches between Sandy Hook and Cape May Point.

36 years of State regulation of the coastal zone has produced a large volume of policy designed to guide and safeguard development especially along the inlet and oceanfront shorelines. Implemented by the Land Use Regulation Program (LURP) within the New Jersey Department of Environmental Protection (NJDEP), the shore protection aspect of the regulation has focused on building design, setbacks from the shoreline and the creation of a wider beach with a storm resistant dune system built between the development and the beach. There has been abundant conflict between those who would build right to the high tide line on the beach and some who would advocate the abandonment of all public and private development on barrier islands. Since most individuals, corporations, and municipal governments fall close to the center between that range of positions, the major battles have been over how large a setback, how wide a beach and controlling dune growth.

As the Federal/State and local municipal beach restoration program emerged in the late 1980's, the wider beaches created by bringing in new sand have reduced storm damage to public and private property. The first reaches completed under the Federal program were Cape May City and northern Ocean City to 34th Street, NJ. Ocean City was completed in the summer of 1992 following the October 31, 1991 northeast storm which did over $4, 000,000 in damage just to the municipal boardwalk and other public infrastructure along the shoreline. In December 1992 an equally intense event produced another Federal disaster declaration for New Jersey, but damage to the Ocean City oceanfront infrastructure was negligible. In Cape May City there was one minor area of overwash into the community at the very northern oceanfront street intersection.

Following the two early 1990's northeast storms, the State Division of Engineering and Construction reviewed the damage history and looked for ways to accelerate the Federal Shore Protection Program for other New Jersey beaches. In 1994 the NJ legislature established the "Shore Protection Stable Funding Act" that initially provided $15 million dollars annually for the specific purpose of conducting shore protection projects along the coastline. The policy was to provide 75% of the project cost with the State funds, with the local contribution equal to 25% of the project. Following consultation with the New Jersey Shore Partnership, local coastal public officials, coastal consultants, public and private, the decision was made to use the Stable Funding Act revenue to provide the required 35% local partner(s) matching funds to seek future Federal assistance. With the Federal Government paying 65% of the project cost, the State/local funds became tremendous financial leverage to proceed with far larger efforts than could be undertaken by the State and municipal entities alone.

The State and its municipal governments began the process of lobbying the Congress for authorization of Shore Protection work along the New Jersey shoreline. The US Army Corps of Engineers (ACOE) is the Federal agency charged with initiating, planning, designing, and carrying out the construction of these projects. By far the largest co-sponsored project was the Monmouth County Shore Protection Project covering 21 miles of shoreline between the Sandy Hook National Seashore and Manasquan Inlet. The New York District is the division of the ACOE responsible for

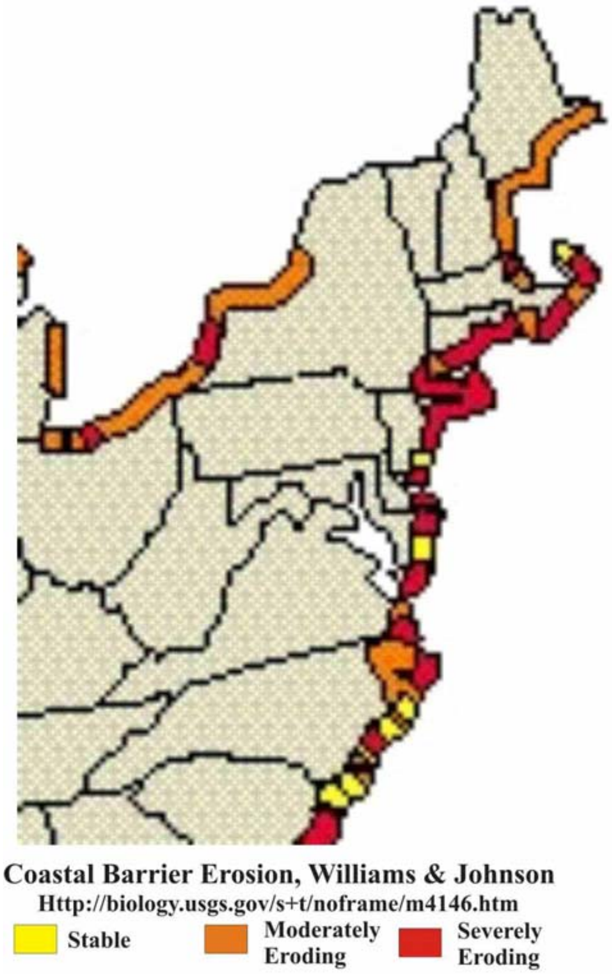
Monmouth County. With three distinct phases required to take a project from concept to construction, the effort proceeded to get started on nearly every shoreline reach in the State. The first step is a Congressional authorization directing the ACOE to undertake a Reconnaissance Study of the selected shoreline to determine the nature and magnitude of the erosion or storm damage threat and recommend moving to the Feasibility Study phase. Federal funds cover the reconnaissance study, with the State matching funds required for the Feasibility Study that follows. That study is conducted by the ACOE and is focused on providing engineering, geo-technical, environmental, and economic answers to the questions raised by the reconnaissance study. In order to proceed to the next step the Feasibility Report must (among other things) show a cost to benefit ratio greater than 1.25 for project approval.

The Planning and Engineering Design phase is where the actual project is laid out and cost documentation with predicted benefits to the region is formulated into a sizable document that will be used to generate a funding request from Congress to go to construction. Finally, after approval and signature at Department of the Army in Washington DC, the project is authorized to go to the construction phase. Most of the effort is expended in lobbying Congress, pursuing the goals of the project and seeing that the State is on-board with the project design in order to proceed from reconnaissance to construction in less than 8 years. Projects were authorized in rapid succession for nearly all developed shoreline sections in the State. The political activism did move the Monmouth County, Absecon Island, Seven-Mile Island and Brigantine Island projects to construction following the initial success of the Cape May City and Ocean City projects. Work is completed or near complete on the two studies for all other reaches in the State. Construction funding authorization from Congress has become increasingly difficult. As the need for beach maintenance has increased, the willingness of the Congress to fund these projects has decreased with multiple attempts to return the burden of funding back to the States and local communities. Coastal communities and economies are clearly important to New Jersey's prosperity and quality of life, but they are vulnerable to devastating affects from northeast storms and hurricanes. This was demonstrated during the 2004 hurricane season in Florida. This threat came to pass again along the Gulf Coast in 2005, which may continue a 20-25 year long trend of enhanced activity in the Atlantic basin that began in 1995. This *increasing trend* in storm activity coincides with a *decreasing trend* in Federal funding for shore protection and beach nourishment. Funding for the 2006 budget proposal is 32% lower than was proposed for 2005, and nearly 50% lower than was proposed for 2004. Responsibility for protecting and maintaining the coast is incrementally shifting to the State and municipal governments.

The details on each of the projects follow in the body of this report under the county in which they are taking place. New Jersey is pursuing the continuation of projects already authorized to ultimately achieve their construction status, especially Northern Ocean County, Long Beach Island, and Ludlam Island. The relatively minor effort on the northern Brigantine Island shoreline was completed in the spring of 2006. Each project authorized for construction comes with an agreement to support the maintenance of the project for 50 years from the date of signature of the final Planning and Engineering Design documents. At the present moment the Federal government provides 65% of the maintenance costs as well, with the "local" share at 35% of the project cost. The "local" sponsor of any Federal project may comprise local, county or NJ State funding agencies. With the State's program of 75% cost sharing of coastal projects, the municipal share of any Federally sponsored project is 25% of the 35% "local" share which amounts to 8.75% of the total Federal project cost. That means for every million dollars in project cost, the municipal share of the project is $87,500. This is the fantastic local economic leverage built into Federal Shore Protection Projects.

STORM VULNERABILITY ASSESSMENT OF THE NJ COASTLINE:

With the upsurge in intense hurricane activity since 2004, the CRC began to focus on just how susceptible the New Jersey coastal communities were to storm damage from dune breaching and overwash during storms. Data on beach elevation and width combined with dune parameters were factored into an analysis designed to predict just when a particular storm would breach the beach/dune system and produce damage inland. Research found initial attempts at quantifying the damage potential from coastal barrier erosion (Williams & Johnson, 1995) where the national shorelines were categorized as Stable, Moderately Eroding or Severely Eroding. The northeast portion of the US is displayed in Figure 1a left, below showing their color scheme with New Jersey shown as severely eroding along all but Atlantic County's shoreline. To the right is an illustration from a 2001 USGS report, which took the analysis of the southern Atlantic shoreline up a level to evaluate the relative elevations of the primary dune along the coast with indications of decreased vulnerability to overwash and breaching based on an increase in dune elevations.



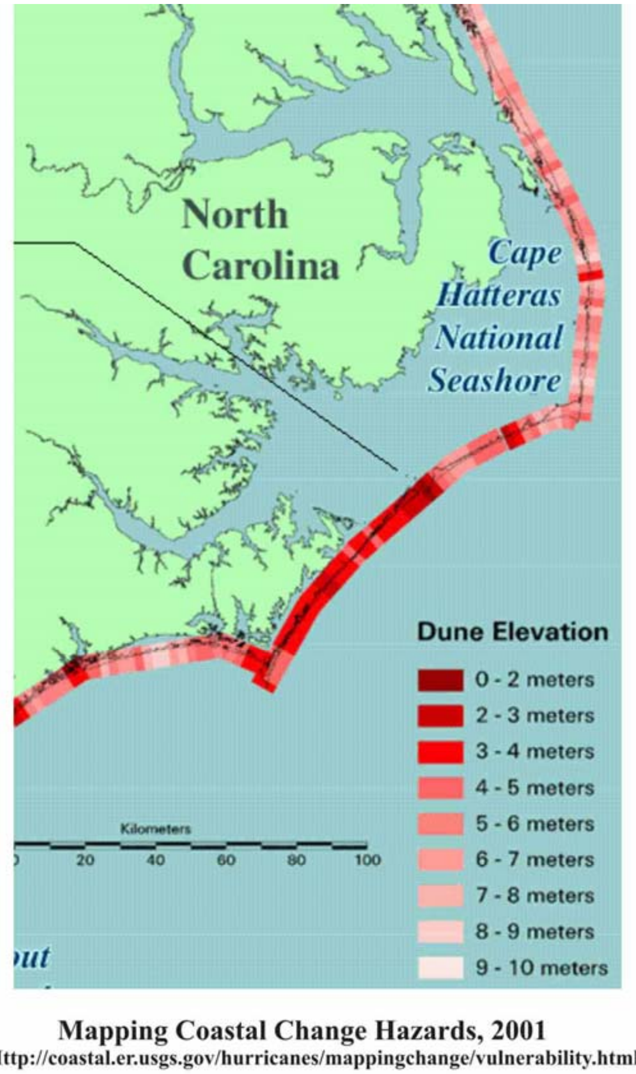


Figure 1a. Initial work attempting to quantify the potential for damage to the shoreline by coastal storms and erosion. Williams and Johnson, 1995 and USGS report 2001.

In 2002 the CRC commenced development of a storm vulnerability assessment for the New Jersey shoreline based on new technology called LIDAR. LIDAR is a laser light pulse sent from an aircraft to the ground and detected in reflection from the ground and converted to an elevation based on GPS determination of the plane's position and elevation and the time for the light to reach the ground and return to the plane's detection system. Digital elevation data with points about every square foot form a swath along the shoreline from the low tide line back landward of the dunes. Water penetration is imperfect at present, but is under development and sub-aqueous data is improving.

The initial project evaluated the relative effectiveness of a stretch of Long Beach Island dunes in Holgate to storm damage based on width, elevation, seaward slope, and vegetation density. The dunes were subdivided based on existing oceanfront property widths and categorized into five classes of increasing ability to resist breaching. In 2004, the Borough of Mantoloking requested that the CRC evaluate the community dune system and add the model impact of multiple storms defined by Federal Emergency Management Agency (FEMA) into probability of occurrence between a 2-year event up to 100-year storm intensity. Each storm's defined parameters of wave height, storm surge elevation, etc, were entered into the ACOE computer program called S-Beach. This one-dimensional model uses the LIDAR data and offshore NJBPN data to provide the "existing dune beach conditions" for the test to see if the system can withstand a particular intensity storm event. If the dune crest is compromised, the determination is made that dune failure occurs and overwash into the community occurs. Figure 1b to the right shows the 50-year FEMA storm event imposed on the Mantoloking oceanfront dunes based on the width of individual oceanfront properties. The digital tax map was provided by the community and used to segment the 2000-dated LIDAR and digital aerial photography. Cooler colors indicate dunes that resisted the 50-year storm surge and waves with the yellow color in the upper set of color bars showing a 90% erosion to the dune crest. The red color indicates dune failure. The lower set of color bars shows the relative performance of the dune/beach system among the 141 properties along the Mantoloking oceanfront. Reds and yellows indicate below average performance, blues and greens indicate above average with white the average dune performance for a 50-year storm. This effort is being expanded, funded by the NJDEP Division of Engineering and Construction to include all of Northern Ocean County on a 250-foot width increment. Designing this for individual oceanfront property widths proved to be an impossible task since not every community has or is willing to provide its digital tax map with geo-referenced coordinates for the project. Work is expected to be complete by June 2007.

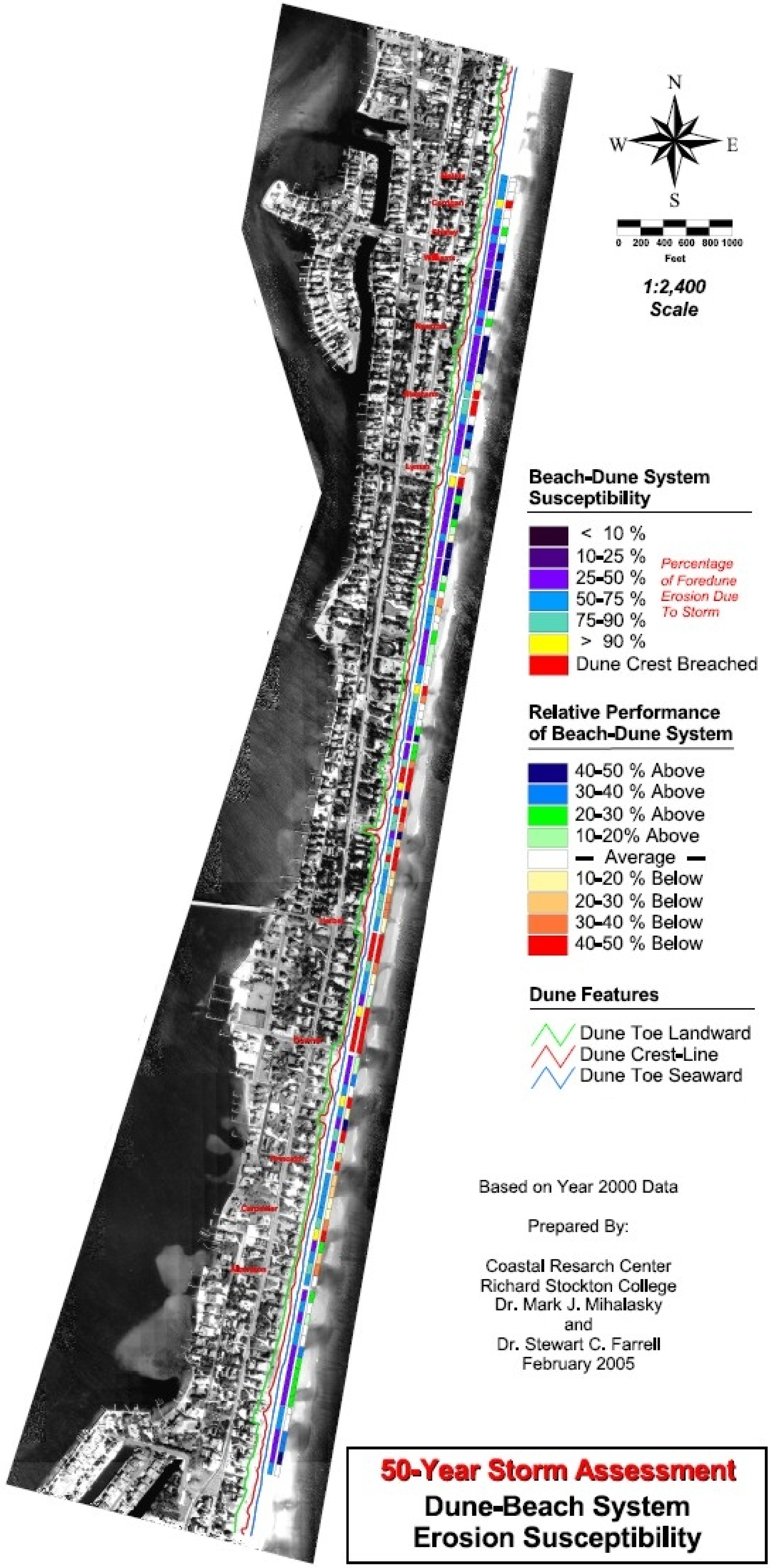


Figure 1b. 50-Year Beach-Dune Erosion Susceptibility Commissioned for Mantoloking, New Jersey 2004.

NJ BEACH PROFILE NETWORK (NJBPN) METHODOLOGY:

The monitoring program performed by the Richard Stockton College of New Jersey Coastal Research Center (CRC) monitors shoreline and beachface conditions twice a year, capturing erosional and depositional trends. Each successive year that the profiles are surveyed adds to a time series of information about long-term erosion and deposition on the New Jersey coast. This data aids NJDEP regulatory and planning personnel in the following ways:

- Determining areas of potential erosion problems.
- Implementing policies to protect beaches, dunes, overwash fans and erosion hazard areas (EHA), as well as reducing risks to development in these high hazard areas.
- Facilitating assessment of disaster impacts following future storm events.
- Providing useful background information, when evaluating NJDEP permit applications.
- Providing evidence on dune development at any site.
- Assisting local municipal governments in developing policies or plans for dealing with coastal erosion or improving storm preparedness.

Beach survey stations were chosen based on the following criteria:

- Each location represented typical community beach conditions.
- Each shoreline community would have at least one site.
- Where possible, sites utilized positions with prior survey data.
- Control profiles were sited on State or County undeveloped beaches.

Presently there are 100 sites that must be profiled after the winter storm season has ended in spring. The second annual survey occurs before the summer beach accretion is removed by the increasing frequency of storms that occur in the fall and winter. The CRC crew uses a Sokkia Set-530-R Electronic Total Station, which transfers the data to an SDR-33 Electronic Field Book. The unit is initialized with position coordinates, the elevation for two known locations, transit height, and target height. Environmental factors such as temperature and atmospheric pressure, and unit columniation errors are entered. Field personnel equipped with an optical prism mounted to a range pole traverse the dunes, backbeach, shoreface, and continue into the water up to a depth of -15.0 feet NGVD. The prism pole height can be changed between data points as necessary. The data is stored in the SDR-33 Electronic Field Book then downloaded at the office into a personal computer. A beach profile typically consists of 35 to 55 individual data points (Figure 2).

The survey information is edited, checked against field notes and sent to a database for use and storage. The profile plots and computations have been performed using ISRP27 a survey reduction program designed by the Coastal Engineering Research Center (CERC) of the ACOE. A new program called BMAP (Beach Morphology Analysis Package, v.2.0) is being used to format the survey data. Also designed by CERC, this program is "windows" compatible and has more versatile data presentation capabilities. The computation of the sand volume change between any two surveys can be set to run in several ways. These unit volumes are given in cubic yards of sand per foot of beachfront (yds^3/ft). These unit volumes are typically valid for up to 1000 feet north or south of any of the profile sites along the beachfront or to any groin/jetty structure. Structures invalidate the calculation because of their sand collecting or starving effect. All profiles were located as close to the center of any groin cell as possible to limit this impact on sand quantity and beach configuration. Corel Draw v12 is used to generate graphical images of the beach profile data.

Electronic reports are available for 1998 and 2000 through the present, including a special 15-year review of select profiles that date back to 1986, which is included as part of the 2000 report. The electronic reports are available on-line to the public at the Coastal Research Center's web page, which is hosted by the Richard Stockton College's web site. They are provided in both html (web page) and Adobe Acrobat (PDF) format. Visiting the Richard Stockton College web site and clicking on the "Community & Visitors" menu item to access the New Jersey Beach Profile Network link can reach the Coastal Research Center web page. The site can also accessed directly by visiting http://www.gannet.stockton.edu/njbpn

Methodology

New Jersey Beach Profile Network

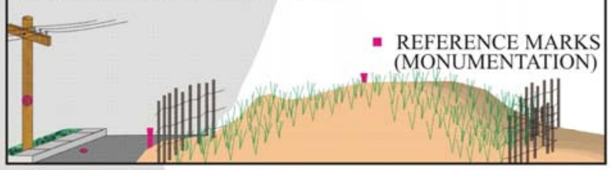
Figure 2

Step 1: Site Selection

NJBPN profile sites were selected to be representative of the beaches within each community. This was done in order to gain the most accurate assessment of the State's beaches, with a feasible number of profile sites. Beach profiles are lines perpendicular to shore that are surveyed repeatedly to monitor beach changes. Today, there are a total of 100 beach profile sites in the New Jersey Beach Profile Network. These beach profile sites range from the Raritan Bay, along the Atlantic Ocean coast, into the Delaware Bay. It takes the CRC approximately two months time to survey all of the NJBPN sites, depending on the weather and ocean climate.

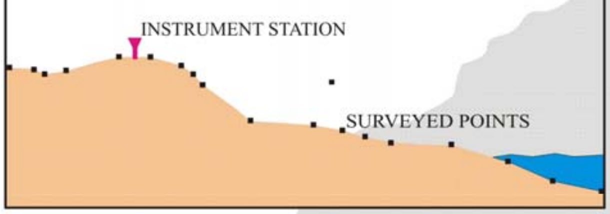
Step 2: Monumentation

Each profile site requires at least 2 known positions to use the survey instrument. The survey instrument station is set on an elevated but stable part of the dune. This assures that the majority of the profile is visible and that the monument will survive a storm. Back up monuments, in the event of serious storm damage, ensure that the CRC will be able to survey the same profile line the following season.

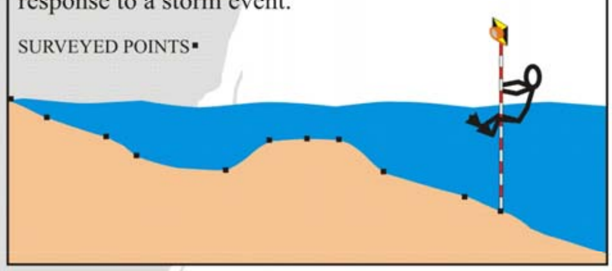


Step 3: Survey the Profile

The survey instrument is oriented using the known reference markers. The profile is surveyed beginning in the back dune, then proceeding across the beach and into the water. Positions are taken for critical points on the profile, breaks in slope - etc., or about every 50 feet, otherwise. Typical profiles have 35 to 50 points.

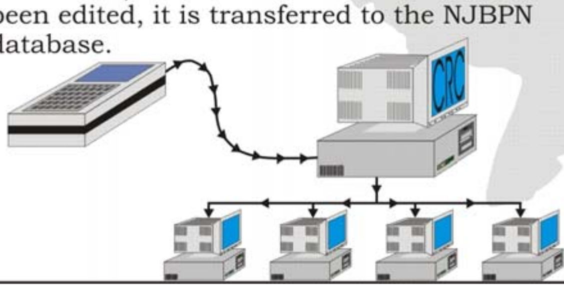


The profile survey continues until the swimmer reaches a depth of 15 feet, Mean Low Water. The survey is often carried out beyond -15 feet MLW. This happens when CRC personnel recognize the need to survey further to include a feature such as an offshore bar that may have migrated further seaward in response to a storm event.



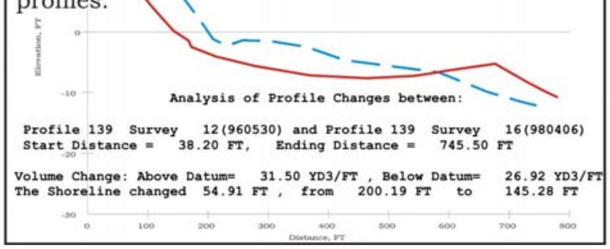
Step 4: Download and edit data

The electronically logged data is downloaded to a Personal Computer at the CRC office. The data is then edited for any possible errors and/or omissions. Once the data has been edited, it is transferred to the NJBPN database.



Step 5: Data Analysis

The data is then input into the ACOE Coastal Engineering Research Center's (CERC) Interactive Survey Data Reduction Program (ISRP). This is currently the program used in the initial profile analysis. ISRP provides sand volume and shoreline change data, for selected pairs of profiles.



Beach Nourishment in New Jersey: 2004 - 2005

(Information provide by ACOE New York & Philadelphia Districts and local entities.)

The oceanfront coast of New Jersey has received large scale Shore Protection projects co-sponsored by the State and the Federal US Army Corps of Engineers. *Sandy Hook* receives sand carried by littoral currents from the beaches in Sea Bright, nourished by the ACOE as well as direct placement north of the end of the Sea Bright seawall. The *Sandy Hook to Manasquan Inlet Shore Protection Project* was completed by the ACOE New York District and has placed 21 million cubic yards of sand, to date. The Ocean County shoreline is in the Planning and Engineering Design phase of study by the Philadelphia District, with Long Beach Island commencing construction in spite of continuing real estate issues. Both Brigantine and Absecon Islands were completed in 2005 and 2004. The ACOE maintains the *Great Egg Harbor to Corson's Inlet (Peck Beach)* project area (Ocean City), placing over 9.9 million cubic yards thus far. Cape May City (1989), Avalon and Stone Harbor (2002), are complete. The District also is sponsoring two Ecosystem Restoration/Shore Protection projects in southern Cape May County as well as an experimental 227 project to evaluate wave barrier systems in Cape May Point. Beach nourishment provides both storm protection for public and private infrastructure and builds a recreational area, the latter supporting New Jersey's 18 billion dollar coastal tourist economy that creates 240,000 jobs annually.

Figure 3