Public Hearing

before

THE STATE BEACH EROSION COMMISSION

"Beach Protection Strategies:
Planning for the Future"

LOCATION: Asbury Park Municipal Hall
Asbury Park, New Jersey

DATE: October 6, 1993
10:00 a.m.

MEMBERS OF COMMISSION PRESENT:

Assemblyman David W. Wolfe, Chairman
Assemblyman John C. Gibson, Vice Chairman
Senator Andrew R. Ciesla
Assemblyman Steve Corodemus

ALSO PRESENT:

Senator Joseph A. Palaia
Assemblyman Tom Smith

George J. LeBlanc
Office of Legislative Services
Aide, State Beach Erosion Commission

Hearing Recorded and Transcribed by
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State Beach Erosion Commission
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NOTICE OF COMMISSION MEETING

The **State Beach Erosion Commission** will hold a public hearing on the following topic:

Beach Protection Strategies: Planning for the Future

The hearing will be held on **Wednesday, October 6, 1993 at 10:00 AM at Asbury Park Municipal Hall, Asbury Park, New Jersey.**

The public may address comments and questions to George LeBlanc, Committee Aide, at (609) 292-7676. Anyone wishing to testify should contact Carol Hendryx, secretary, at (609) 292-7676. Those persons presenting written testimony should provide 15 copies to the committee on the day of the hearing.

DIRECTIONS:

FROM THE SOUTH:
Garden State Parkway North to Exit 100. This exit puts you on Route 33 East. Take Route 33 East to the end (you will see a sign for "Ocean Grove"). You are now at the intersection of Route 33 and Main Street. Turn left onto Main Street. Proceed North on Main Street into Asbury Park for approximately 4 lights. The Asbury Park Municipal Building is on your left. You can park anywhere on the right side of the lot.

FROM THE NORTH:
Garden State Parkway South to Exit 100B - Route 33 East and proceed as above.

Issued 9/28/93

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ASSEMBLYMAN DAVID W. WOLFE (Chairman): Good morning. I'd like to call the fourth meeting of the New Jersey Beach Erosion Commission to order. We have no gavel, although we have this thing up here that looks like a brick. I didn't want to drop it to get your attention. Thank you very much for coming to Asbury Park. I'd like to explain very briefly what we've done, what we will be doing, and the purpose of our meeting today.

The Commission was founded in 1948 by the Legislature. It's composed of eight members appointed by the Senate President or the Speaker of the Assembly, and four members appointed by the Governor -- public members at large. The Commission has been basically inactive. As a result of the storms that we had the past two years, because of the concerns over restoration of the beaches, and also the problem of getting money back to the municipalities, the Commission was revived.

We had an organizational meeting early in the summer. We met in Spring Lake about two months ago. At that time, the status of all the beaches in New Jersey was discussed. At our third meeting, which was held about two weeks ago in Ocean City, the issues involving FEMA, restoration moneys involving Corps of Engineers projects, and also projects involving the DEPE were discussed.

Today's hearing is primarily concerned with ongoing and new emerging technologies involved with beach protection and beach restoration. That's really why we're here today. A number of people have indicated that they would like to testify before the Commission, and there is a list of people basically in the order which they indicated that they would like to testify. If you have not indicated that you would like to testify before the Commission, there is at this table down here a tablet which you may fill out indicating the organization

that you represent and what you'd like to speak about. Just give it to George, up here next to me, and we will take you in the order in which you indicate you'd like to speak.

I just would like to say one more thing, I'll then introduce the members of the Commission. In fact, I'll do that first. On the end are Assemblyman Corodemus and Assemblyman Smith. This is George, our right-hand man here. From the Office of Legislative Services, George LeBlanc. This is Assemblyman Gibson, from Atlantic County; Senator Ciesla; and Senator Palaia. A member of the Commission that was unable to be with us today is Assemblyman Robert Smith, from Middlesex County, and Robert is represented by Randy Kansagor--

MS. KANSAGOR (Minority Staff): Roni Kansagor.

ASSEMBLYMAN WOLFE: Roni Kansagor, I'm sorry, a member of his staff. We also have people from the Democratic Minority in the Assembly with us today. This is not a political group. It is bipartisan. Both Houses are represented -- Republicans and Democrats. What we are lacking, though, are members of the public to be part of the Commission. We've called upon the Governor to appoint public members, and to date he has not chosen to do so. We will certainly reiterate that request, hopefully. The business that we have at hand is very important. It is not a Republican or Democratic issue. It is something that we think is very important and needs to be addressed by all of us.

So with that, I would just like to add one further comment. I have a letter from Senator Joseph Kyrillos, who ordinarily sits on the Commission. He is attending a funeral today and is unable to be with us today. He extends to us his support.

Before we begin, do any of you have anything you'd like to add or say?

Steve?

ASSEMBLYMAN CORODEMUS: A quick statement if I may, Mr. Chairman. I'll be brief.

Although this Commission isn't officially charged with the administration of the expenditure of the $15 million annually renewing fund for beach protection, we've waited so long in the State of New Jersey for this money and there is a lot of pent up anxiety to see that as much work gets done as quickly as possible. But we want to make sure it's done as cost-effectively as possible. I'm sure everybody on this panel and the taxpayers present today would like to see our tax dollars spent and spread as long as we can.

It's going to be up to us to recommend the most effective -- and cost-effective -- return on that investment. Hopefully, although each and every one of us has been approached on an individual basis by perhaps other engineers, I think it's up to us to make a comprehensive recommendation to DEPE for the expenditures of that fund.

We don't want to go through another devastating storm. I think many people here would testify today that the beaches that had the most nourished beaches with the gentlest slopes along the shore were the ones that fared the best. This is all our mutual desire to see the whole 127 coast miles restored to that capacity.

ASSEMBLYMAN WOLFE: Okay. Thank you.

Anybody else? (no response)

One last comment: The Commission is required by law to report to the Legislature and also to the Governor, and it is my intent -- hopefully with the assistance of our staff -- that we will be able to have at least an interim report prepared so that in the next budgetary cycle any recommendations coming forth from the Commission could be considered fully by the Legislature, and also by the Governor.

So with that as an opening statement, I'd like to call on Dr. George Klein, who is the new Director of the New Jersey Marine Sciences Consortium based in Sandy Hook. I had the

opportunity to meet with Dr. Klein last week. I was very impressed by his staff and facilities, and he's had a lot of experience.

Dr. Klein, thank you for coming, and welcome.

G E O R G E D. K L E I N, Ph.D.: Thank you, Mr. Chairman. By way of introduction, although I have been introduced, I'm George Klein. I'm the new President of the New Jersey Marine Sciences Consortium, and have been on deck, as they say, since May 24, 1993. Before I discuss the topic at hand, Mr. Chairman, I would like your permission to briefly summarize what the Consortium does, because in my travels through New Jersey the last four months, when I've given my vision of what the Consortium is, everybody says, "Oh, that's what you do. Thanks for telling me." So I'd like to put it on the record, if I may?

ASSEMBLYMAN WOLFE: Sure.

DR. KLEIN: Essentially, the Consortium consists of 33 member institutions -- colleges and universities: 26 in New Jersey, 3 in eastern Pennsylvania, and 4 in southern New York. These colleges and universities range from the community college level to the research university level. The Consortium is a common platform and facility to conduct joint interinstitutional research, education, and marine science services for the benefit of the citizens in New Jersey, focusing on the coastal and shelf problems that are of interest to the State of New Jersey.

In the area of research, I've identified four initiatives that I believe we should be exploring in the decade ahead:

First and foremost, and of interest to you is beach erosion, shore erosion, and remediation. A second initiative deals with the scientific aspects of the dredging issues that have recently come to the fore with respect to the problems involving the dredging of Newark Bay. The third area,

motivated by the passage of the Marine Biotechnology Act of 1993 by the House of Representatives, is in the area of marine biotechnology, and the fourth area that we want to explore is aquaculture.

Our educational programs focus both on summer courses for college students, fall field programs and spring field programs for college students, and a very large active program in the precollege arena for K through 12 school children, who are taken on one or two day, or weekend field trips at our Sandy Hook base to become exposed to what the marine environment is all about.

The State of New Jersey, through the generosity of the Legislature, funds our activities. Our cost-effective ratio for the amount of dollars that New Jersey spends to the amount of grants and contracts we raise is 3.8. In other words, every dollar New Jersey puts into us, we're able to match it with $3.8 from other sources. The services that we perform are organized around conferences, workshops, information sessions, public affairs sessions, and also operating a fleet of research vessels that are available to our member institutions and others on a charter basis.

Now, with respect to the future strategies and planning for beach protection, let me share with you some of my perspectives of some things that might be considered for the long term.

The issues of beach erosion and remediation have been of concern to citizens of New Jersey for well over 50 years, and have involved the active cooperation and engineering design of the U.S. Army Corps of Engineers for at least that long. Despite the good work they have done over this period of time, the approach that has been taken is what I loosely call a short-term approach. Because what it has involved, as I understand it, is beach nourishment, obtaining material from the inner-shelf zone; that is, the zone below sea level but right adjacent to the shoreline.

The problem there, gentlemen, is fundamentally this: The beach and inner shelf are dynamically linked because you've got a mixing of surface and wind-driven currents with bottom currents. So the consequence is, as the currents' intensity changes during the winter cycle, as you well know, erosion takes place and the sediment that was on the inner shelf that was used to nourish the beach goes back to the inner shelf. The solution is to shortcut this problem, but I guarantee you it will be expensive.

The alternative that I propose for you to consider is what I call the import model, for lack of a better word. In other words, the sand that you need to nourish the beaches has to come from somewhere else besides the inner shelf.

The guiding principle that is behind this is actually very simple. In coastal areas in the world where sea level is rising, just as it is here -- sea level rises on a global basis -- but in coastal areas where there's more sand being deposited or accumulating than can be eroded, you get coastal progradation, seaward building out of the beaches, and you don't have the problems that you do here in New Jersey.

What is the common basis for this coastal progradation? It is that these beaches are near or adjacent to, or downstream in terms of current transport from large river systems. You do not hear of massive coastal erosion problems on the coast of Texas. Why? Because the Mississippi River and the Rio Grande River are providing the necessary volume of sand for the beaches to build out naturally. The same is true for the beaches of Holland, near the Rhine River; and along the coast of Brazil, near the Amazon and Sao Francisco river systems. There are other examples, but I think those three get the point across to you.

In New Jersey we are cursed, because the Hudson River and the Delaware River do not provide the necessary volumes of sand to replicate what happens in Texas, so we have to substitute some other way to do it.

The import model proposes that you obtain sand from a distant source. The nearest distant source would be the middle or the outer continental shelf, and you can dredge it, convey it, and nourish the beaches with a shoreward dredge. Another possibility is a land source. The trouble is -- land sources -- the transportation costs are expensive, and the environmental impacts are formidable if we stay in the United States.

What the import model calls for is dredging offshore from the outer shelf -- not necessarily off the coast of New Jersey, but whereever we can get it -- using ocean-going dredges, and transporting it with the cheapest possible mode; that is, chartering laid-up ore carriers and oil tankers which are looking for work. They would have to be cleaned, but they could be used to transport this sand at the cheapest rate, bring them near shore, and off-dredge them with the standard beach nourishment techniques.

Now, that's the principle and the guiding framework of the import model. What we don't know is how much sand we need. That can be determined both with numerical scientific modeling, as well as experimental studies. We know how much sand has disappeared over the last 50 years, so we could replicate that from existing data.

The second thing we need to determine is how much the whole thing will cost, and the third thing is over what time frame. You want to build your beaches to withstand the erosion problems and replicate the conditions you have along the Texas coast. Once you know those costs, then you have to design ways and means to finance these large fronted costs and a payout schedule in order to use this kind of system.

Now, in order to do that, it would require a multidisciplinary team of people involving mathematical modelers, physical scientists, coastal geologists, coastal engineers, and of course, inevitably, the economists and the

policy people who would have to guide such studies as to what the ultimate payout is. This kind of approach -- this team approach, I think, is feasible in New Jersey. The people are here to do it. There are people in this State who are capable of doing it; it's just a matter of organizing them if there is a will to organize them and get the job done.

I want to close my remarks by saying, yes, the New Jersey Marine Sciences Consortium would be happy to put together such a team if so mandated. Thank you very much.

ASSEMBLYMAN WOLFE: Thank you.

Questions?

Senator Palaia?

SENATOR PALAIA: Dr. Klein, does the Consortium deal at all with the building program along the shore? Have you taken a stand on that issue, because obviously it's paramount.

DR. KLEIN: We have not taken a stand on that issue. We try as much as possible, as a scientific institution, to make recommendations on a scientific basis, or make proposals on a scientific basis. But we try to avoid taking political stands, for lack of a better word for it.

SENATOR PALAIA: In other words, there are no scientific findings about whether maintaining residences is detrimental to the buildup, or should we pull back?

DR. KLEIN: There are none that I know of or have come across my desk in the last four months. I'm prepared to check back and report back to you.

SENATOR PALAIA: I think it would be helpful to us.

DR. KLEIN: I'm sure it would. My guess is, from things that have been said to me, that we don't have that information, but I think it's something we could get into if that's, again, mandated by the Commission or other agencies.

SENATOR PALAIA: Thanks, Dr. Klein.

ASSEMBLYMAN WOLFE: Senator Ciesla?

SENATOR CIESLA: I have a question regarding the present Army Corps project for renourishment that is supposedly underway in its first reach. The comment that you made was that you thought that an effective source for sand nourishment was from the middle or outer continental shelf?

DR. KLEIN: Yes, sir.

SENATOR CIESLA: And that it required tankers or whatnot in order to bring it in. Is that the project-- Is that essentially the way that the project is going to go forward as currently contemplated by the Army Corps?

DR. KLEIN: I'm not aware that it's being handled that way.

SENATOR CIESLA: I thought that it was being pumped.

DR. KLEIN: They have an-- As I understand it, they have large oceangoing dredges, and they load them on those ocean-- They load the material on the oceangoing dredges, and bring it closer to shore, and offload it, but I'm not exactly certain of the technical details.

SENATOR CIESLA: Because the question that I really have is my concern that if that is the source that seems to be reliable for the replacement of sand in order to break the dynamic balance that interrelates the shore to the close continental shelf, I'm concerned that perhaps the project that is being undertaken is going to pull sand from a source that might not be of a permanent nature and might erode prematurely.

DR. KLEIN: I'm left with the impression -- but I could be mistaken -- that they're still dealing with inner-shelf material. They traditionally have done so.

SENATOR CIESLA: So my question becomes, based on your scientific knowledge, is that a proper source for the investment that's being made?

DR. KLEIN: Only for the short-term, sir. For the long term, I would have questions.

SENATOR CIESLA: Do you know what that period of time, short and long, is?

DR. KLEIN: Minimum of one year, maximum of five.

SENATOR CIESLA: What would be a-- I'm just trying to understand the cost benefit of the current project, that we're being -- if, in fact, -- and I'm not concluding this based on your preliminary remarks -- we're being penny-wise and dollar-foolish; that perhaps we might be well-advised to look at an alternative source for a longer solution than to provide an immediate, apparent resolution of a problem only to find out in the short term -- one to five years -- that we're back to the original problem that was defined.

DR. KLEIN: Well, that is the essence of the model that I've proposed. By looking for a source that is out of this coupled dynamic system -- the linkage of the shore and the inner shelf -- looking elsewhere; by adding and building the sand onto the beaches and even out into the inner shelf to establish a dynamic equilibrium -- and, again, this can be modeled and has been -- we'll be able to short-circut the present problems that we're having, and in effect, replicate what you see along the Texas coast.

SENATOR CIESLA: My final question: So it really is your testimony that what we're spending now on this program, in all likelihood, will disappear in five years?

DR. KLEIN: It is not unreasonable to expect that to happen.

SENATOR CIESLA: Thank you.

ASSEMBLYMAN WOLFE: Assemblyman?

ASSEMBLYMAN GIBSON: Doctor, the middle shelf-- In the example that Senator Ciesla brought up, and based on what you may know about that particular project, how much further from the probable source of sand is this middle shelf? How much further out in the ocean?

DR. KLEIN: Well, we're talking about a distance ranging from say as close as 20 miles offshore, to as much as maybe 100 to 110 miles offshore. The edge of the continental shelf is about 200 miles offshore.

ASSEMBLYMAN GIBSON: Then how deep is the water when you get there, approximately?

DR. KLEIN: It's about 300 feet at the edge of the continental shelf.

ASSEMBLYMAN GIBSON: Thank you, Doctor.

ASSEMBLYMAN WOLFE: Assemblyman Coredemus?

ASSEMBLYMAN CORODEMUS: Just a comment, Dr. Klein, as opposed to a question. I'm really encouraged by your recommendation of ocean dredging and transport by open-hold ships or dredges to be deposited along the beaches, because not more than -- and I see many faces here from another hearing, on another day, about dioxin dumping-- We had numerous people criticizing and strongly advocating the failure of that type of transport system when it comes to dredge materials, in that it was beyond the scope of sound naval architecture to put dredge sediments in a ship and transport them. They told us it absolutely couldn't -- it's not feasible and it couldn't happen.

Now, if I understand your testimony, you're advocating the dredging of sand from the middle to outer continental shelf there, which I think is a farther distance than six miles than we're currently experiencing, and it's anticipated to succeed.

DR. KLEIN: Well, I'm not a naval architect. My training is in geology, but the reason I recommend using ore carriers and oil tankers is that they are designed -- at least certainly the ore carriers are -- to carry this kind of particular material. I've been watching the dredging issue at a distance as it's evolved over the summer. I'm not familiar with the type of vessel they're using for the transport, but from the descriptions -- some of the experiences were -- gates were opened up too early and this sort of thing.

It led me to-- I could see where there would be problems along the line that you have discussed. But the ore carriers do not open out the way, apparently, these dredging

scows open out into the ocean floor. You would have to pump the sand into the ore carrier, and then you would have to pump it out just like they do when they collect the ore and transport it across the ocean to a fabricating plant.

ASSEMBLYMAN CORODEMUS: I understand. The criticism was that that type of procedure would make the vessel so unstable, it couldn't possibly dock along a pier facility until such time as the dredge material could be processed at a future date.

DR. KLEIN: With the ore carrier, the design has taken into account the potential of those problems that you're mentioning.

ASSEMBLYMAN WOLFE: Dr. Klein, thank you very much for your testimony.

If anyone wishes to speak and they haven't signed up, you can fill out this form down here on the desk.

Thomas Gagliano is the Director of the Jersey Shore Partnership based in Middletown. Welcome, Senator Thomas Gagliano

S. T H O M A S G A G L I A N O: Thank you. Good morning, Mr. Chairman, members of the Commission, and ladies and gentlemen. My name is Tom Gagliano, a native of the Jersey shore and President of the Jersey Shore Partnership, which was established immediately after the Halloween storm a couple of years ago. We're almost two years old, I guess, this month.

I was in the New Jersey Senate from 1978 to 1989, and during that period of time, I am totally aware that we were unable to establish any stable funding source for shore protection and preservation. I congratulate this Legislature for having done so. The importance of that is tremendous because, for the first time in the history of New Jersey, we have the $15 million, which is in the budget and will be in the budget, hopefully, each year to provide for the shore protection that we need.

The stable funding is very much appreciated, but the amount is something that we really do not have a handle on for the future. I think we saw this summer the viability of the Jersey shore. We had the weather. We had good weather most weekends and as a result, the business was great, the visitors were certainly happy with the shore, and I think that the investment paid off. But for the future, I believe that this body, this Commission, would be really well-advised if you could establish somehow a timetable of future projects, what those projects will cost -- at least an estimate of what those projects will cost -- and then have the Legislature determine the amount that stable funding should be for the future years.

Now, I say that because we're about ready -- and I understand the bidding should take place on the Monmouth Beach/Sea Bright job that Senator Ciesla referred to sometime this month -- which probably means that, weather permitting, the Army Corps could start pumping sand from offshore either by the end of this year, or certainly by early spring, again, I'm sure, weather permitting.

That means that we will have a tremendous amount of money that is due from the State of New Jersey as its share to this project. I'm not sure that $15 million will be enough, but I think it probably will be enough for the first year or two. But as the project proceeds-- I refer you to an article by a woman by the name of Lynn Marie Bocomozzo (phonetic spelling), in fact, I could send it to you. She wrote the article. She works for the Army Corps of Engineers in the New York District, and she explained the entire project as she saw it at that time.

As we know, this project has been thought about for a long time, but four or five years ago I think it was, Ms. Bocomozzo wrote this article, and she explained where the sand is coming from and the overall project that starts at the foot of Sandy Hook and eventually goes to Barnegat. My point is

that as we get to that point, I think the call for money -- for the State's share -- will be increased, and it may increase dramatically. I think that it's up to the people of the State to be ready for those increases, and that we look forward to generating additional revenues so that our share will always be there. Because while we are tied to the schedule that the Army Corps establishes, and therefore what Congress establishes in terms of paying for it -- our share being approximately 35 percent -- the local share combination of State, county, municipal, whatever it is, I feel will go up.

One of the things that this Commission should think about in its report to the entire Legislature is how we can establish a timetable based upon reports from the various departments of New Jersey, and from what the Army Corps has in mind for the future, a timetable of projects so that we can establish the money that's needed.

I think that the Legislature, even though it's not easy to ask for money, will understand better the process once we all know what the projects are, approximately what they'll cost, how long they'll take, and when it will happen. So that I felt today we should talk about-- Because I heard Dr. Klein's testimony, and what he's talking about, of course, is importing sand from further offshore. The program is to import sand from immediately offshore. The borrow area, as I understand it, is off of Sandy Hook, at least for this first project. It's good for the interim; I hope it's good for the long term. But the point is that I don't think we can continue to just talk about these projects. What we have to do is get the projects done.

The mission of the Jersey Shore Partnership is to see to it that there is created for the State a constant, meaningful, and stable source of funding to effectively combat beach erosion, storm damage, and provide meaningful property protection along the New Jersey coastline. We still feel that

that mission statement, even though we have now stable funding of $15 million, is important, because we want to look to the future. We want to look to the next three, five, ten years, and in connection with that, we support everything that this Commission is doing, especially the studies that you're providing for and the fact that you will be reporting back to the Legislature.

If there is anything we can do to help you, we'll be happy to try. Thank you.

ASSEMBLYMAN WOLFE: Thank you very much.

Anybody have any questions?

ASSEMBLYMAN CORODEMUS: I'd just like to add it's good to have you back in good health, Tom, before the Commission.

MR. GAGLIANO: Thank you very much, Assemblyman. Thank you.

ASSEMBLYMAN GIBSON: We also take pride in the establishment of a permanent source of beach funding and, I might add, at no additional cost to the taxpayers. I'd like to recognize Senator Gagliano's contribution to that success.

MR. GAGLIANO: Thank you, sir. Thank you very much.

ASSEMBLYMAN WOLFE: Certainly, we recognize that.

Thank you, Senator. Thank you very much.

Next we have two individuals: Dr. Norbert Psuty, Associate Director; and Dr. Karl Nordstrom, Professor, Rutgers Institute of Marine and Coastal Sciences.

Good morning.

N O R B E R T P. P S U T Y, Ph.D.: Mr. Chairman, Assemblymen, Senators, ladies and gentlemen, my name is Norbert Psuty. I am a professor at Rutgers, the State University of New Jersey. I'm in the Department of Marine and Coastal Sciences. My area of expertise is coastal geomorphology; this is a study of beaches, dunes, sediments, waves, and currents in the coastal area. I've been at Rutgers since 1969, and have been studying aspects of the coastal zone of New Jersey during this time.

I'm here to provide testimony to the New Jersey Beach Erosion Commission regarding what I consider to be key issues, objectives, and strategies leading to improved management of our coastal area. My comments are directed to the Legislature as the ultimate managers of our coastal zone, and of necessity to guarantee that the things that we value as resources, as attributes, be available to the citizens now and in the future.

Anyone who has been to the shore will realize that our natural system is extremely dynamic and is in a state of flux; that many different time scales -- whether it be the tidal variations, the seasonal contrasts, or the changes over the centuries, this is, in fact, part of the allure of the coast. Further, as we look at the variety that exists from Cape May to Sandy Hook, Delaware Bay to Raritan Bay, and all the bays and estuaries between, we become aware of the fact that there are many different coasts within New Jersey -- many different conditions -- and when we combine these spatial differences with the differences that occur along time scales, we realize that there are, in fact, many different portions of the coast that require different approaches to management.

I believe that it is probably most important to management that we are able to provide some direction and control relative to a particular objective. I think it is necessary that some particular aim be established before we are able to apply strategies. Before we're able to evaluate strategies, we must decide if management is for the protection of the infrastructure; whether management is attempting to maximize the recreational opportunity; or whether management is attempting to preserve and protect some natural resource, either for its preservation or for some subsequent exploitation.

There in fact may be other objectives as well, but the issue remains that some primary objective must be identified in order for us to put the strategies in place. In order for us

to manage the achievement of, and measure the achievement that many of these strategies-- Certainly, it is possible to have secondary and primary -- I'm sorry, secondary and tertiary objectives, but there must be a primary objective. I think that's a very critical point. In the application of strategies, it is very important to realize that our coastal zone is, indeed, extremely complex. The strategy that works in one area and produces extremely positive results there may not work in another area. What was successful at one time may not be successful at another.

What we are finding out as scientists is that in the dynamics of the coastal system, the interaction of the natural processes and anthroprogenic processes -- essentially the development of the shoreline -- produce yet even more complex scenarios. It's very difficult to just look at the action of a wave working on a piece of sand and say this is what's going to happen because of all the other things that are there that have been put by people.

Further, we find when we evaluate the conditions of a particular storm, it depends an awful lot in terms of what was there in the first place; whether it was a natural system; whether it was a cultural system; whether it had been able to store sand for a long time; or whether or not it had been operated on by a storm a few weeks earlier. Thus we find there is no uniform reponse to particular storms. We find, in fact, it is dependent upon the preconditions of the beach, the dune, and the offshore zone prior to the storm.

In the course of taking testimony today, you will hear claims about the virtues of one approach of coastal management over another. You may learn about the success of a particular strategy that has been produced at some location. I don't doubt the veracity of the claims, but pick your approach in a limited time, in a limited space. But I suggest to you that there is no universal panacea that will cure the problems that

we face along the New Jersey coastal zone. We need to really have a great deal more information about our coastal zone just to be able to understand what is going on there.

I realize that you'll be asked to address pressing situations that exist, and to spend our limited tax revenues to solve short-term problems. You, indeed, will have to consider many of these problems, because they are real. They are threats to property; they are threats to economic investment; they are threats to the infrastructure that exists along our shore.

But I ask you also to consider the long-term needs of management. For example, as a State we need to establish a statewide database of basic natural, physical, and biological processes. We need to have a storehouse of information concerning the measurements of waves. We need to establish wave climatologies in various parts of our coastal zone in the same way we have weather records.

We need to have measurements of the sediments that are moving through the system -- sediment budgets in the sectors of our coastal zone. We want to manage sediment. We need to have more information about how much material is moving and where. We need to know the vectors of sediment transport. We need to have knowledge about what the structures are doing along our shore zone.

We have a lot of interference with the natural processes. We need to establish what is being done, how materials are being moved, and in what direction -- what effect they're going to have upon the sediment budget. We need to have good tidal records. We need to know something about how deep the water is, associated with individual storms. We need to know what the effects of the long-term sea level rise will be. We need these dimensions. We need to measure and monitor the coastal dune building programs that are so common along our

shoreline. We need systematic data gathering and easy retrieval so that we can respond to questions about how well certain strategies have achieved stated objectives.

In regard to strategies, I favor the emphasis on beach nourishment and coastal floor dune enhancement as a means to buffer the effects of erosion and restore the beach environment. We must bring new sediment into the system. Just to rearrange the existing sediment, making use of some structures does not solve the problem. We are working with a reduced sediment resource. Rearranging it does not solve the erosional problem.

Our need for sediment along the coastal zone of New Jersey is so great that we may have to eventually set up some sort of sand management board -- some sort of agency that is able to redistribute, direct, and make decisions about sediment transfers, because this is a very finite resource. This is not something which is being just made available at some infinite scale. Indeed, there are just certain quantities of material available of appropriate sizes to be used within our beach zone.

Beach nourishment, as was mentioned earlier, is really just a short-term solution. Each episode of beach nourishment will probably last on the order of one to five years; that's the history. It will have to be repeated again, and basically at higher costs. In some areas it may be economic to do so. There may be returns which cause this to be an economical venture. In other areas, it may not be. Beach nourishment cannot be applied universally because it is patently not appropriate in all areas. This comes back really to the variety and complexity of the coastal zone of New Jersey.

What I favor as a strategy is the establishment of guidelines, principles, and procedures by which situations are evaluated relative to objectives and relative to proposed strategies, of which beach nourishment is only one. I favor

the application of land use zoning as a strategy to direct the kind and amount of investment in the coastal zone. I favor the use of retreat option where it is the most appropriate means to achieve an objective. I favor the application of guidelines and procedures in poststorm situations when it will be necessary to make decisions regarding the reallocations of land use for the protection of the citizens.

I suggest the conversion of part of the coastal zone to public holding be part of a management strategy to reduce exposure and provide for open space and access. We need to create some innovative incentives to prompt participation in this conversion, and we need to provide some disincentives to prevent further development on our barrier islands.

My recommendations to the Commission involve a series of steps that I think are consistent with good management. They are as follows:

First, we need to establish and maintain a good database. We need to begin to assemble and build basic measurements of waves, currents, tides, sediment budgets, beach profiles, sediment quality data, and rates and effects of sea level rise. We need to do so as part of a comprehensive plan with quality control vested in some of the State agencies, such as DEPE. We currently have a multitude of projects at the shore, but there is very little networking and there is very little continuity in the data gathering. As soon as funding for some project ends, that data gathering also ends. We really require long-term fundamental data sets upon which to base decisions.

Second, we need the State to support fundamental research and data gathering. Some portions of the funds available for shoreline management should be directed to basic inquiry on the processes, the geomorphology, and engineering approaches to the coastal zone. We need far more detailed knowledge on the inshore circulation systems and the spatial

variation of sediment transfers. We need far more knowledge on the role of coastal dunes and shoreline protection, and the dynamics of sediment exchanges between the dunes and the beach. We need far more knowledge about sediment transfers in the vicinity of, and the transfers across inlets.

Third, we need to establish management which is directed toward specific objectives. We need to monitor all projects that occur along the coastal zone in order to provide evaluations of the approaches of shoreline protection, preservation, stabilization, or enhancement. We must be especially aware of any downstream effects of particular approaches. It's one thing to stabilize the beach in one area, but if, in fact, it is changing the sediment budget in an adjacent place, then that's certainly a negative response. We need to manage our public holdings with as much care as we have within the private areas -- the developed areas.

We need to look at Island Beach State Park, consider its attributes, and maintain them. I think we need to incorporate Sandy Hook, even though it's a national park and sort of out of our jurisdiction. It's part of New Jersey, and it's part of the recreational resources of the State. I think we ought to incorporate them within our long-range management plans. I think these two areas really offer outstanding opportunities for recreation, tourism -- natural areas. They need to be incorporated within our plans.

Fourth, I think it is of prime importance to develop poststorm guidelines and procedures to assess the options regarding the redesignation of land use in those areas that are damaged. This will be the appropriate time to apply incentives toward reducing vulnerability and exposure along our coastal zone. We must be prepared to exercise all options. The application of the planning option through established procedures is, in fact, a situation which is utilized in virtually all other parts of the State.

Fifth, as an approach, it is necessary that the extreme mobility of the coastal zone be recognized, and that both long-term and short-term objectives be identified within this system. There are many opportunities for use of the coastal zone. We shouldn't just be wedded to one use, one strategy forever within this dynamic environment.

I leave you with a few additional words of our coastal zone, something that I'm sure you are completely aware of, and that is that coastal change and coastal erosion are not small problems. There are no quick solutions. There are no inexpensive solutions. There, in fact, may not be any or many long-term solutions that we can continue to afford.

I don't have the answers for shoreline erosion, and I doubt that the answers are going to be forthcoming in the near term. I do know many of the questions, and I do realize that there are properties, income, ecologic systems, and lives at stake in decisions that are reached regarding protection of the coastal zone.

I do know that the supply of sand at our shore is decreasing. I do know that the barrier island volumes are decreasing. I do know that sea level is rising at one of the highest rates, drowning our shoreline at the highest rates of the entire eastern seaboard of the United States. I delivered to the Commission a report that was begun under former Governor Kean and completed under Governor Florio; a report to the Governor's Office and The Science Advisory Committee; a report that we did on the effects of sea level rise within New Jersey. Sea level rise is happening; it has happened. In fact, it's probably driving a lot of the changes that occur along the shoreline.

I do know that the Legislature and the scientific community both have an obligation to provide leadership in both understanding what is possible and what is not possible in our coastal zone. We need scientific data gathering. We need to

work from knowledge and not from guesswork. We need to establish primary objectives on a site by site basis. We need long-term monitoring and measurement. In essence, we need to evaluate everything that we do in the coastal zone, or we will just not progress.

I thank you for your patience in listening to me, and I stand ready to help you in any way I can.

ASSEMBLYMAN WOLFE: Thank you, Dr. Psuty.

Assemblyman?

ASSEMBLYMAN GIBSON: You're a professor at Rutgers? You have students in this beach erosion course?

DR. PSUTY: Yes.

ASSEMBLYMAN GIBSON: Is that a major, or is that part of another course where they--

DR. PSUTY: It would be a kind of direction within either geology, geography, or marine sciences. It's not an individual specialization.

ASSEMBLYMAN GIBSON: And when they graduate, where do they go from there generally?

DR. PSUTY: Some people go to work for the State. We have a number of individuals within State DEPE. We have individuals who go on and have positions within universities and colleges.

ASSEMBLYMAN GIBSON: Are you saying when they go to work for the State, as an example, they're not collecting data from year to year as to where we've been going for the past 20 or 30 years in this area?

DR. PSUTY: The only data set that I am aware of that, in fact, is being collected at the present time is the one that Stu Farrell is collecting under support from the DEPE, in which he's profiling the beaches of New Jersey once per year.

The answer is, no. There isn't a heck of a lot of data being collected. We need information, for example, on just waves. We have to turn to old records of wave data when

we try to come up with what are some of the energies that are present here. We look at information that has been -- we call it hind casted -- taken from weather records, and we generate waves from that. It's never really been tested to see whether or not these data are, indeed, accurate.

No, we don't have a good data gathering system for the State of New Jersey that allows us to refer back to either what happened or what are some of the characteristics of our shore zone. It's kind of a paradox. We have a long-term interest in the coastal zone, but indeed, we don't have a long-term data set.

ASSEMBLYMAN GIBSON: How about the coastal air photography that is taken every year? Isn't that a source?

DR. PSUTY: It's not every year. For the span of time from 1951 to about 1972, in fact, we as a State took photography twice per year. It's excellent information, but we stopped in 1972. Since that time we have had at some intervals -- three-, four-, five-year intervals -- there has been a photographic mission that has looked at the State, taken the entire State, and we have access to that. But it's a little different than what was done previously, and the scale is much different.

ASSEMBLYMAN GIBSON: I would presume you would recommend that we continue and decrease the interval in the air photography that we're taking? (laughter)

DR. PSUTY: I think it's absolutely necessary, and I also think it's necessary to take it at appropriate scales and appropriate times. I think what was done through the '50s and to 1972 was excellent. Essentially, it was spring/fall photography. It showed what had happened as a result of, let's say, the past winter, and then what recovery was during the summer. It gave us really some idea of what the variation was. It showed us where sediment was going in many areas. It was excellent, excellent photography.

I think you need that kind of up-to-date information just to be able to measure what the effects of a December storm were, or the March storm. I think we need that kind of coverage. It's really not very expensive, and it's something that is a lasting data set. It can be constantly returned to and made use of by the scientists, by the managers. I certainly recommend continuing air photography.

ASSEMBLYMAN GIBSON: My last question, Doctor: In your department, are there any ongoing studies that you're conducting in this area?

DR. PSUTY: Yes, we have a couple of studies that we're working on. We're starting now -- actually through some support of the New Jersey Marine Sciences Consortium -- sea print programs. The New Jersey experiment station will begin to look at monitoring some of the effects and the attributes of some of the dune building programs up and down the shore. We are in the process of selecting sites that we will begin to sort of try to evaluate the (indiscernible) strategy.

In addition, I have in fact been working with the National Park Service at Sandy Hook since 1976. We have indeed been monitoring virtually all the things they do along the shoreline there, including all the beach nourishment. Therefore, I speak from experience when I say that this is a short-term solution. They're going to have to be doing this again for about the fourth time within a couple of years -- beach nourishment.

ASSEMBLYMAN GIBSON: Thank you.

Thank you, Mr. Chairman.

ASSEMBLYMAN WOLFE: Assemblyman?

ASSEMBLYMAN CORODEMUS: Just one question, Professor: I might take objection with some of your retreat recommendations and restrictions on public property use unless there are funds there to compensate the home owner. But given unlimited resources for the research that you're advocating,

how many years would it take to complete it to get a model that you would feel comfortable with to recommend some type of remedial action?

DR. PSUTY: I can't answer your question directly. Number one, I think it's a continuing need. I don't think you can just sort of say we need 20 years of data, and therefore that's the end of data collection. I think you need to have a program -- a State-run or State-overseen program much like Florida has where -- in fact, there are a number of workers out there gathering data, but under the general auspices of the state. They proceed to accumulate and accumulate and accumulate, and every once in a while, you can go back to look at that and make some projections and make some analysis.

But I don't think you ever stop gathering information, because conditions are changing; weather systems are changing; sea level is rising; the shoreline is retreating. These are all variables that are going to produce different reactions to any particular storm. I think that you need to have the information as a continuing source of data in order to sort of assess any particular instance when you need to make a decision.

I didn't exactly say that you retreat without compensation. I did not say that. I said that I think there are opportunities, or there may be opportunities, when retreat is the most appropriate option. If that involves compensation, then so be it.

But I also believe that there are some places that are just so vulnerable that I think it may not be good stewardship to consistently put people back into exposed areas. I think those are the places that we have to look at, and I think we have to look at them each and every time. Every time there is a storm, 99 percent of the shoreline survives, and survives well. There are not major changes; there isn't major damage. But 1 percent of it may, in fact, be in an area that just can't be reoccupied, it's too vulnerable.

I think there's the opportunity to look at it, and I don't want to do it on a knee-jerk reaction basis. I think there have to be some sort of procedures by which areas are evaluated and decisions rendered, so that, in fact, we need to establish criteria; we need to establish the principles by which we apply the criteria and then come up with certain results.

ASSEMBLYMAN CORODEMUS: It's hard to argue against a plea for studying the problem that faces the shoreline, but it comes to a point that some action has to be taken, and I think the time is now. We've suffered so many storms in the last two decades that some action -- perhaps it is not the cure-all that will last centuries, but some remedial action has to be taken.

DR. PSUTY: First, I agree with that in terms of short-term solutions, but I also think that it's incumbent upon us to evaluate that particular action. Let's find out how well it works, how long it works, and what are the positive and negative things about that action, so that we learn from that and we are able to apply that the next time that need arises again.

ASSEMBLYMAN CORODEMUS: Of course, I agree with that.

Thank you, Mr. Chairman.

ASSEMBLYMAN WOLFE: Thank you, Assemblyman.

Doctor, I'd like to thank you very much, and also the previous speakers -- and I'm sure the future speakers -- have certainly shown us there is not a solution. I think the Commission has its work cut out for it. Thank you very much for your testimony.

At this time I'd like to call on Dr. Michael Bruno, who's the Director of the Davidson Laboratory at the Stevens Institute of Technology.

Dr. Bruno?

M I C H A E L S. B R U N O, Ph.D.: Thank you, Mr. Chairman.

ASSEMBLYMAN WOLFE: Thank you for coming.

DR. BRUNO: Assemblymen, Senators, I'm Michael Bruno. I'm a professor at the Stevens Institute of Technology in the Department of Civil and Coastal Engineering, and also Director of Davidson Laboratory, which is a coastal and ocean engineering facility.

I think we need to-- Well, first of all, let me just say that I admire and respect all of the remarks of Professor Psuty before me. He has laid out for you, I think in very good detail, the complexity of the issues that face us. They are complex but, Assemblyman, as you said, we are faced with a crisis situation right now that requires immediate action. A short-term solution for sure, but we need to get into, I would like to say, the maintenance mode before we can get on to longer-term planning -- the preparation of longer-term action on what our coastline needs for proper maintenance and remediation.

Let me just say that we need to come to grips with the fact that the Jersey shore is a developed coast. Much as many of the people in this room, and perhaps many of the members of this Commission would prefer not to see that development, would prefer not to see homes lying so close to the dune line, those homes exist, those properties exist. Many of those homes have existed along the shoreline since the 1800s, some of them before.

It is our job as engineers to see what we can do to protect those properties. That's our mission. It will continue to be our mission. I agree with Professor Psuty that there will come a time, no doubt, when there will be some areas, some properties for which it will be economically unfeasible to continue protecting. I'm not sure if we've reached that point yet.

I can report that with Professor Nancy Jackson, and Professor Karl Nordstrom from Rutgers -- Nancy Jackson is at NJIT -- we are preparing a sea grant proposal which will go

through the New Jersey Marine Sciences Consortium, which will address and study the New Jersey coastline as a developed system. This is a quite unique approach to coastal study. I think it will be useful to many other coastal states in the United States.

But first and foremost, we have to come to grips and deal with the fact that we have a developed coastline, and all of our study and all of our action has to be in that context. We are not at liberty, we do not have the freedom, we do not have the luxury to speak of a dune, foreshore, offshore, inner-shelf system. We have properties that in many people's minds are in the way of that system, but in our minds are worth protecting. So that study I think bears some watching. We hope that it will start next year at some point and will bear fruit within the year.

As many of you know, Assemblyman Wolfe and Senator Ciesla were the sponsors in the Legislature of the Coastal Protection Technical Assistance Service, which is now headquartered at Davidson Laboratory at Stevens. While in that service and working with Professor Psuty and his group at the Institute of Marine and Coastal Sciences at Rutgers, as well as Professor Stu Farrell at Stockton, and others in the State, we hope to begin the process in more fervor, at a higher rate of activity, putting together some plans and some new ideas -- new technology -- for the protection of our coast.

Foremost in our minds right now, and in agreement with what Professor Psuty said, that task must begin with data acquisition and data processing. We have a fractured system not only of shore protection in this State, which has always been a piecemeal, knee-jerk reaction to storms, we also have a fractured system of data collection. Part of the reason is because the State of New Jersey is divided into two Federal regions: the New York district, from Manasquan inlet, north to Sandy Hook; and the Philadelphia district, from Point Pleasant down to Cape May.

There are Federal programs for data acquisition; they exist. There is wave data being collected as we speak off of the coast of New Jersey. The problem is acquiring that data and processing that data. Perhaps not to this Commission's surprise, in many cases there are funds that exist for the acquisition of the data. But there's no funding for the processing and analysis of the data, so it sits there.

One of the first missions of the Coastal Protection Technical Assistance Service will be to gather that data and some of the other data that exists, such as Professor Farrell's beach profile information that Professor Psuty alluded to earlier. We need to bring all that together. We also have many local programs. Many of the towns run their own beach profiles. Many of the people in this room are aware of those programs. But that data remains very often in somebody's drawer, or worse yet, on some hard disk on a computer and nobody's using it.

So we are beginning the process right now. We hope to have that in full force by the end of this year,,to pull together the information that not only will, we hope, provide some needed guidance in what we can do with protecting our coast, but also will illustrate the gaps in the data so that we can go then to the State of New Jersey and, we hope, to the Federal government to say that there are some obvious gaps that we require filled before we can proceed with a sensible plan for shore protection in this State.

The other aspect of the Coastal Service is the analysis -- experimentation of new ideas, new technologies for beach protection. You are, I'm sure, all aware of the ongoing reef -- pilot reef -- project at Avalon. You will be hearing from Dick Creter from Breakwaters International shortly. Stevens is involved in the two-year monitoring effort of that project, as well as two similar efforts -- two similar reefs to be constructed next spring at the border of Belmar and Spring

Lake, and the other one at Cape May Point. Those projects -- while I agree with Professor Psuty, they may not be a panacea for the entire coast. I agree that there is no one solution for the entire coastline. They are certainly worthy of trying, and members of this Commission I know supported that attempt. We are appreciative of your support.

But there are other ideas out there you'll be hearing from other people here today. I think it's important for people to know that there exists at least a program of inquiry into these ideas, not saying that they will all work, but at least something is being done. There are people out there studying the problem, and not merely for academic reasons -- basic research -- although we do that. There is an urgent need for much more applied research, much more fast-track research.

The State of New Jersey put this reef project on a very fast track. I know of no other such project that moved as quickly from the paper, to laboratory, to field application. If we can continue that kind of a cycle and see if we can get new technology out there, we may be further along when we meet again next year.

Thank you.

ASSEMBLYMAN WOLFE: Senator?

SENATOR CIESLA: Mike, one of the concerns that we all share is that there are particularly vulnerable areas of the coastline that maybe need some remedial action now in order to prevent damage from a future storm which is likely to occur. Is, or can one of the missions be of the Technical Assistance Programs that are now being pulled together to maybe do a quick brushfire type of assessment of the coast of New Jersey to identify particularly vulnerable areas, and then maybe to go as far as to suggest short-term remediation projects knowing full well that they won't provide any permanent solution, but they may be considerably less costly than the need to fix the damage that would occur after a likely storm?

DR. BRUNO: We are working with staff members from the DEPE. That is one of the mandates of the service. We are working very closely with Jim Hall, the Assistant Commissioner, and Bernie Moore. The DEPE has for many years continued the process of a priority list of projects, the highest priority being areas that are most vulnerable to destruction from storms. There really is no argument with that list and their method of prioritizing.

I think for accelerating the process, perhaps what needs to be done is to put together all the various sources of funding. This just goes on and on and on ,getting the local, the county, the State, and the Federal government all together, getting through the maze of public access and the other requirements. There are towns that are ready now -- perhaps you'll hear from some of the mayors today -- that are ready to go. They have no difficulty with public access. They have no difficulty with local funding -- local share funding, so perhaps if--

SENATOR CIESLA: Which ones are they, Mike? (laughter)

DR. BRUNO: What's that?

SENATOR CIESLA: Public access and funding are the keys. (laughter)

DR. BRUNO: Is Mayor Roman right behind me? Okay. (laughter)

ASSEMBLYMAN WOLFE: One of our mayors.

DR. BRUNO: But if one needs to-- If one could argue for some quick look, maybe you could do something along those lines to see not only where it is needed right now, but also where a town is ready and willing to go. Because I think too often, like we saw up at Sea Bright and Monmouth Beach, you have a project on the books; you have contractors ready to go; and you get into a maze of delays, whatever, because of some other issues like public access.

SENATOR CIESLA: Mr. Chairman, I think it would be a request -- a formal request through the Chair that we ask DEPE, Jim Hall, or Bernie to provide that list to us so that we can maybe take a look at it to see when the latest update has been, and perhaps might have that as a subject for a future discussion.

ASSEMBLYMAN WOLFE: Very good.

Anyone else?

Yes?

ASSEMBLYMAN GIBSON: When the previous professor spoke, he indicated a lack of testing with waves and things like that. You have a wave tank. You are testing waves at Stevens, aren't you?

DR. BRUNO: Yes.

ASSEMBLYMAN GIBSON: Was the previous speaker there to encourage us to give you more resources to do more testing? I thought you were already doing that. I really thought you were going to come up and say, "Well, here we are. We're doing all this". But what was his intention in bringing up the lack of wave resources, when you in fact have a wave tank, and you are in fact testing this?

DR. BRUNO: Norb, do I owe you lunch?

ASSEMBLYMAN WOLFE: He owes him lunch, yes. (laughter)

DR. BRUNO: Norb was not speaking about the wave tank testing. The experiments that we can do, although they are at large scale because of the large size of the tank, we can study possible technologies -- solutions -- to the problem. What Professor Psuty was referring to was actual offshore field data. We need long-term data. Often for coastal engineering projects and planning you need at least 20 years of continuous records of wave data. We have nothing near that in New Jersey. The Federal government has begun the process recently. The State of New Jersey does not have such a program.

ASSEMBLYMAN GIBSON: The Federal government has been doing this for at least 20 years. They've had tests with the poles out -- how high the waves come. They've had individuals who either volunteered or were public works employees for the town to do this. I presume maybe then the message to us is -- and you correct me if I'm wrong -- is that the data has been gathered, I believe, for at least 20 years, but it hasn't been digested. It is not in one common place where everybody can refer to it and utilize it?

DR. BRUNO: Well, that is right now the most immediate problem. There are just too many different acquisition systems, and it's not all being tied together. But as I said, one of the problems is you don't get a clear understanding of where the gaps are until you've brought in all the various sources and seen where you need additional sources of data. We don't-- The Corps does not have high-quality wave data for that length of time. There have been various programs, many of them citizen-based. There have been long-term programs of measurement of tide levels and storm surge levels, but what Professor Psuty was alluding to was surface wave data. The technology is fairly recent for doing that in a high-resolution, high-quality method.

ASSEMBLYMAN GIBSON: All right, thanks for clearing that up.

Mr. Chairman, one other line of questioning. We're going to hear next, or somewhere this morning from Breakwaters International on one specific pilot reef project that I have a personal interest in because it is, in fact, in my legislative district. You are monitoring that.

DR. BRUNO: Yes.

ASSEMBLYMAN GIBSON: Should you be telling us now about the monitoring procedure, will you be coming back up, or is that going to be part of their testimony?

DR. BRUNO: I can describe the process. We've gone out there a few times to this point.

ASSEMBLYMAN GIBSON: I'd like to hear that process, Mr. Chairman.

ASSEMBLYMAN WOLFE: Sure.

DR. BRUNO: The monitoring project involves systematic beach profiles along that reach of coastline starting from the Eighth Street jetty, which is the location of the northern extreme of the reef. The reef extends 1000 feet south from the jetty. The monitoring will extend 2000 feet from the jetty to inquire as to whether there is some downdrift effects, as Professor Psuty alluded to.

In addition to the beach profiles, we'll be doing offshore bathymetry surveys to a distance slightly more than one mile offshore. The reason for going that far offshore is because there was a massive beach fill -- beach nourishment -- project in concert with the placement of the reef. We feel that if that sand disappears at some point during a storm, we want to be sure we know where it went. It remains a question in the field, referred to as the depth of closure, on how far out that sediment can move. The feeling is that during the December 1992 storm, the sediment moved quite a distance offshore.

So there are those two measurement programs, as well as a wave and current measurement program from meters that will be more immediately offshore of the reef, as well as immediately inshore of the reef to look at the impact of the reef on the nearshore processes. We will be doing a series of dye studies -- dye release studies to look at the possible impact of the reef on the flushing -- the water quality behind the reef.

ASSEMBLYMAN GIBSON: Will be? Will be doing the dye studies, or have been?

DR. BRUNO: We have done one, and we will continue to do those.

ASSEMBLYMAN GIBSON: All right, thank you.

DR. BRUNO: We will also be doing some biological monitoring. There already is evidence of barnacles and other living organisms on the reef. Those will obviously attract small fish, big fish to the small fish, and on up the chain, ultimately leading to fishermen on the surface fishing for them. (laughter) But that's another aspect.

We have some sample plates in place inside the reef as well as outside, and we'll be monitoring those as well. This is a two-year monitoring project. We'll be going out there every two to three months, as well as after any major storm for two years. Obviously we get calls all the time, "How's it going?" And the answer is, "No comment" all of the time. We need to get through all four seasons before we have a definitive answer on at least how it's going.

ASSEMBLYMAN GIBSON: Is the comment this morning still no comment?

DR. BRUNO: Still no comment. (laughter)

ASSEMBLYMAN GIBSON: Let's see if we can glean some surprises from you. The habitat that you mentioned, is that a desirable thing?

DR. BRUNO: Yes.

ASSEMBLYMAN GIBSON: And you are experiencing some growth of habitat?

DR. BRUNO: Yes.

ASSEMBLYMAN WOLFE: How's that sound?

ASSEMBLYMAN GIBSON: That sounds great.

DR. BRUNO: It's a very positive result.

ASSEMBLYMAN GIBSON: The plates, I didn't understand the plates. You said you had plates there?

DR. BRUNO: Yes. When the reefs were cast, there were a few openings created at the top of the reefs. They are hollow and the feeling is that the first settling of organisms such as barnacles or mussels and the like will be inside the

reef where they're protected from the wave environment -- the high current environment. So we set down some plates that are attached to cable, and those plates can then be picked up from the center of the reef and sampled.

ASSEMBLYMAN GIBSON: Then you can see what's growing on those plates? You have been doing that?

DR. BRUNO: Yes.

ASSEMBLYMAN WOLFE: Want to ask him if there's something growing on it?

Is there something growing on the plates?

ASSEMBLYMAN GIBSON: There is, he said that. There are barnacles. (laughter)

ASSEMBLYMAN WOLFE: Okay. I heard him say on the reef.

ASSEMBLYMAN CORODEMUS: Mr. Chairman, one question?

ASSEMBLYMAN WOLFE: Yes?

ASSEMBLYMAN CORODEMUS: Professor Bruno, we've had satellite technology -- telementry -- for perhaps 30 years. Isn't any of that data of assistance to us?

DR. BRUNO: Yes, it is. The high-resolution coastal scanners are more recent than that, but they've been around for a number of years. Some of the investigators down at the Rutgers Institute of Marine and Coastal Sciences are currently working with that data. Professor Scott Glenn, who is working with the coastal service that I mentioned, is a leader in that field actually. He's been working in that field for about 10 years. So we'll be working very closely with him on making use of that data in a GIS -- a geographical information system -- a type of system that looks to monitor the long-term evolution of the coastline, and then overlay on that long-term evolution a pattern such as patterns of development, land use patterns, perhaps hopefully wave information -- wave intensity patterns.

ASSEMBLYMAN CORODEMUS: Isn't there any type of peace dividend that we can derive in this area by asking NASA to recommand any of those satellites to gather information that we specifically want?

DR. BRUNO: That's interesting since the Navy just recently decommissioned a submarine for arctic oceanography, perhaps we can-- The Navy would be a valuable source of that kind of information. That's an interesting suggestion.

ASSEMBLYMAN CORODEMUS: Thank you.

ASSEMBLYMAN WOLFE: Dr. Bruno, thank you very much. I apologize for stepping out for a moment there, but you've also added to the very impressive presentation we've heard today of the wealth of data that's available in New Jersey. I think our concern is that we need to bring it all together, and that's very, very good. Thank you.

DR. BRUNO: Thank you.

ASSEMBLYMAN WOLFE: Dr. Stewart Farrell is the Coastal Research Center Director at Stockton State College. I've never had the pleasure to meet him. Although I did, one day -- I read, almost from cover to cover, his study of the shoreline of the coast of New Jersey, and I've corresponded with him.

It's a pleasure to meet you, Dr. Farrell.

S T E W A R T C. F A R R E L L, Ph.D.: It's a pleasure to meet you folks. I've met a number of you previously from time to time. Stockton State College is primarily an undergraduate institution, but the Coastal Center, which started in 1986 actually under the auspices and encouragement of the NJDEPE-- Mr. Steven Whitney and a person who's moved to another division, Dr. Susan Halsey, and Lea Hulmes (phonetic spelling) said, "We need to have a monitoring program for the State of New Jersey -- for the whole State."

In 1986 we set up 91 profiles: 3 in Raritan Bay, 84 on the ocean-facing coast, and 3 along the Delaware Bay coast on the southern peninsula of Cape May. Essentially, we did not go up into the far reach of the Reach 16, which would be the Delaware Bay/New Jersey shoreline, simply because of: 1) lack of development; 2) limited funding on that marsh-front coast.

The mission was to take data out to as far as we could with swimmers. We've gotten better at it over the years, and now we go to about 12 feet below mean sea level. Once a year done in the fall-- We're starting for the 1993 season on Monday. So we completed the data set which resulted in a publication which I sent to you -- the compilation of it all. The individual reaches -- Reaches 1 through 15 -- had separate serial versions of this prepared and are available through Mr. Whitney at the DEPE, the old Coastal Resources Division. It was delivered to Rene Jones, so that was the contract supervisor on that.

These profiles are essentially repeated surveys from a point in the dunes -- actually behind the dunes -- which is the reference, and that is surveyed to the NGVD -- elevation datum from 1929. The information is entirely electronic, so it's reproducible quickly -- graphically as well as in numeric form.

The rules of the game were that every community have one profile, at least. So even Avon-by-the-Sea with four blocks has a profile. Larger, longer coastline communities have up to four profiles. Ocean City being an entire island all to itself has five individual profiles. This is a start, because while once a year doesn't get seasonal-- For example, we finished collecting data last year just prior to the December storm -- we were about two weeks ahead of it -- and then we won't do it again until now, which means we'll see if the beaches net gained or lost as a result of that storm. But we don't see the storm effect in this data set at all. The time it takes to do it with the resources available is what limits it to 90 profiles, because you can only do about six of them a day.

Since a lot of the discussion this morning has centered around data sets and what's available and what's not-- You do, of course, know the difference between the

Federal sets, the State sets, and the local ones collected for short periods of time by individual research efforts? This State effort, which is entirely DEPE funded using Federal Coastal Zone Management pass-through funds, is an annual affair since 1986. Individual towns have come to the College and asked us to provide more frequent data measurement at closer spaced sites, particularly--

My original talk today was to deal with the town of Avalon, why it qualified for FEMA money and was reimbursed for the December storm. Well, Avalon was the first town that we ever worked with starting back in 1981, when the Environmental Commission, under the direction of von Ballenger (phonetic spelling), came to us and said, "Could you help us say how fast our dunes are growing or not growing, as the case may be?" So the program was established at the Environmental Commission level. We went before the City Council and got not an ordinance, but at least a resolution passed to give us a contract to do the work on an annual basis.

The Mayor's office got involved on a kind of relationship basis, and then we went from there to the public works. Public works became very much involved in supporting us as far as access to the beach, materials, and supplies like cedar poles to put in the reference marks, and for things that were happening on a daily basis in the town; collecting information that we could then work into activities such as the pan scraper program, which has been very successful on Avalon in moving sand to critical areas of erosion as long as the erosion does not exceed the ability of the machinery to cart it. So it has been, from top to bottom, a cooperative effort. The College supports the program. The people that work for it are graduates of the institution, and are essentially part- or full-time employees.

The individual communities that have been part of this are: Cape May Point, Avalon, a little bit in Sea Isle City, Brigantine, Mantoloking, Bay Head -- we're going to visit them

to start a program today, after we're finished -- and Manasquan. I'm not forgetting any, I don't think. Anyway, all of these communities get quarterly surveys at at least six locations. Avalon has fifteen locations, so it's a three-day project just to collect the data quarterly.

In addition to Dr. Bruno's study of the reef project, we are also doing the entire town, which is 12,000 feet of oceanfront, plus the inlet shoreline. So we're essentially taking the reef project too, but we're not doing as intense work on the reef project, since why do it twice? But we have, I think, four profiles going across the reef-project site, but we also continue all the way down to the Stone Harbor line to see -- for the town's purposes, this is strictly a town project -- to see in their own eyes what's happening, and also to maintain their FEMA qualification by having this efficient monitoring data on hand to actually make the qualification work.

So as the 1980s rolled by and the Federal Emergency Management criteria became more crystalized following Hurricane Gloria and the March 1984 northeast storm which produced severe damage to the Jersey coast, Avalon -- from the Public Works Department on up -- sought to do what it could to comply with the regulations so that in fact they did have, according to the current guidelines, an engineered beach. They also, of course, were willing to put their own money on the table in large quantities -- seven figures. Far over $1 million has been spent locally as the local share, starting in 1987 with a last-of-the-bond-money project which was sponsored by the Bureau of Coastal Engineering. So the beaches were nourished in 1987 under State 75 percent funded money. It was done as a total community funded project in 1990 to fix things up.

It was done in 1992 under the same deal, but a joint project with Sea Isle City, so they split mobilization costs by cooperating together. So they, again, jointly nourished both

community beaches. Of course, the December storm kind of kicked them in the pants pretty badly to the tune of about 90,000 cubic yards lost directly because of the storm from the engineered beach, which, as you know, was compensated for including the mobilization costs to start. So the Federal government picked up the entire mobilization and the cost of putting 88,000 cubic yards on the beach.

This whole program that I'm telling you about-- I think the reason that it works so well in Avalon is because of the very close cooperation that exists between ourselves, the public works, who actually delivered the goods to the beach in terms of daily operation, and the City government which has been, I would say, nearly unanimous in its endorsement of coastal management at their level, which has not occurred in other communities.

As Dr. Bruno pointed out, there are projects that are waiting to go that are tied up with either private municipal strife in litigation, or even within the community itself; arguments over which is the best, or should something be done at all. There are those who say, "Let's not do it", and those that say, "Let's do it." A classic case in point is the recently settled litigation in Manasquan over the dunes. There was a long, drawn out process of litigation there, where a group sought to block the creation, or recreation of the dunes in court. So these things are also tied in with the larger scale scenario of putting sand on the beaches and maintaining the shoreline.

Our work has been at a kind of grassroots level. We try to get very good relationships going between the city council, the environmental commission, and those who do the work, in many cases the Public Works Department of the town, and actually, essentially act as an overseer, so that they send us the information. We collect the information during the

monitoring. Then we make presentations, often maybe once every two months, to the city council as to what's happening, what's good, what's not good, and assist them in any way possible.

The statewide monitoring program is ongoing. In addition, there is a GIS series of-- GIS is Geographical Information Systems. It's part of the DEPE's prime computer network, and it's called the historical shoreline study. We digitized coastal maps that met map accuracy standards starting in 1839, and there are 11 map series: 1839 to 1842; the 1860s; 1889; 1930s; 1951, '52, '53; 1971; 1977; and 1986. These shorelines were chosen because the data existed in the Federal NOS archives, or the Philadelphia/New York district archives as maps that met qualifications for latitude, longitude, and locatability. They were digitized at the University of Maryland and converted by Department of Defense people moonlighting for the University, working overtime -- essentially high-end computer people -- into algorithms that took the shape of the earth as it was known in 1939, and changed it to reflect our current knowledge of the shape of the earth and its map projections.

So the shorelines were actually moved as much as 700 feet based on latitude and longitude errors that they just didn't know about. So with that correction and smoothing of the data, it is now there ready to be used. It's accessible at a tide/land scale of one inch equals 200 feet, or at page size just to look at. This is user friendly to the point that any one of us could go up there and turn on the plotter and get a tidelands tile, which is a single tidelands map for any part of New Jersey coastline. So those are data sets that do exist, can be used, and are hopefully to be used by planners and others to say, "Well, the shoreline has been eroding here at the rate of seven feet a year. Hmm, maybe we ought not put something 25 feet from the dune line." I really would prefer to see if I can help you by answering questions, instead of sitting here and pontificating further. (laughter)

ASSEMBLYMAN WOLFE: I have two questions. Number one, did the last data that you indicated -- the computer modeling of the changing coastline of New Jersey -- is that available in layman's terms?

DR. FARRELL: Well, it's available as map form, and there are different color shorelines. The user can choose which color they want for which shoreline. Essentially, the screen comes on, you pick shoreline dates, you pick-- The first thing you have to pick is the map you want, so you have to know where this area is. Then you pick the map, then you pick yes or no answers. With a mouse, you click on the things that you want, the colors-- You pick the dates; you choose the colors; and you say, "Plot it." You just have to remember to turn the plotter on and put the pens in it. Mr. Mark Mauriello is the DEPE contact person who knows the most about it as far as its operational delivery, and requests generally get filled as long as it's not an avalanche of requests.

ASSEMBLYMAN WOLFE: Very good. The other question I had may or may not relate to what you said, or some of the other speakers. But recently, I'm sure you're aware -- everyone in the room is aware -- of the changing policy of the passage of the new CAFRA legislation for whatever reason, or whatever they want to call it. One of the requirements is that a dune reference line be drawn for every muncipality. DEPE is requiring that now. Does that exist? Is that current?

DR. FARRELL: Some it does. The City of Avalon has what they call the dune park line, and it coincides with the bulkhead or revetment where that is essentially. But in the case of the oceanfront, that's the revetment of the inlet. In the oceanfront, it actually sets back between 0 and 75 feet from the revetment.

ASSEMBLYMAN WOLFE: But in these studies that you've done -- your ongoing studies, these different map fields that

you indicated before -- is that data in that research that you've already done?

DR. FARRELL: Where the dune park lines are?

ASSEMBLYMAN WOLFE: Yes.

DR. FARRELL: Well, on the map is background information: our streets and roads, municipal boundaries, street names of the main streets, and town names. Boundaries such as dune park lines could be added if someone was willing to actually provide the means to do it. The DEPE could do it. They have people themselves who could update their-- But they have to have the kind of directive to do this, as opposed to do something else -- which they all have a full plate anyway. So to get somebody in there-- They were training someone to do GIS work, but they could also certainly do it by having anyone they chose come in under contract and add this information.

The counties have been encouraged to develop what are called "spark stations", where the data is available all around. We have things on that GIS program where you can get mapped data on abused children, locations where abuse-- You can do social functions on GIS. So, essentially, it's a whole graphic map display of all kinds of data for the entire State. The coastal piece is just one little, tiny piece of this huge pile of geographical information, and they're adding to it hourly as time passes.

So, yes, it's probably time for a new shoreline to be digitized. 1986 was the last one done, and we did this in 1988. Sure the 1992 shoreline-- They have a series of pictures from March of 1991, that's the most recent complete set for the whole State coastline. Keystone Aerials flew a post-December storm set on speculation at a low altitude, so that exists. I've got pieces of it for our client communities. None of this has actually been added to this computer data bank.

ASSEMBLYMAN CORODEMUS: Mr. Chairman.

ASSEMBLYMAN WOLFE: Yes, go ahead, Steve.

ASSEMBLYMAN CORODEMUS: I just have one quick one, Mr. Chairman.

Do you have the address where we can obtain these maps, or could you leave it with us, Professor?

DR. FARRELL: Well, it's North State Street, the DEPE Headquarters.

ASSEMBLYMAN CORODEMUS: Oh, the DEPE has all these digitized maps?

DR. FARRELL: Yes. They have them on the primes. They're sitting on the hard disks. They do not produce-- They're overlays on the tidelands maps, the photoquads -- the big one-inch-equals-200-foot photoquads. They lay right on it, and you can see the 1977 shoreline. It was digitized from those photoquads. But the 1986 shoreline is also on the overlay.

ASSEMBLYMAN CORODEMUS: Okay.

DR. FARRELL: So they can print them either as a opaque map, or as a transparency. Boom, put it down. But you see, to do the whole State is 165 tops. So I don't believe that they have ever created a library with all 165 maps for someone just to go up, pull them out, and look at them.

ASSEMBLYMAN CORODEMUS: Okay.

ASSEMBLYMAN WOLFE: Very good.

Senator?

SENATOR PALAIA: Professor, it seems to me, listening to all the testimony today, we are getting bits and pieces all over the place here. Would it behoove us, Mr. Chairman and members of the Commission, to set up some centralized focal point for all of this? It seems like-- Professor Farrell has given us things, and all of the others, and it's very important information. Each one is pertinent in its own right, but yet there's no way to put it all together in one piece so we can

see what's out there. "They're doing a great job. Hey, they're doing a great job. Hey, I like that." We can't keep going like that.

I think what we have to do is centralize all this information. Maybe you'll have to set up something separate under DEPE, I don't know. Is it possible that maybe the funding could come out of the $15 million for shore protection that we have? I'm not looking to erode a little bit-- No, I'm just saying it's not going to be a cheap thing, because it's a matter of processing all the information. But right now it's all in everybody's head out there, or on paper somewhere. We don't have it, and the State doesn't have it, Mr. Chairman. It just seems to me you've got to bring this all together at some point in time, because we've heard some good information here today.

DR. FARRELL: Well, Dr. Bruno has started that process by this creation of a kind of clearinghouse, and we're going to contribute to it. So it's basically--

SENATOR PALAIA: Yes, but it's almost on a volunteer basis, isn't it?

DR. FARRELL: No, I think people are going to--

SENATOR PALAIA: I mean, nobody's saying to you, "Hey, bring it in here. We'll keep it for you here." I know what Dr. Bruno is doing. I'm familiar with that. It seems to me, Mr. Chairman, it's food for thought for this Commission to look into something like that.

DR. FARRELL: Well, we provided our information electronically and in paper form to the DEPE.

SENATOR PALAIA: Any time they want it?

DR. FARRELL: Yes. It comes to the DEPE routinely. They keep it and so does the Bureau of Coastal Engineering. We've trained them in how to use the program, to actually use this data as they go along.

SENATOR PALAIA: I don't want to reinvent the wheel, maybe it's there already to do it.

ASSEMBLYMAN WOLFE: Excuse me.

Assemblyman Smith?

ASSEMBLYMAN SMITH: It seems to me that there must be a clearinghouse somewhere in the State. Since we have the State University at Rutgers, why can't that be used as the clearinghouse to gather all the information, collate it, and coordinate it so we have a clear picture of what's happening? Everything here seems to be-- Different individuals are coming in with different ideas. Until we get it coordinated, what can we do?

DR. FARRELL: Well, the coordination amongst Rutgers, Stockton, and Stevens is pretty good because we all know each other and work together. The real problem seems to be in getting from us to you folks, and us to the municipalities. We had hoped to attack that somewhat with this Reach Report Program that was done last year, so that these were available. But you see, if the folks in the communities don't know they're available, they don't know to ask for them.

SENATOR PALAIA: That's my point, Dave. That's exactly my point.

DR. FARRELL: That seems to be one of the key ingredients that is part of the DEPE's activities. They review permits; they pursue policy; they do all these things, but there is nobody who's sole purpose up there is to deal with this kind of data collection, information-- "That person knows what Bruno is doing. They know what Farrell is doing. They know what Psuty is doing." It's their job to deal with us on a daily or at least monthly basis, and set up a clearinghouse type of thing so that the municipal governments -- they do change from time to time -- so that these people know -- at least the municipal clerk -- where to go to get stuff. It's one of the key things that is missing.

ASSEMBLYMAN SMITH: What do you suggest we do then?

DR. FARRELL: Well, the Davidson Clearinghouse that was mentioned earlier by Dr. Bruno is certainly a possibility. It also is possible that through us we go to either Bernie Moore's operation and the coastal engineering, or to Trenton to Steve Whitney's outfit -- John Weingart is the Director -- and say-- Well, he's moving on, or has moved on in the last few months. But anyway, to go back to these people and say, "Let's set up someone who is responsible to know where this stuff is. If somebody wants some of this old coastline data, provide it." They're going to need a person who knows it and a small staff. This is going to take some money, again.

SENATOR PALAIA: That's my next question, Mr. Chairman.

Are we talking a large sum of money, or are we just talking--

DR. FARRELL: I think you're talking about someone who's in charge of it and, say, two assistants to deal with it. What's that with benefits, maybe $80,000 a year?

SENATOR PALAIA: I was going to say $100,000 probably could very well put it all together.

DR. FARRELL: Yes.

ASSEMBLYMAN WOLFE: Well, since this isn't the School Funding Commission, we might consider something of that nature. (laughter)

I just want to say that many of you in the audience have been to our previous meetings, and the other ones have been as voluminous in the amount of information and data presented. It is the responsibility of the Commission to issue a report not only to the Legislature, but also to the Governor. I'm counting on George, here, to help us in doing that. But I think that realistically, financial considerations are something that we will also take as part of our recommendations as we complete our task.

DR. FARRELL: Well, gentlemen, the last time this was done was 1922.

ASSEMBLYMAN WOLFE: Well, we don't want to reinvent the wheel, but--

DR. FARRELL: The report is in the Legislature. It was done by a committee of the whole and published in 1922 and January of 1923. It's a wonderful document to read because, interestingly enough, based on no data other than their gut feeling -- having been to the beach a lot -- they looked at and saw things in the future that have become problems and have come true. So it's an interesting document, if you ever get a chance to find it up there in the archives.

ASSEMBLYMAN WOLFE: Thank you very much.

Do you have a question?

ASSEMBLYMAN GIBSON: Yes.

Doctor, the measurements that are being taken at Avalon, do you do that with your own survey crew, or does the Borough provide the survey crew to do that?

DR. FARRELL: No, we do it totally. They provide access, that's all.

ASSEMBLYMAN GIBSON: In the 90 cross sections, I presume, that are being taken on the statewide monitoring--

DR. FARRELL: Right.

ASSEMBLYMAN GIBSON: --are you responsible for doing that with your survey crew?

DR. FARRELL: Yes, that is correct.

ASSEMBLYMAN GIBSON: And the money that finances that comes to you through DEPE?

DR. FARRELL: DEPE contract, and the money -- all the money is taken from the CZM -- Coastal Zone Management -- grant every year. That's for a whole lot of things, but part of it is called contractuals. They take a piece of that and use it to fund the operation, or they have up to this point.

ASSEMBLYMAN GIBSON: Are there similar cross sections being taken in other states along the coast?

DR. FARRELL: The big believer in this activity is South Carolina. They have a monitoring profile every 1000 feet down the entire coastline of the barrier islands. Florida has a very large coastline, and it does surveys on county-by-county, so that the surveying is administered on a county by county basis and is done annually at each of many sites. I forget how many, but I think it's 450 different sites. Each county government administered the program in its own county. A person who came briefly and left was in charge of Pinellas County's monitoring after he got his master's degree from the University of South Florida. So that program is a very well developed program.

ASSEMBLYMAN GIBSON: You testified that what you're doing with the 90 sections in New Jersey is digitized?

DR. FARRELL: Yes.

ASSEMBLYMAN GIBSON: Is it on the same system that it's digitized in North Carolina and Florida?

DR. FARRELL: Each state uses the Corps of Engineers program developed at the research facility in Duck -- that's spelled, D-U-C-K- -- North Carolina. There, there is probably the most long-term, most intense group of data collecting going on in the nation, because they have their own concrete pier. They monitor waves, tides, currents, storm activity, beach profiles on 100-foot spacing. They do all this kind of stuff, and it's all published and released on a monthly basis.

ASSEMBLYMAN GIBSON: And is your's part of that?

DR. FARRELL: Our's is sent to them, but they don't publish it--

ASSEMBLYMAN GIBSON: They don't?

DR. FARRELL: --because they just-- We work with them on the program development to do the job.

ASSEMBLYMAN GIBSON: But they could?

DR. FARRELL: They could. Oh, yes.

ASSEMBLYMAN GIBSON: Because you're digitized?

DR. FARRELL: Right.

ASSEMBLYMAN GIBSON: How about what you're doing in Avalon, and what you're doing with the other individual municipalities?

DR. FARRELL: It's all done through the same electronic means, so it's all a group of data.

ASSEMBLYMAN GIBSON: So, if somebody wanted to look at the overall picture, that would be relatively easy to put together?

DR. FARRELL: Yes.

ASSEMBLYMAN GIBSON: All right. One last question, a prior speaker indicated that they felt that dredging immediately offshore was short-term, and that we should go, perhaps in some cases, 100 miles off for a long-term solution. You're cross sectioning out to, I think you said, 12 foot below low water, or 12 foot below mean water. Are you noticing changes at the 12-foot point?

DR. FARRELL: Absolutely.

DR. FARRELL: Do you agree that 100 miles off is as far as we have to go to make sure we have a permanent solution?

DR. FARRELL: No. The research is just getting started on this kind of activity. The Corps of Engineers and the United States Geologic Survey is engaged, as we sit here, in a coring program off Atlantic and Cape May Counties to test this hypothesis.

Just to digress a little bit on science, sea level did not kind of come up like an elevator. It came up and stopped; stood for a while; then up again quickly and stood for a while; and then has cruised kind of like a docking boat into the present situation where we are now. So sea level rise has come up periodically -- episodically. The last big still stand occurred at about minus 60 feet below present sea level. Data done for the New York bite study in the late 1960s, early 1970s, documented a paleo -- meaning former position of Sandy Hook -- in 60 feet of water. There is a beach ridge that runs

down about a mile and an eighth offshore, which was then finally -- by the New York Corps district -- documented as suitable material. That's the dredge spoil site. The first indication that this was ever there was in 1969, '71, by the U.S. Geologic Survey.

We went up for Bradley Beach in 1986 and took samples of the material from the surface and were, "Holy-- This stuff is beach sand." It had rounded surf clam particles in it that don't happen in 60 feet of water, so this was once at sea level. So that particular portion of Monmouth County is where the sand is coming from. That's only a mile and an eighth offshore. The gradient flattens out down in the southern counties and you have to go further at sea. But they're looking between two miles and five miles in the current study going on by the United States Geologic Survey, and the State Geologic Survey.

ASSEMBLYMAN GIBSON: The 12 foot below mean sea level, about how far out is that from--

DR. FARRELL: It varies. In Avalon, it's about 1200 feet from the high tide line. In Manasquan it's about 300 feet from the high tide line, so it varies with the slope gradient dramatically. We saw three feet of accretion in Manasquan after the December storm, at the minus 12-foot level.

ASSEMBLYMAN GIBSON: So it's dynamic at ten?

DR. FARRELL: Since we've been back there, it's only in the shallower waters of about eight feet or less that sand has moved back onto the beach. So we're looking at a long-term net loss there of about 50,000 yards.

ASSEMBLYMAN GIBSON: Thank you, Dr. Farrell.

Mr. Chairman, this issue I think is of importance to this Commission. Rather than a series of questions, because we may not have the answers just yet anyway, and it sounds like the scientists are out there trying to find the answers. I think the Commission would be interested in being kept informed

of the progress as to where -- I don't know that it has to be 100 miles out, myself -- but as to where it is to make sure that we have a much longer solution from where we dredge.

The Army engineers may already know the answers and they may be very, very comfortable with where they're putting those dredges. But I think the Commission ought to be satisfied, and whatever information is out there I would ask, through our Chairman, that we be kept apprised of this kind of information.

DR. FARRELL: I can provide you the names and telephone numbers of the folks that are actually currently out there. Alpine Geophysical is taking the cores this week. They started on Monday getting mobilized to do it, and they're taking, I think, 22 cores at $1200 a pop. Now, I don't know who all is paying for it, but I think it's partly federally funded. So this work is actually going on right now.

ASSEMBLYMAN WOLFE: What is it that you want?

ASSEMBLYMAN GIBSON: I want the results of whatever studies have been completed to date as to why, or where -- how far out we should go to have a reasonably long-term solution to securing dredge material from the ocean. We have long sets of beaches where inlets are not necessarily available, so they're going to secure offshore sand. The first speaker indicated that that offshore sand should be much further offshore.

ASSEMBLYMAN WOLFE: Right. We'll get to that.

ASSEMBLYMAN GIBSON: And while we don't want to spend-- We don't want use all our money up just barging things from 100 miles. We ought to know where there is a reasonable safeness that we're going to have a long-term solution for that. I think there's information being developed and maybe some already available that the Commission would want to have.

ASSEMBLYMAN WOLFE: Okay.

Thank you very much, Doctor.

DR. FARRELL: Any other questions? (no response)

Thank you very much.

ASSEMBLYMAN WOLFE: I would like to indicate the hearings will continue. As you can see, some of the participants are dwindling up here. They have other commitments. I have a class to teach at 3:00, so I'll be here until 3:00. Hopefully we'll be done by then. I'd like to read the order in which people will be speaking. If you want to grab a bite to eat or do something else, go do whatever you want to do.

Next we'll be hearing from Mr. Richard Schwartz, who's the Mayor of Highlands, New Jersey. Then, Richard Creter, President of Breakwaters International; Dery Bennett, American Littoral Society; Frank Cacossa, Erosion Control Corporation; Robert Kunzel, Beach Development Manager of Coastal Stabilization of Rockaway; and Kenneth Smith, President of Coastal Advocate of Ship Bottom. So that's the order that people have signed up and that they will be speaking -- and also a Mr. Ed Kronin.

So at this time we'll call on Mr. Schwartz. Mayor Schwartz, I'm sorry.

Welcome.

M A Y O R R I C H A R D C. S C H W A R T Z: Thank you, Mr. Chairman. My comments today are not only to the Commission, but to the many technicians and scientists that are in the audience.

I'd like to speak about what a beach means to a mayor of a coastal town. It's more than just a place to spread a blanket on a sunny afternoon. I'd like to refocus -- rather than replacing a grain of sand or many, many grains of sand -- on what lies beyond that beach and why it is important not only to a municipality but to the State.

The beach itself will serve as a protection, as a barrier for the many things that lie behind it, such as the boardwalk in many municipalities; such as summer and full-time residences, and those supporting businesses in the commercial

zone that support the beach and the municipalities -- both year-round businesses and part-time businesses for the summer.

Highlands enjoys a very unique geographic position. Sometimes it's an unfavorable position. We lay inside Sandy Hook, on the Navesink River. I've heard many terms used today: coastal zone, coastal resources, beach erosion. But what we are talking about is waterfront protection. I'd like to talk about what that means to the borough of Highlands and a couple of other towns that have exposures on shores that are other than surf bound. Fifty percent of my ratables are in the flood zone. Over half of my residents are in the flood zone. Ninety-five percent of my commercial district is in the flood zone.

In the Halloween storm of two years ago, the most recent December storm of '92, and then again in March, my entire downtown area -- over half of my town -- was flooded not due to wave action or surf action, but to tidal surge and tidal flooding. Retreat is not an option for this municipality. We do not have great expanses and stretches of beach. I have a small municipal beach. There isn't even a beach management program for that small stretch of beach, so it doesn't qualify for FEMA reimbursement. We have no sand dunes, and we have no great sea walls. My first lines of defense are my large homes and my restaurant industry.

And now -- someone mentioned aquaculture not too long ago -- we're developing a $1.3 million clam depuration plant right on the river. So we have a lot at stake, but we also have a lot to lose. We seem to fall in a black hole -- an abyss -- due to our geographic location. We're at the bottom of the bay shore, but we're not generally included in the bay shore plans. That seems to get foggy around the Atlantic Highlands Harbor, and we're not yet in the shore because that seems to begin at Sandy Hook -- as was stated earlier -- and goes south. But we're a Borough in need of some type of

waterfront protection. It is not going to come from beach erosion per se, because Sandy Hook, the Federal project, serves us as natural barrier reef.

What I'd like to suggest, having said all of that, is that the Commission broaden their scope of concern to not only beach erosion and sand replenishment, but to waterfront protection. That is where the basis of many of the municipalities derive their income. It's where the State derives a tremendous tourism revenue. It's really what is driving the whole effort as to why we're here today; that is, restoring the beach.

I've had several conversations with Stephen Kempf, Jr., Regional Director of FEMA, in this regard. There are two driving issues that will affect my municipality and probably others, and they are hazard mitigation -- of all categories including beach erosion -- and flood control. Technology exists today to restore beaches. It also exists to control certain effects of flooding, and there exists technology for certain types of hazard mitigation.

I would like to suggest not only broadening your concern and including it as waterfront protection, but maybe even considering changing the name of your Commission to expand upon those concerns which affect the entire Jersey shore -- possibly Waterfront Protection, or just a play on words. It's nothing more than a name but it does-- The title in itself will give some credibility to the overall concerns of the entire shore that go beyond just beach restoration.

We do have programs on the drawing board. We know the direction we have to go. Of course the old cry is, "Where are we going to get the funds?" The smaller municipalities such as mine-- It's less than a square mile, crammed with 5000 residents year-round, and with an aggressive economic stimulus program beginning, controlling the effects of flooding and mitigating those existing hazards is high on my priority list.

Anything the Commission can do to help, apart from saving the rest of the beaches, I certainly don't want to be forgotten, because we fall in that little, black abyss right inside Sandy Hook.

ASSEMBLYMAN WOLFE: Thanks again.

MAYOR SCHWARTZ: Thank you.

ASSEMBLYMAN WOLFE: Thank you very much.

Richard Creter is the President of Breakwaters International, Flemington, New Jersey.

R I C H A R D E. C R E T E R: Could somebody get those lights? Is this mike working?

MR. LeBLANC (Commission Aide): It's used for the transcript. You can just hold it, there won't be amplification, but--

MR. CRETER: Okay.

Thank you, Mr. Chairman and the Commission members, for the invitation to testify before you this morning, or actually this afternoon. I think this is one thing that we can look at: When beaches were broad, we had dune systems, and in the last year and a half of storms there was very little damage, if any, to infrastructure.

If we could put aside for the moment the question of whether or not we should protect our developed coastline and begin to look at the strategies, which is the purpose of today's session, you'll see -- and I agree with much of the testimony here today -- that there are a number of options. There's no single solution. Certainly, some of the technologies that you'll be looking at today, including our own, don't purport to be the only silver bullet or the single solution.

It's generally accepted, and has been for quite some time, that sand nourishment is the best option available for coastal protection not just in New Jersey, but throughout the United States.

Sand nourishment: When you add more sand to a beach system and you build a beach system, that beach becomes the buffer zone, the zone that actually absorbs the shock of storms. The problem with sand nourishment is that it's short term, it's temporary. You've also heard much testimony about that here today.

The combination of a reef similar to our's with sand nourishment is what we have proposed through the New Jersey Pilot Reef Project. It's where you've got a combined effort of protecting the sand nourishment, perching the sand nourishment, using less sand, less time back to renourish the beaches, and therefore make the whole process more economical. That's what the reef system is all about.

I've got a few slides to go over with you this afternoon that show the testing of the beach protection system and also the New Jersey Pilot Reef Project that just got underway this summer. (witness shows slides) Is that better? Can you see that now?

SENATOR PALAIA: I thought it was me for a minute there. (laughter)

MR. CRETER: What we're looking at here is our manufacturing site at Port Monmouth, where we manufacture the reef modules. To give you an idea of the reef modules in size and scope, that particular module that you're seeing there on the screen is a 21-ton module, 6 feet high, about 16 feet from front to back. The beachward side--

ASSEMBLYMAN WOLFE: Did you say Port Monmouth or Fort Monmouth?

MR. CRETER: Port -- Port Monmouth, near Earle Military Pier.

The beachward side, that's the front here. I'm sorry, that's the seaward side. The beachward side is from the rear. You can see the interlocking mechanism. There's a mortise/tenon type of interlocking mechanism that make the

whole entire reef, which would be submerged, an articulated device that will meet the uneven seabed of the shore bottom.

The concept of the reef is threefold: One, the reef is submerged parallel to the shoreline. There's about six feet of water at mean low tide of freeboard that's on top of the reef system. It's placed offshore. In Avalon's case, there's about 12 feet of water at mean low tide. It acts as a perch. Sand nourishment is put behind the reef. As you can see, there is sand that would be placed behind the reef. The amount of sand would be less because the reef is acting as a perch.

The reef reduces onshore wave activity. You get a reduction in wave absorption so that the wave activity is reduced, at the optimum about 30 percent, and most important, the reef acts as a limit to the offshore movement of sand. Sand is limited from moving offshore during a storm event through the function of the very back of the reef, which has a feature called the backwash flume. What that does is, as you get a strong rip current or offshore current during storms, that current goes up the back of the reef module, enters into one large opening that funnels to a smaller vertical opening, and you get a high velocity vertical curtain of water. It's that curtain of water that limits the offshore movement of sand; in essence, creates a cycle where most of the sand that would be lost offshore beyond closure point is now being cycled back within the nearshore area. That's one of the main concepts of the reef.

This is testing that was done at Stevens Institute of Technology back last year. You can see the tank; it's one of the largest in the country. It's 320 feet long by 12 feet wide. The tank is split in half between the area where the reef modules are and the unprotected area on the other side. You can see the reef modules submerged here. Various storm events were simulated. That's a one-sixth scale, which is very large scale, in the Stevens' tank testing.

The reef is submerged. You're looking down on the reef. You can see there the slotted openings on the very top; that's that flume I talked about earlier. The water is bubbling up through the flume. When you get a simulated six- to eight-foot wave, that's when the flume begins to function.

This is another view of the tank. On the left-hand side is the unprotected side; the right-hand side is where the reef is. Some of you I think actually visited Stevens and saw some of the testing going on. It's very dramatic between the unprotected and protected side. You get a spilling type of wave where the reef is installed, and a plunging, scouring type of wave on the unprotected side.

Something that was brought up a little bit today by Dr. Bruno during the monitoring study:

Within the reef there is an ecosystem that develops. There's certainly some benefits for fishing, and eventually for and around the reef, but we've had previous studies done that show that there are 20 million clams, mussels, and crustaceans that grow within a 500-foot section of reef. The internal cavity is hollow.

There's a picture of one of our earlier installations. You can see that's the internal cavity; it's quite abundant. It's a breeding ground; it's a safe ground for breeding of crustaceans and mussels. Obvious benefits: Biofiltering, when you get that concentration of mussels and clams in a close, nearshore area, it would have a positive impact upon water quality. It's one of the things that will be monitored by the Stevens' study.

Also, the material that the reefs are made of is a microsilica enhanced concrete -- extremely durable concrete. It's not the normal that you'd see on bridge abutments or bridge decks, which would be a 4000 to 5000 PSI compressive-strength concrete. Microsilica concrete is two times that strength, almost 8000 to 10,000 PSI compressive

strength. More important, it reduces the impact upon the structure. That's increased by 10 times, and also the salt resistance of the concrete is about 20 times that of normal concrete. The reason is because the microsilica is a fourth component of normal concrete mix, which actually fills in all the voids.

On the left-hand side is a microscopic view of concrete. It has a lot of voids in it. When you look at the right-hand side with the enhanced concrete, all those voids are filled, so you get an almost impermeable structure -- very strong, very durable concrete that should last in excess of 50 years with testing that was done by W. R. Grace.

This is our facility. You can see how the reef modules interlock. I talked about the mortise/tenon joint. They're six feet high, and if you put 100 modules together, as was done in Avalon, you have a 1000-foot-long reef system. You're looking in the foreground here; that's the seaward side that would be submerged facing the ocean.

ASSEMBLYMAN WOLFE: Excuse me. When the reef is in place, is it just like one long interlocking, or is it a series of maybe two or three deep--

SENATOR PALAIA: Spaced out.

MR. CRETER: No. It would be one long interlocking reef module of 1000 feet. We follow the contour -- the general contour of the nearshore slope, as you'll see in a little bit.

This is the Avalon installation. The contour gently sloped, headed in a southeasterly direction off the Eighth Street jetty, and then headed due south, so there is a turn that was actually built into the reef itself.

This is the installation -- aerial view, obviously -- of the installation at Avalon. You can see the modules are on a supply barge. There is a crane barge that's placing the modules and interlocking them together. It's offshore about 400 feet in about 12 feet of water at mean low tide. In the

background you can see sand nourishment is ongoing. They've already-- If this light shows up a little bit, it wasn't too well before. Back in here is the outfall pipe around Eleventh Street, the Eighth Street jetty is off the screen. You'll see that in a minute.

I also wanted to mention that the reef is installed on a filter fabric. It's a large filter mat that's placed down on the seabed with a steel frame. That's placed first, the reef modules are placed on top of the filter mat, and the steel frame would be removed.

Here you see the reef is being installed in the water. The divers are in the water, radio-controlled to the crane operators, confirming that the interlock was properly connected, and then they'd release the module and go place additional modules.

This is an aerial view looking straight down at the Avalon site. Prior to installation, you can see the Eighth Street jetty ends here. That outfall pipe around Eleventh Street is here. The reef starts at the Eighth Street jetty, goes about southeast and due south along for 1000 feet, around 400 to 450 feet offshore.

The second site that would be installed is Cape May Point. That will be early spring -- May of next year. That goes from Lehigh Avenue at Cape May, to Coral Avenue in Cape May Point. They've got a trough system that actually sweeps out a lot of the sand right offshore of these jetties. It's fairly deep. Once the sand moves off into that trough from the crosscurrents between the Delaware and the Atlantic, it's not coming back, so this is a very good site for testing when you've got cross currents and limiting the offshore movement of sand. This is a good site. That will be taking place spring of next year.

The next site is Belmar/Spring Lake, the borderline. You can see there's Lake Como there on the very top of the

screen. The site is about 1100 feet long. There will be about 70,000 cubic yards of sand nourishment that will be added to that beach system within this groin cell, along with the reef. Again, all of these will be part of a monitoring program -- a 24-month monitoring program -- just like Avalon.

ASSEMBLYMAN GIBSON: The beach nourishment is just in that one cell? How about the cell to the right that we're looking at?

MR. CRETER: No, it's dissipated just in this particular cell. This is the most eroded cell within the two towns. It is a sand-starved area. There's some history on what happened to that in the last 30 years -- on what happened to that particular cell -- but it is the most eroded area.

ASSEMBLYMAN GIBSON: So it will make the test even more severe if you don't pump on either side?

MR. CRETER: That's correct. Unfortunately, it's not-- Within the total program, there's not enough to be able to go without several thousand feet in each direction.

SENATOR PALAIA: The only thing protecting that whole area is that little seawall, which is no more--

MR. CRETER: That's right, the seawall--

SENATOR PALAIA: I know because I live there. There's nothing there.

MR. CRETER: The seawall is right up at the top there. On the other side of the seawall, within feet, is a major sewer line -- a 36 inch sewer main.

SENATOR PALAIA: That's right.

MR. CRETER: So it is quite an exposed area, and it is a significant problem that will be addressed early next year with the pilot program.

In summary -- and I'm sure you've got some questions about the pilot program -- the reef performs a series of-- It is a combination with sand nourishment; it reduces wave energy. It performs a series of functions: acts as a perch

with sand nourishment, limits the offshore movement of sand during storm events -- and that's one of the main functions of the reef, to keep the sand from moving offshore -- it makes the sand nourishment process last a little bit longer. To promote sealife is a side benefit and, of course, it becomes something that remains at the site so that renourishments that would take place later would require less sand each time. The reef would actually be paid for by savings in sand during subsequent renourishments.

At this time are there any questions about the pilot program? It's just under way. Avalon was completed about two and a half months ago, so it's certainly early to say anything about results -- as, I think, when you were asking Dr. Bruno, since he's gone out there and done his initial surveys.

The reef took about two weeks to install at Avalon. The sand nourishment was right backed up behind it, and the sand is perched behind the reef. The reef has seated itself and is performing as we would expect it to at this early stage. There certainly is no data that's available that could be used for any performance information at this point.

SENATOR PALAIA: How much does it cost?

MR. CRETER: The entire New Jersey Pilot Reef Project, which includes all three sites and the monitoring that would be associated with it for two years, is a $2 million project.

SENATOR PALAIA: Two million?

MR. CRETER: That does not include the sand nourishment component. That's several million dollars separate. But the reef and the monitoring for 24 months at all three sites was $2 million.

ASSEMBLYMAN WOLFE: The Spring Lake project, when will that begin?

MR. CRETER: Belmar/Spring Lake would begin first thing in the spring. Manufacturing is ongoing now. We will be able to start installation as soon as-- We're hoping to try to

get them done this year, but the window of installation to be done on a safe basis has just left us with October, so we're looking at end of May, beginning of June.

ASSEMBLYMAN WOLFE: Dr. Bruno would not really share with us his preliminary findings. What is your sense of what's happening in Avalon?

MR. CRETER: Avalon is a unique site. We've got the inlet right next to us. They've had tremendous losses of sand in the past where it's averaged 50,000 yards a year. I think you've heard testimony that Avalon has had three nourishments in the last five years. We are very pleased with the way the reef is installed. It is seated where it belongs. There is no scouring about the reef. The sand nourishment behind it has perched as we expected it to. There is a pillow of sand in the front of the reef -- on the seaward side of the reef -- as we expected to. There is no scouring, so what we expect to see at this time is there. There's going to be a lot of studying going on over the next 24 months. I think then, at that point, you'll have more definitive data.

ASSEMBLYMAN WOLFE: Any questions?

ASSEMBLYMAN GIBSON: We don't really have any results other than-- I can understand Dr. Bruno being cautious since he's the scientist and that's his job. I was hoping that you'd have a little bit more optimistic report, but it's as you expect it?

MR. CRETER: I would like to, but it would be wrong of me to say positive things at this point.

ASSEMBLYMAN GIBSON: You're an honest man, and I appreciate that.

ASSEMBLYMAN GIBSON: What we're looking for here, and correct me if I'm wrong-- Just to sort of sum up: If you can save Avalon sand -- and anywhere where these installations are -- that's been pumped in, and where it's traditionally been expected that that sand will be gone in five years-- If you

can save that sand so that it's gone in 10 years, we've gotten double the time that we spent for that sand. If the frequency of pumping it in now instead of five years is ten, the cost of that additional pumping would justify the cost of installing these reefs. We would expect that if that happens, these reefs will prove to be very economical. Is that what we're looking for?

MR. CRETER: That's correct. In fact, when you combine the reef with sand nourishment and use it as a perch -- put the reef in and sand behind it immediately thereafter -- you could save 20 to 25 percent of that sand nourishment cost initially. And every time that you go back and renourish every four or five years, whatever the case may be -- or let's say 10 years -- now you're using 20 to 25 percent less sand each time. So that alone will pay for the reef because of these savings in amount of sand -- quantity of sand that you would need for each nourishment, because the reef is still going to be there.

We're not going to stop the erosion completely. Erosion is a natural process. It's going to continue, but we're going to slow down the erosion process and keep the sand from moving offshore so rapidly. So if we get a doubling of life span of the sand nourishment process, we save 20 to 25 percent each time we go in, including the initial time. It's not just a one-for-one payback, it's several times.

ASSEMBLYMAN GIBSON: We have the bonus of marine life, which would help with fishing and so on. Also that does, in fact, cleanse the ocean to whatever extent.

MR. CRETER: Well, it would be a positive impact. We certainly would like to say that it's going to cleanse the ocean. But we certainly anticipate when you have that many clams and mussels in an area inside the reef, it's going to have a positive impact. The study will bear that out on water quality.

ASSEMBLYMAN WOLFE: Thank you very much.

MR. CRETER: Thank you.

ASSEMBLYMAN WOLFE: Senator?

SENATOR PALAIA: My apologies to the speakers that are coming up, but I have to get back to the office.

Thank you for letting me sit on the Commission. I really enjoyed that today.

ASSEMBLYMAN GIBSON: We'll spend a lot of time together on this I think, Joe.

ASSEMBLYMAN WOLFE: Thank you.

Dery Bennett, please, the Director of the American Littoral Society from Highlands.

Not literal, littoral, right?

D E R R I C K S O N W. B E N N E T T: Either way. There's a third pronunciation, littoral (indicating pronunciation).

ASSEMBLYMAN WOLFE: Okay.

MR. BENNETT: I have a statement and I'll leave you copies. I won't go through it for purposes of speeding things up. I was asked to give 15, there are about 12 there . I basically came here to listen more than to talk.

The statement is really in the form of seven questions that I would urge the Commission to address in its report, and most of the questions that I've asked you to ask or propose, have been covered by previous speakers.

I did want to make a couple of just brief points. One is that, as you've heard before, it's a very complicated, dynamic system. Any time you try to interfere with that system of sand moving -- in New Jersey, it moves north from about Bay Head, and from there south, it moves south. If you interfere with a system to try to hold the sand in one place, you starve the area just downstream. You have to understand that it's running counter to science and natural systems when you try to stabilize an inherently unstable environment. If you go away

with one understanding, it is that sand moves. Any time we try to hold sand, we're fighting against the natural things that are trying to happen.

You may not be aware, or you may be, that there is a shore protection master plan. It was written in 1972. Before that master plan, the expenditure of shore protection funds was total anarchy. It was really sometimes fun to hear about the meetings. They would meet in a room near Island Beach State Park and they'd have $1 million, and the mayors would all come in as supplicants or mendicants, and they would dole out essentially this money to, "You take some. You take some."

There was no plan, no idea that what somebody might be doing in Monmouth Beach might be affecting Sea Bright and whatever. The shore protection master plan was an attempt to look at the coast, at least from inlet to inlet, so you got the reach idea introduced. That master plan is going to be revised, and it would be, I think, important for you all to support the revision and to introduce some of the things you've heard into that revision.

The things that that plan did not look at were some of the things that Norb Psuty addressed; that is, that the plan should not only include how much sand, how much rocks, how much money, but whether there are alternatives. I also want you to be sure -- and I think I understand from the questions you've asked -- that you are going to hear some proposals, or you have already heard proposals for beach replenishment that are not going to work and are obvious right on the surface. Coastal storms breed this kind of thing. I get them in my office about once a week -- complicated blueprints of solutions to the beach erosion problem. In fact, the most recent one would produce an acre of land a day or something, offshore at no cost. Magic solutions like that don't work. It's a lot more complicated.

Let's talk about Avalon for a second. I always enjoy talking about Avalon because I have a sibling who has a fancy

house in Avalon, and we disagree on almost everything that has to do with the shore. (laughter) It also has to do with one of the questions and one of the emphases I want to make, which is on access to these sands that are paid for by public money. In some respects, I can't think of a town that needs less Federal money to fix itself up than a town like Avalon. They have very expensive houses.

It's not a town that has a big sign at the entrance on the Garden State Parkway, "Welcome Everybody To The Beautiful Beaches of Avalon." In fact, it's a challenge to try to get on the beaches. There's no "No Parking" signs necessarily, there's just very few places to park. There's only one place that I know of in town where you can change your clothes. There is about 20 blocks with no bathrooms, no eating facilities--

I have less sympathy for towns like Avalon -- despite the great work they may have done on doing profiles -- than I have with towns that have gone out of their way to welcome daytime visitation. If there's a way that those towns could be rewarded for their efforts to serve that kind of use, I think that's where the money should go, and not to towns that make it very difficult for the people to feel at home when they go down there.

I summarized at the very end that this Commission can do New Jersey a real favor if it winnows through all the proposals that come before it, while keeping in mind the basic questions we have asked: How much will it cost? How long will it last? Who pays? Who benefits? What are the alternatives? The rest of the questions are fleshed out in a little more detail in my statement, and I'll leave it at that.

Thank you.

ASSEMBLYMAN WOLFE: Mr. Frank Cacossa, President of Erosion Control Corporation of Livingston.

Thank you for coming.

F R A N K C A C O S S A: Thank you. I'm going to read a very, very brief statement here, and then I'm going to show you about three minutes of a film. I think it says more than I can say.

I would first like to extend my sincere gratitude to the members of the State Beach Erosion Commission for allowing me the opportunity to address the Commission on a topic which is so detrimental to our State. I believe that the increased attention to the problem of beach erosion, in part through the efforts of this Commission, will eventually result in the implementation of a satisfactory solution. Unfortunately, many have substituted recognition of the problem for rational solutions. I'd like to just read that again. Unfortunately, many have substituted recognition of the problem for rational solutions. It is in this context I offer the following brief comments:

There are many factors that influence beach erosion. Two of the most significant factors are the quantity of sand available and the material transport system, and second, the dissipation of mechanical energy as the waves interact with the shoreline. There is very little that can be done to positively impact on the first factor. However, consideration should be given to the negative effect which may result when a quantity of sand available on the transport system is limited by excessive storage in the back-shore dunes.

The second factor, namely the dissipation of mechanical energy, provides the greatest opportunity for the control of beach erosion, particulary during the conditions associated with storms. Specifically, this can be treated as an engineering problem with a corresponding engineering solution.

I would like at this time to show you a short video of one such engineering solution. This will just take a couple of minutes. (witness shows videotape)

I thank you very much for the opportunity. I just want to leave you with one thought: I think the immediate potential for solving beach erosion is an engineering solution. I think it's all well and good to look at this long-term scientific gathering of data, but these are really the tools that can be used by engineers to solve the problem. I think it's very interesting that I'm probably the only engineer that was invited here to talk when really, as I say, it is an engineering problem. Thank you.

ASSEMBLYMAN WOLFE: Excuse me. How long is the Spring Lake project?

MR. CACOSSA: It's going to be 1000 feet. It's going from jetty to jetty, and we hope to start it in two weeks. Stevens is going to monitor it, so we'll get some good monitor levels.

ASSEMBLYMAN WOLFE: Very good. You have a question over here.

UNIDENTIFIED SPEAKER FROM AUDIENCE: How much does the (indiscernible) cost?

MR. CACOSSA: It's going to run with the piles and the monitor about $95 a foot. The Army Engineers have said that a beach stabilizer that would cost less than $235 a foot is low cost, so you can see that we are well within that range. If you want to compare renourishment at a couple of thousand dollars a foot, you can see that it really is a bargain. I think the secret is to try to hold the sand that's up there. I mean, it doesn't seem to make a lot of sense to keep pushing sand up on the beach if you can do something with retaining the sand that's there.

I'm sorry, are there any other questions? (no response)

Okay. Thank you.

ASSEMBLYMAN WOLFE: Okay. Mr. Robert Kunzel, Business Development Manager of Coastal Stabilization Incorporated, from Rockaway.

R O B E R T G. K U N Z E L: Thank you very much.

ASSEMBLYMAN WOLFE: Thank you very much for coming, Robert.

MR. KUNZEL: Mr. Chairman, Assemblymen, I appreciate you hanging out until what appears to be almost the bitter end. Let's not take anything away from Ken.

My name is Bob Kunzel, from Coastal Stabilization, in Rockaway, New Jersey. Coastal Stabilization, together with the Danish Geotechnical Institute, has developed a method that stops beach erosion, and in the four instances in which we've actually installed the system, has actually accreted sand.

To do this, we have to look at the normal processes for what causes beach erosion. Normally, the water level is very high underneath the beach and a wave that comes in carrying a little bit of sand will hit the saturated beach and want to run right back out again. This process tends to carry a little bit of sand with it. What we do with our system, which is more commonly referred to as beach face dewatering, is to actually lower the water level underneath the beach. Now, when a wave comes in carrying a little bit of sand, it hits the relatively dry soils and wants to percolate down through the soils. That tends to deposit a little bit of sand there with it.

Coastal Stabilization is a subsidiary of the Moretrench American Corporation, which is the nation's largest construction dewatering contractor. We have been in business for 100 years, basically dewatering excavations prior to building something within them, so we know -- and it's well-known in the construction industry -- that lowering the water level in granular soils renders them more stable.

This whole process was discovered quite by accident in 1981 in Denmark, when a Danish company was retained to supply a source of filtered seawater to an aquarium. To do that, they buried a perforated pipe parallel to the shore, ran a

perpendicular pipe back to a wet well, and from there pumped the water to the aquarium. After about two to three weeks, they noticed that the flow of water had dropped significantly. When they went out to the beach, they noticed that the beach had grown in width, so to repair that, they moved the pipe further seaward.

Again, within a period of about two to three weeks, the beach had grown in width once again and the flow of water had dropped off. After the third time of moving the pipes, they noticed that they actually had a system that could build beaches. This system has become such a problem on that beach, in that it accretes so much sand, that they actually have to truck it away. They actually use it as a mining source, truck it away, and renourish other beaches.

We had installed a system in Stewart, Florida in 1988, and I just wanted to show you the results of that real quickly. This site at Sailfish Point was experiencing about 15 feet of erosion per year. This is a picture taken from ground surface prior to the installation.

ASSEMBLYMAN WOLFE: Excuse me. You people want to come on up. The rest of you- It's very interesting.

MR. KUNZEL: I was told not to bring slides, so I ended up with this. (witness indicates photographs)

ASSEMBLYMAN WOLFE: That's okay. Maybe somebody in the audience wants to come over to this end to see it.

MR. KUNZEL: I can turn it around.

This is a picture taken from the land view prior to the installation of the system. What I want you to note here is this pier that you can basically drive a truck under.

Commissioner, that's the pier that I wanted you to notice there. Okay?

ASSEMBLYMAN WOLFE: Okay.

MR. KUNZEL: Within the following year, another picture was taken from the land view, and here, again, you can see the beach had grown about 60 feet in width and three to

four feet in elevation. This is the pier here, again, compared to what this looks like. Now, we have been monitoring this with profiles about 100 feet apart on a quarterly basis since 1988. The erosion at this site has been completly halted, and, in fact, we've seen an accretion of sand of up to 60 feet, while the downdrift and updrift beaches, have continued to erode at the rate of 15 feet a year.

ASSEMBLYMAN WOLFE: Fifteen feet a year?

MR. KUNZEL: Fifteen feet a year. That's right, except for the positive effects that we see from the system on the downdrift side. What we see is that as this beach builds it actually acts as a feeder beach to the downdrift beach, so it serves as a supply of sand to the downdrift beach and we've actually seen a benefit to it. I just want to show you real quickly an aerial shot of the before and after.

This is the before. Again, here is the pier, notice the shoreline. This is the after. Here is the pier, notice the shoreline. About six months afterwards, you can see a noticeable bulge in the sand.

So we have a system that was developed in 1981, was described in literature as early as 1940, and is based on some very sound engineering principles and the natural laws of physics. We have four systems that have been installed around the world to date. They have all worked. There has not been a failure of the system yet. We are in the process this month of installing another one in Florida, and there is a third system to be installed in Florida when the funding becomes available. What we need is help from the Commission in finding a suitable spot in New Jersey to demonstrate the system's effectiveness.

ASSEMBLYMAN WOLFE: Do you have a spot in mind?

MR. KUNZEL: No, not at this time. We started in Florida and we found-- The reason for that primarily is the willingness of the Florida departments to accept the system and to go ahead and try it.

ASSEMBLYMAN WOLFE: For this system to work there has to be a dune source on the landward side, correct?

MR. KUNZEL: No.

ASSEMBLYMAN WOLFE: No?

MR. KUNZEL: The sand comes from two places. It comes from the onshore/offshore movement of sand and through the lateral drift.

ASSEMBLYMAN WOLFE: Okay. Then Monmouth Beach and Sea Bright, would that system work where there is a solid wall?

MR. KUNZEL: Yes, and I would agree with Richard Creter that it's not applicable to all sites. An engineering study does need to be done to determine the applicability of this system to the particular site. But from what I've seen, it can be applied in New Jersey quite easily. There is an electrical cost associated with operating a system like this which is fairly minimal: on the order of $3, or $4, to $5 a foot per year in electrical costs. When you compare that to beach renourishment and the costs associated with that on a yearly basis, you'll find that this is extremely cost competitive.

ASSEMBLYMAN GIBSON: Mr. Chairman?

ASSEMBLYMAN WOLFE: Yes.

ASSEMBLYMAN GIBSON: You do leave your pipes in continuously once they're installed?

MR. KUNZEL: Yes. They are buried. They are completely out of sight, and you don't hear or see anything.

ASSEMBLYMAN GIBSON: I'm familiar with your system. It would seem to me that maybe the Commission would like you to select a couple of potential sites. I would think that your system would be best where the sand is the most coarse as opposed to maybe our finer sand in some of the beaches, and where the beach is the steepest as opposed to a long flat beach. I think your system would work better on a steeper beach with coarse sand.

Why don't you look around and make some recommendations? I'm sure the municipal officials that are suffering in those areas will be very, very glad to get some help in a test installation that has the potential of solving some of their problems, so I would suggest that we leave that part to you.

MR. KUNZEL: Okay.

ASSEMBLYMAN GIBSON: But give us an idea-- We know $3 per foot per year in continuous electrical costs. What's the initial installation costs per foot compared to some of these others?

MR. KUNZEL: We're looking at about $200 to $300 a linear foot.

ASSEMBLYMAN GIBSON: Okay.

Thank you, Mr. Chairman.

ASSEMBLYMAN WOLFE: Okay. Thank you, Assemblyman.

MR. KUNZEL: Thank you.

ASSEMBLYMAN WOLFE: Thank you.

Mr. Kenneth Smith, President of the Coastal Advocate, Incorporated, from Ship Bottom.

Ken, welcome again.

K E N N E T H J. S M I T H: Chairman, Assemblyman Gibson.

ASSEMBLYMAN GIBSON: Ken, how are you?

MR. SMITH: Pretty good. Since Orrin Pilkey isn't here, I'm going to give his talk for him. (laughter) I'll tell you what, I will allude to one thing about the Pilkey school of coastal management and take one of his quotes, because I think part of it was echoed by what I heard from Dery Bennett. It's a shame that Dery isn't here, but Jack read the transcript of Dery's remarks on Avalon.

ASSEMBLYMAN GIBSON: Do I have it?

MR. SMITH: Well, it will come out. Basically, he shared -- probably shares the view that Orrin stated when he said, "Compared with the number of people who want to use the

beach, the number built right next door to it is very small, so the hell with them. There's not much good you can say about these people. They build in dangerous places; they're responsible for flood insurance expenditures; they make access to the beach difficult for the public; and they make the beach ugly."

ASSEMBLYMAN GIBSON: I'm glad you saved me the trouble of reading that.

MR. SMITH: I love Avalon, and I will be there this weekend for a festival that they are having to attract people into the community postseason, as we do on Long Beach Island and a number of areas.I thought the remarks by Dery were very shortsighted regarding that.

This hearing today, I think from my own perspective, produced some of the best testimony that I've heard. It's really an excellent agenda that you put forth with Stu Farrell, Mike Bruno, and the people that are really recognized experts that have the information at their fingertips.

I am speaking today for the Coastal Advocate and my constituency, and also for American Shore and Beach Preservation Association and the New Jersey Alliance for Action. Again, I commend this Commission on the frequency of your meetings and your tenacity on this issue. As you've heard today, it really is a complex issue. There is a lot more than people realize. It's not just a matter of picking sand up here and depositing it there. There's a lot more to it. The processes are complex -- the techniques, the environmental monitoring, and particularly the funding, as we will see over the next several years.

As the cost of pumping sand escalated in the '80s, the search intensified for innovative, inexpensive technologies to protect beaches:. You've heard the testimony on a few of them. The three organizations I represent strongly support increased funding for research and the utilization of those

technologies. My only caution would be that we consider carefully any suggestions of implementing the new technologies as a replacement for beach nourishment.

As Dick Creter attested, the best use of his Breakwaters system is in conjunction with a beach nourishment program. We may find that his installation, or some other installation could work independently. For instance, offshore breakwaters generally build up sand in their lea. They may have some downdrift effects also. But even if these installations only serve to lengthen the period between renourishments, as you noted, we're going to save millions of dollars and that would be their best utility.

We need to coordinate the installation of new devices with the Corps in areas where Corps projects have been authorized, are under construction, or even waiting renourishment. We've got to be very careful that what we do is consistent with their program. The Corps is initiating a program of innovative technology transfer in their Washington headquarters. I've been in touch with John Housley, a colleague of mine down there, and I'll have more information for you on that hopefully in the near future. Inasmuch as the methods that we discuss today can fit into that Federal program, we support them.

Some devices may be adaptable to the heavy wave attack of the Atlantic coast, and some may be better suited to lower energy back tidal -- back bay environments. We'll work to secure the needed funding for wave tank and field test research that will lead to their potential application.

Just in conclusion, I want to recommend strongly that we do not depart from the program of study, permitting, and construction of beach restoration projects which is proposed by the Corps for the State of New Jersey. The Corps program is not only the most cost-effective plan of protection, it is the only program that is going to save the beaches of New Jersey

for the next 50 years. While we're waiting for Corps projects -- the permitting review process to take its course -- there are critical areas that we need to address:

Quite frankly, we need more money. As you've heard in previous hearings, 100 percent of that $15 million within three years probably is going to go to cost-sharing Federal projects, and that's good. We can't let them get away because the 65 percent match that we get from the Feds -- we'd be crazy to let that go. I've suggested a $5 million increment each year. Let me retrench on that a little bit. Let's take a look and see what we need really, and find out what we need currently each year.

So we offer the services of my firm and the expertise within American Shore and Beach. Our annual meeting next year will be in October in Virginia Beach. We'll have presentations from the entire Mid-Atlantic region. We'll certainly invite you or your designates to come.

ASSEMBLYMAN WOLFE: We'll be there.

MR. SMITH: Representing the New Jersey Alliance for Action, I can of course pledge to you their full cooperation to get this work done.

Thank you very much.

ASSEMBLYMAN WOLFE: Thank you, Ken.

Ed McCrohan?

E D W I N B. M c C R O H A N: Thank you, Assemblyman. I'd like to make two comments as an oceanfront property owner. I spoke to your group in Spring Lake, so possibly some of you remember my situation. I'd just like to say-- The first thing is, in the last month or so I've had difficulties with one of my neighbors' houses, which was seriously damaged by the northeaster back in December, who's now plowed sand eastward complaining that sand from my dune -- part of the dune is falling into his yard. He's threatening litigation.

This person is an educated person -- actually he's a school principal -- but as a permanent resident of the shore, I would have to classify this individual -- in fact, his family over the last 40 or 50 years as summer bunnies as opposed to day bunnies. You know our term about people who come down the Parkway for the day. These people come down for the summer. They don't live on the beach in the winter.

I think if there was one thing I could say, it's that you might get the most leverage out of some of your money if you try to enlist the support of a skilled public relations person, and try to encourage more articles such as published by the Asbury Park Press on the dynamics of dune systems and overwash areas. I am just appalled that the lack of information on the part of my neighbors, most of our councilmen, and the general lack of attendance at your meetings of municipal engineers and this sort of thing. I think it's appalling.

Given the limitation you have in the funds and the prior commitment of so much of those funds to the Corps of Engineers' projects that are waiting for Federal money, you might consider investing some or all of your money in trying to get more money by getting more public support and more information. I think the idea of educating K through 12 kids, getting them out on the beach, and doing this sort of thing-- This will pay dividends not next year, but in 10 or 20 years in terms of the support of your Commission.

Thank you very much.

ASSEMBLYMAN WOLFE: Thank you very much.

Anyone else wish to speak? (no response) If not, I'd like to thank all of you for coming. It's been a very productive day, and I can assure you that the remarks made today, as well as the three previous meetings, will be included in our report of recommendations to the Governor and also to the Legislature. We may be having another meeting in the next month or so, and that certainly will be publicized.

Thank you all for coming. I especially want to thank the people from the Office of Legislative Services staff who are with us at all our meetings and usually don't get recognized, so thanks for coming.

(HEARING CONCLUDED)

APPENDIX

NEW JERSEY MARINE SCIENCES CONSORTIUM

NEW JERSEY MARINE SCIENCES CONSORTIUM

Reply to EXECUTIVE OFFICE

TESTIMONY GIVEN BEFORE THE NEW JERSEY STATE BEACH EROSION COMMISSION PUBLIC HEARING ON "BEACH PROTECTION STRATEGIES; PLANNING FOR THE FUTURE"

October 6, 1993

ASBURY PARK, NJ.

by Dr. George D. Klein,
President, New Jersey Marine Sciences Consortium.

Mr. Chairman, Ladies and Gentlemen of the New Jersey State Beach Erosion Commission. My name is George D. Klein, and since May 24, 1993, I have been President of the New Jersey Marine Sciences Consortium. That Consortium, which receives funding from the New Jersey State Senate and Assembly, is undergoing a redirection in its mission. Before testifying on the topic at hand, I would briefly like to state what the Consortium's mission is because it is relevant to this hearing.

The New Jersey Marine Sciences Consortium has 33 member institutions consisting of 26 colleges and universities in New Jersey, 3 in eastern Pennsylvania, and 4 in southern New York State. Our mission is to provide, through the joint efforts of our membership, research, education and services in coastal and shelf marine sciences for the people of New Jersey. Our research emphasis over the next three years will focus on (1) Shore erosion and remediation, (2) Dredging issues including source pollution and disposal, (3) Marine biotechnology, and (4) Aquaculture. Our educational programs consist of summer course offerings at the college level, as well as fall and spring college field trips, and a large program of precollege field trips in marine sciences for over 15,000 school children ranging from K-12; these school children (organized into small groups of 30 to 40 people) spend a day at our facility in Sandy Hook to learn about beaches, marine life, marine ecology, and marine pollution through a show-and-tell presentation and field experience. Our services to the marine community are organized around a fleet of five coastal and shelf research vessels which are available to the member institutions and other relevant users in New Jersey on a charter basis.

BEACH EROSION AND REMEDIATION:

Beach erosion and remediation issues have been at the forefront of citizens' concern in New Jersey for at least 50 years when the U.S. Army Corps of Engineers began a variety of studies and took several steps to mitigate the problem. Yet, despite their good work over the short term, the problem is still with us. The principle difficulty, from my perspective, is that the proposed solutions, as good as they are and as cost-effective as they appear to be, deal with too short a time range.

It must be remembered that the beach and inner shelf area (from which most sand is "borrowed" for remediation) are the most dynamic parts of the ocean because BOTH surface driven waves and currents combine with bottom-driven currents to erode and redistribute sand. To improve remediation, sand must be obtained not from the inner shelf, which is linked to the beach dynamically, but from a source away from this beach-inner shelf dynamic system.

SANDY HOOK: Executive Office Building 22, Fort Hancock, NJ 07732 908-872-1300
FAX 908-291-4483
SEAVILLE Field Station Box 549, Marmora, NJ 08223 609-390-3320

IX

I propose that the NJ State Beach Erosion Commission consider a longer-term solution which I call "the Import Model". The guiding principle of coastal geology that underscores this new concept is that in areas where sea level is rising, and where the volume of sand being incorporated onto beaches exceeds the ability of coastal processes to erode them away will result in long-term natural beach remediation. Such large and excess influxes of sand are characteristic of coasts associated with large and medium-sized rivers that provide large volumes of sand. The beaches of Texas and Louisiana, Brazil, and the Netherlands, to name but three examples, all are associated with large river systems (Mississippi and Rio Grande, Amazon and Sao Francisco, Rhine and Meuse) that provide large volumes of sand.

New Jersey's shore suffers from a different problem. Sea level is rising, but the two rivers that flank the coast (Hudson, Delaware) provide too little sand to be effective. Consequently, with the dynamic linkage of the beaches and inner shelf, erosion is dominant.

The solution is to obtain sand from a substitute source which would provide sand in the way that the Mississippi River and Rio Grande provide it for Galveston and Corpus Christi, Texas.

What's possible? Large sources of sand exist offshore. Large sources of sand exist on land areas also, but to remove them poses added environmental problems. Under the import model, I propose that the New Jersey State Beach Erosion Commission consider studying the feasibility, including the economics, of dredging offshore sands and providing them to New Jersey beach areas.

Here is what it would require. First, sources of sands need to be identified in detail, including calculation of volumes of available sand. Second, such sand could then be dredged with ocean going dredges and stored in laid-up ore carriers or even oil tankers (both would need to be cleaned) and transferred close to shore. Third, another dredge would offload the sand from these ships. The volume of sand to be dredged and pumped on shore would need to exceed the ability of nature to erode it, thus creating a system similar to the Gulf Coast.

Two options exist. First, one could provide sand by this method annually to satisfy coastal community needs. Alternatively, one could calculate, using newer numerical modeling techniques, how much sand would be required to be dredged on a one time basis that would provide a beach for a specified period of time such as 50 years or 100 years. Erosion would occur, but from studies of flow directions of erosive currents, one would know where that sand is accumulating and it could be dredged periodically for remediation to prolong beach life even longer.

How feasible is this? The answer is, we don't know. To undertake such a remediation program requires a very high front-end cost. To obtain the answer, numerical modeling is required to determine the volume of sand needed and the life of such a remediated beach. That would provide a baseline for an economic analysis of ocean dredging costs, charter costs for laid-up ore carriers and oil tankers, shore dredging costs, and remedial dredging. Without either the numerical modeling or the economic analysis, no one will know if this is feasible. It requires a multidisciplinary team effort. Its likely success is, however, based on a well-known coastal geological principle, namely:

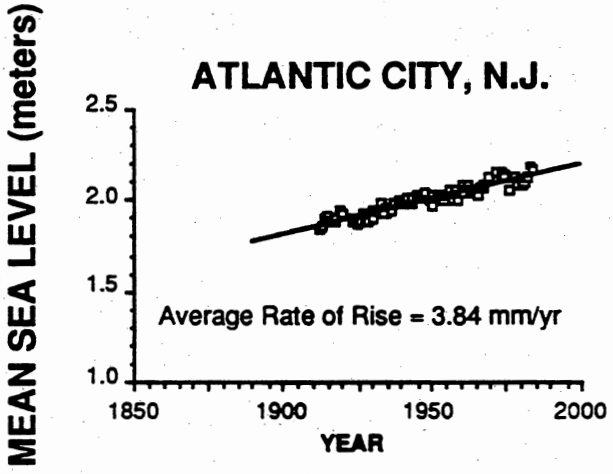
> If sand influx exceeds the rate of erosion, beaches will build seaward even when sea level is rising (as they have along the Texas coast over the past 5,000 years).

2X

I recommend that the New Jersey State Beach Erosion Commission consider this "Import Model" among the options available to remedy a problem that is of vital importance to the economy of the state. The New Jersey Marine Sciences Consortium has the ability to put together a multidisciplinary team of scientists, engineers and economists from its member institutions to carry out the relevant investigations for the New Jersey State Beach Erosion Commission.

3X

THE EFFECTS OF AN ACCELERATED RISE IN SEA LEVEL ON THE COASTAL ZONE OF NEW JERSEY, U.S.A.



A Report by

The Panel on Sea Level Rise

Dr. Norbert P. Psuty, Chair

to the

Governor's Science Advisory Committee

4X

REPORT TO THE GOVERNOR'S SCIENCE ADVISORY COMMITTEE ON THE IMPACTS OF SEA-LEVEL RISE ON COASTAL NEW JERSEY

Dr. Norbert P. Psuty, Chair
Panel on Sea-Level Rise

December 1991

This is Contribution 91-55 of the Institute of Marine and Coastal Sciences
Rutgers - the State University of New Jersey
New Brunswick, New Jersey 08903

Reproduction of this report is supported by a grant from NJ-DEPE, Office of Regulatory Policy

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PREFACE

Concern for the impacts of sea-level rise on the natural and built environments of coastal New Jersey were highlighted in a proposal by Dr. Norbert P. Psuty of Rutgers University to the Science Advisory Committee (SAC) of Governor Thomas A. Kean. With the approval and encouragement of the SAC, Dr. Psuty assembled a panel of experts to address this topic and to prepare a statement that, in the judgement of the members, conveyed the importance of the sea-level rise issue to the State's managers and decision-makers.

The panel did not concern itself with the rates of sea-level rise, but instead addressed matters of effects and impacts of the rise. Thus, the discussions and descriptions of change remain applicable independent of the rates of change. It is the vast range of modifications to the natural and built environments that is central to this report.

The panel consists of the following persons:

Dr. Norbert P. Psuty (Panel Chair)
Center for Coastal and Environmental Studies
Institute of Marine and Coastal Sciences
Rutgers University
New Brunswick, New Jersey 08903

Dr. Brian Howes
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

Mr. Elwood Jarmer
Cape May Planning Board
Cape May Court House, New Jersey 08210

Dr. Lee Meyerson
Department of Geology and Meteorology
Kean State College
Union, New Jersey 07083

Dr. James K. Mitchell
Department of Geography
Rutgers University
New Brunswick, New Jersey 08903

Ms. Fredrika Moser
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Department of Environmental Protection
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Dr. Lindsay Nakashima
Louisiana Geological Survey
Coastal Geology Program
Box G, Louisiana State University
Baton Rouge, Louisiana 7080

Dr. Charles J. Roman
Center for Coastal and Environmental Studies
Rutgers University
New Brunswick, New Jersey 08903

Mr. Steven Whitney
Division of Coastal Resources
Department of Environmental Protection
CN401 Trenton, New Jersey 08625

Dr. Ralph E. Good (Liaison from SAC)
Biology Department
Rutgers University
Camden, New Jersey 08102

6X

Dr. Richard Orson, scientific support
Center for Coastal and Environmental Studies
Institute of Marine and Coastal Sciences
Rutgers University
New Brunswick, New Jersey 08903

Ms. Susan Kaiser, scientific support
Center for Coastal and Environmental Studies
Institute of Marine and Coastal Sciences
Rutgers University
New Brunswick, New Jersey 08903

Begun under the administration Governor Thomas A. Kean, this report was completed under Governor James J. Florio. It is to the leaders of the State of New Jersey, past, present, and future, that this report is submitted. It remains appropriate and timely because it treats a process that is occurring during a long period but which has had, is having, and will continue to have a profound effect on the coastal resources of our State.

FOREWORD

The New Jersey shore is one of our State's greatest resources. It is our responsibility to preserve the shore for our children and our children's children. That responsibility must be taken seriously because in recent years we've been learning a lot more about how vital our coastal areas are to our State. Preserving the shore and other coastal areas is not simply a question of having a nice place to go on the weekends, it's about having clean water to drink and a healthy environment in which our children can grow up.

This report on the "The Effects of an Accelerated Rise in Sea Level on the Coastal Zone of New Jersey" has been prepared by leading scientists. It confronts some important problems and poses important questions. Some of the information is rather technical, but the basic idea is very straightforward: protecting our shore and coastal areas requires a serious commitment to the future from all of us.

Whereas global warming and sea-level rise are certainly issues that have causes and impacts far beyond New Jersey, New Jerseyans can play an important part in addressing these problems. We can offer the knowledge of our best scientists and experts, and all New Jerseyans can work to contribute to a solution. This study is an important part of that effort.

I want to thank all the men and women who contributed their knowledge and expertise to this report. They are to be congratulated for their hard work on behalf of our Statewide community. This report keeps alive the tradition of holding scientific conferences on our shore and coastal areas. As Governor, I'm honored to endorse this project and to have the results made available to the citizens of New Jersey

Governor James J. Florio

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TABLE OF CONTENTS

BACKGROUND INFORMATION

The prediction of the magnitude of future sea-level rise has generated considerable concern about the impacts on existing uses in the coastal zone. Whereas earlier estimates were pointing to inundations on the order of 350 cm (11.5 ft) over the next century (Hoffman, et al, 1983), these figures are currently being reduced downwards to about 85 cm (2.8 ft) during the next century (Titus, et al, 1990). By way of comparison, the coastline of New Jersey has recorded a general increase of the ocean level amounting to 40 cm (1.3 ft) over the past century through a combination of sea-level rise, subsidence of the land, and compaction of the sediments in the coastal zone (Hicks, et al, 1983).

As sea level rises, the coastal zone will be heavily impacted, a condition complicated by intense urban development which has occurred along many coastlines. This report presents information and assesses the effects of a rising sea level on the coastal zone of New Jersey, U.S.A. The report is being presented in three parts; (1) available historic and baseline data, (2) specific sites representative of the coastline, and (3) response of institutions and agencies. Assessments include physical and biological processes as well as socio-economic issues.

The coastal zone of New Jersey (Fig. 1) is divided into four administrative zones (Fig. 2) under the jurisdiction of the State's Department of Environmental Protection. The Northern Waterfront Area includes coastal features in the northern portion of the State, primarily along the Hudson River. The Hackensack Meadowlands District incorporates the area drained by the Hackensack River, a site of extensive marshland. Both these northern administrative zones are in highly urbanized areas and many of the natural features have been extensively modified. The Bay and Ocean Shore Segment includes those areas defined as part of C.A.F.R.A. (Coastal Area Facilities Review Act) and covers a major portion of the Atlantic Ocean and Delaware Bay coastlines, encompassing most of the state's recreational beaches. This segment is low to moderately developed except in areas nearest the beaches and the area immediately inland of Atlantic City. The Delaware River Area extends along the tidal portion of the Delaware River from the Delaware Memorial Bridge to the fall line above Trenton. This segment is primarily rural except for the areas around Camden and Trenton.

Information on population and employment is important in assessing effects of sea level rise on the continued economic development of an area. Today, over 7.62 million people reside in the State of New Jersey (Brail, 1988). Of the total population, about 15% reside directly along the coast and an additional 15% to 20% live in flood-prone estuarine areas. In the event of a rise in sea level of 200 cm, approximately one-half of the State's population could be affected.

10X

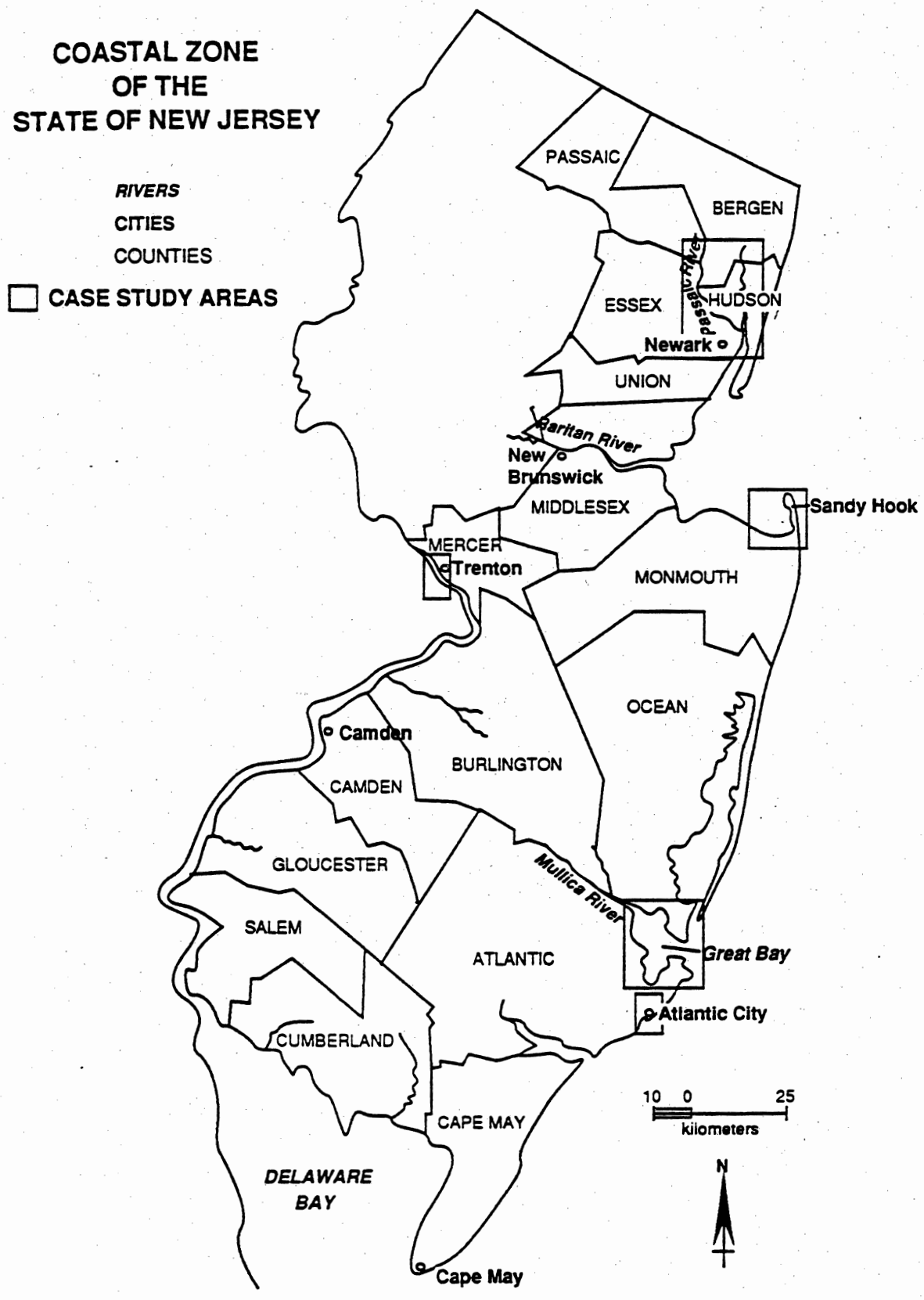

COASTAL ZONE
OF THE
STATE OF NEW JERSEY
RIVERS
CITIES
COUNTIES
CASE STUDY AREAS
PASSAIC
BERGEN
ESSEX
HUDSON
Passaic River
Newark
UNION
Raritan River
New Brunswick
MIDDLESEX
Sandy Hook
MERCER
Trenton
MONMOUTH
OCEAN
Camden
BURLINGTON
CAMDEN
GLOUCESTER
Mullica River
SALEM
ATLANTIC
Great Bay
Atlantic City
CUMBERLAND
CAPE MAY
DELAWARE
BAY
Cape May
10 0 25
kilometers
N

Figure 1

11X

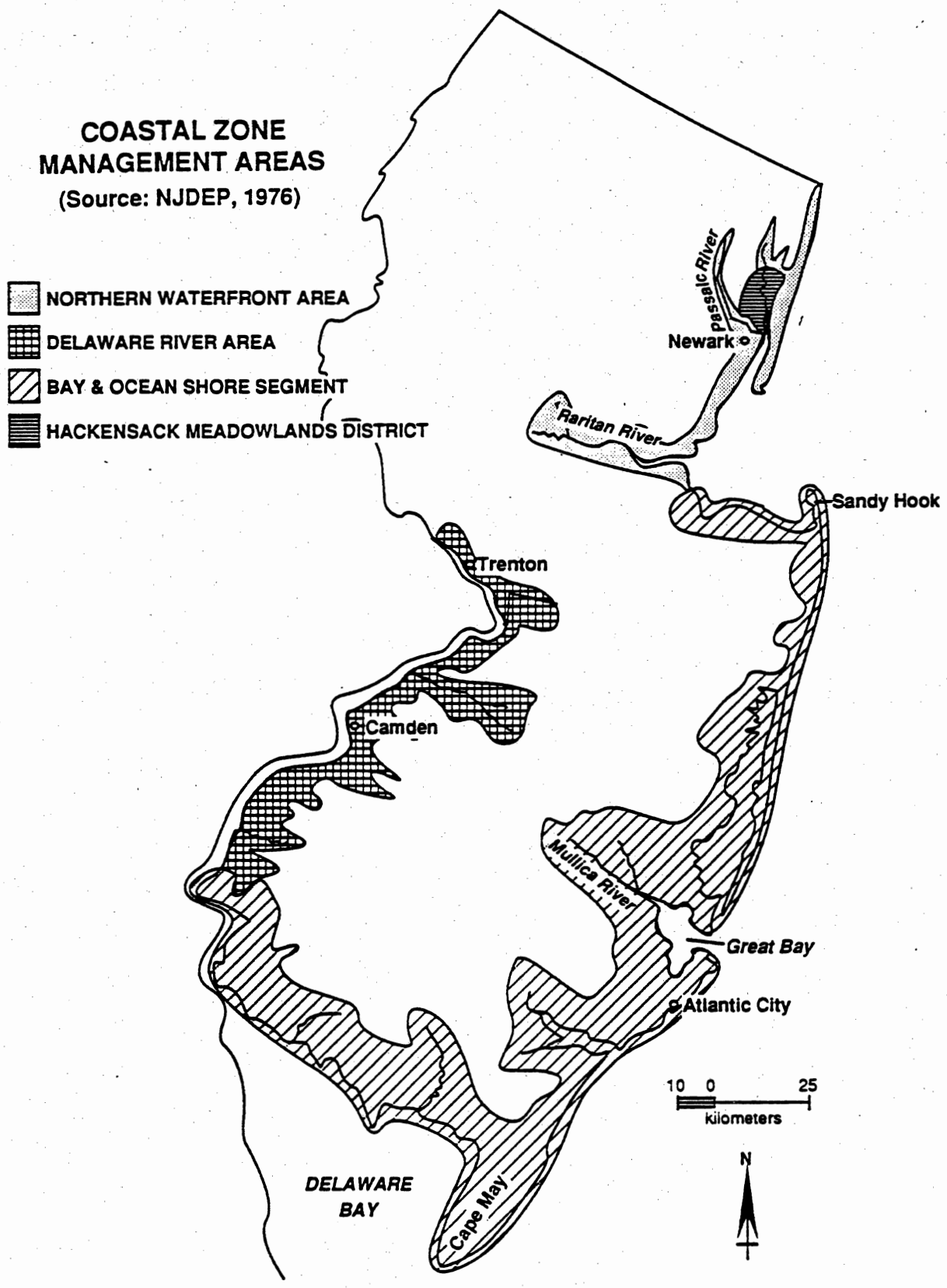

COASTAL ZONE
MANAGEMENT AREAS
(Source: NJDEP, 1976)
NORTHERN WATERFRONT AREA
DELAWARE RIVER AREA
BAY & OCEAN SHORE SEGMENT
HACKENSACK MEADOWLANDS DISTRICT
Passaic River
Newark
Raritan River
Sandy Hook
Trenton
Camden
Mullica River
Great Bay
Atlantic City
10 0 25
kilometers
N
DELAWARE
BAY
Cape May

Figure 2

12X

Statistics for New Jersey (Figs. 3 and 4) reveal that a majority of people live and work within the Northern Waterfront Area and areas near Atlantic City and Monmouth County on the Atlantic and areas surrounding Camden and Trenton on the Delaware.

The New Jersey coastal zone is low-lying and is classified as having a general slope of less than 15%. Flood prone areas (Fig. 5) extend almost the entire length of the shore and along all major rivers. In the event of a rise in sea level it is these areas that will be affected initially and most directly.

Sea level has been rising along New Jersey's shore since the termination of the Pleistocene Epoch. A relative standstill occurred about 2500 years B.P. and since that time sea levels have been rising on an average of about 0.5-0.95 mm/yr (.02-.037 in.)(Psuty, 1986)[1] . During the last century, however, it appears that rates of net global sea level rise have been increasing, reaching rates as great. as 4 mm/yr (.157 in.). Figure 6 shows net sea level curves based on tide gauge measurements taken around the state. Further, due to downward movement of the coastal zone, it is estimated that water levels in our area will rise at least 25 to 30 cm per century more than predicted global sea-level rise rates (Hull and Titus, 1986).

Historically, New Jersey has been hit with fewer storms than other U.S. Atlantic coastal states . A history of major storms is shown on Table 1. Storm damage and costs vary with the intensity and duration of the storm. For instance, a small northeaster hit Sea Bright and Monmouth Beach on March 29, 1984 and caused over $160 million worth of damage (Nordstrom, et al. 1986). The October 31, 1991 storm is reported to have caused damage estimated at $72 million (Star Ledger, 11/19). Storm frequency has changed over the years. Of the 24 major hurricanes that have affected New Jersey during the last 100 years, 16 have occurred since 1939.

Erosion along the New Jersey shore has varied through time. Individual sites can oscillate between erosion and deposition depending on the year's storm activity, source of sediment, and extent and type of coastal construction found along the shore. A general rate of erosion for the entire State has been estimated to be 0.5 m (1.6 ft) per year and includes the effects of construction, natural erosion rates, beach alterations and the drowning of the coast (Nordstrom, et al, 1986).

[1] Sea-level rise calculations based on past changes usually incorporate the variables of fluctuation in the volume of water in the ocean basin plus subsidence of the land-margin and the compaction of sediments in this zone. These measurements of past events therefore refer to net sea-level change whereas the future predictions tend to isolate the absolute sea-level change based only on the variation of the volume of oceanic water.

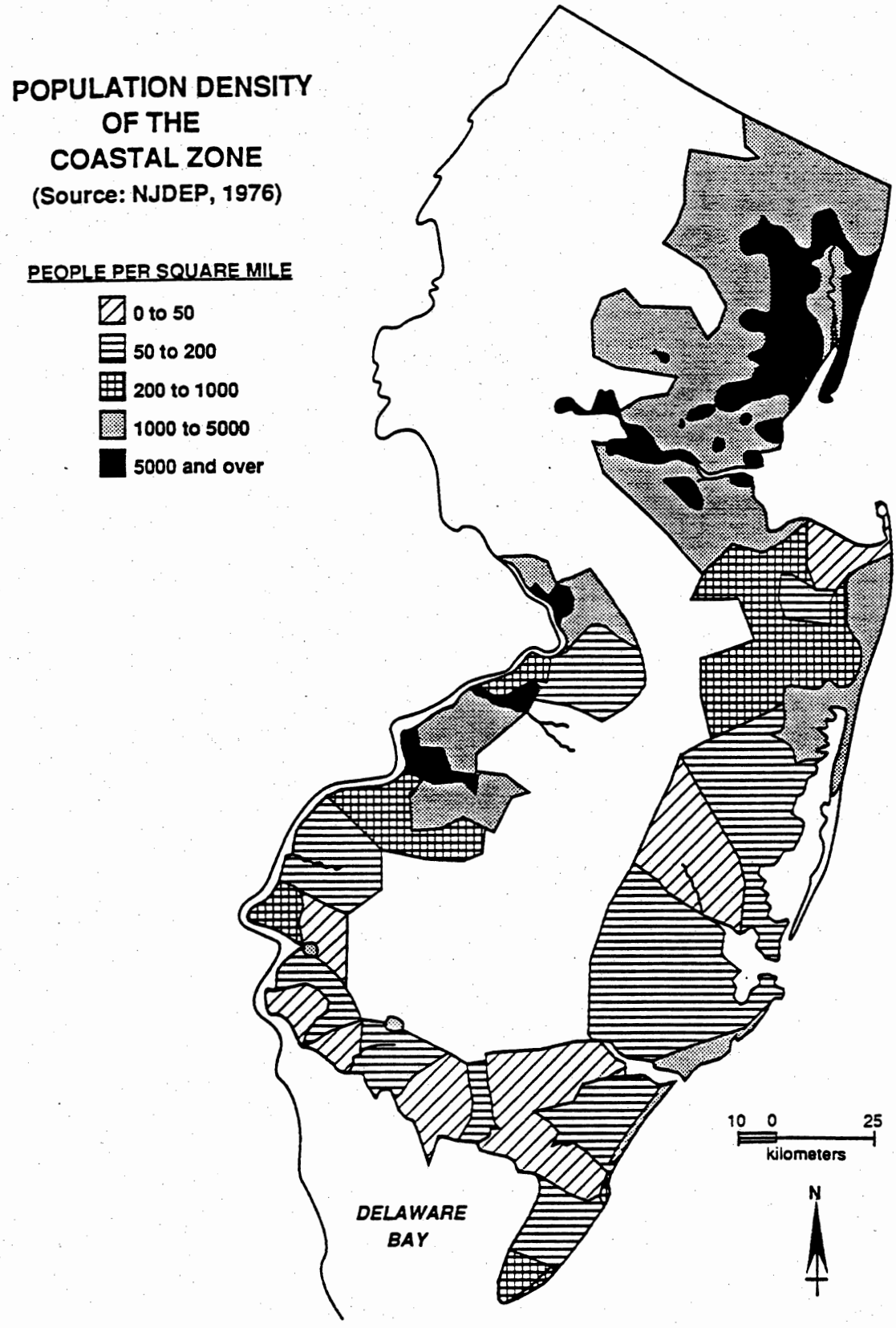

POPULATION DENSITY
OF THE
COASTAL ZONE
(Source: NJDEP, 1976)
PEOPLE PER SQUARE MILE
0 to 50
50 to 200
200 to 1000
1000 to 5000
5000 and over
DELAWARE
BAY
10 0 25
kilometers
N

Figure 3

14X

EMPLOYMENT DENSITY OF THE COASTAL ZONE
(Source: NJDEP, 1976)

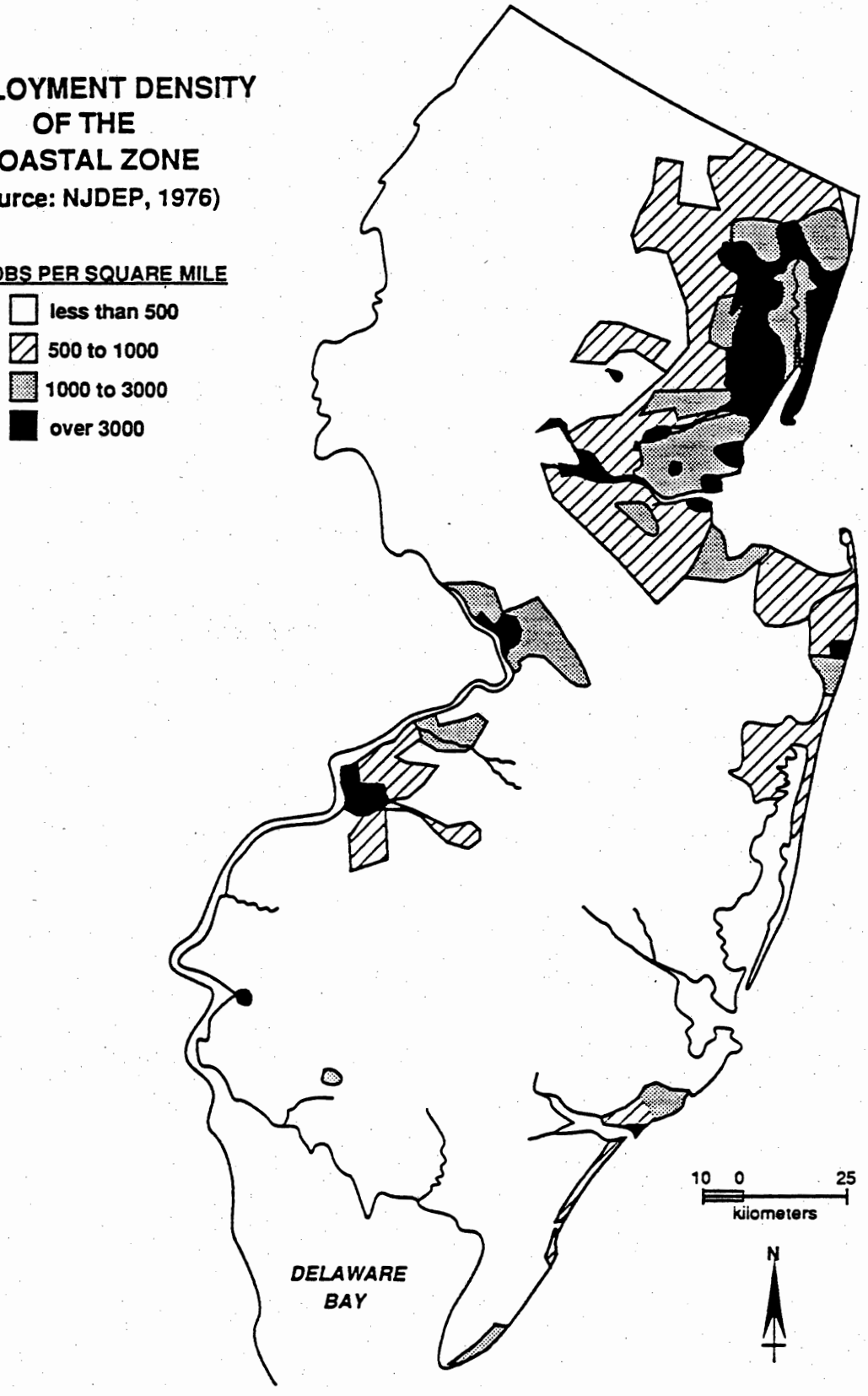


Figure 4

15X

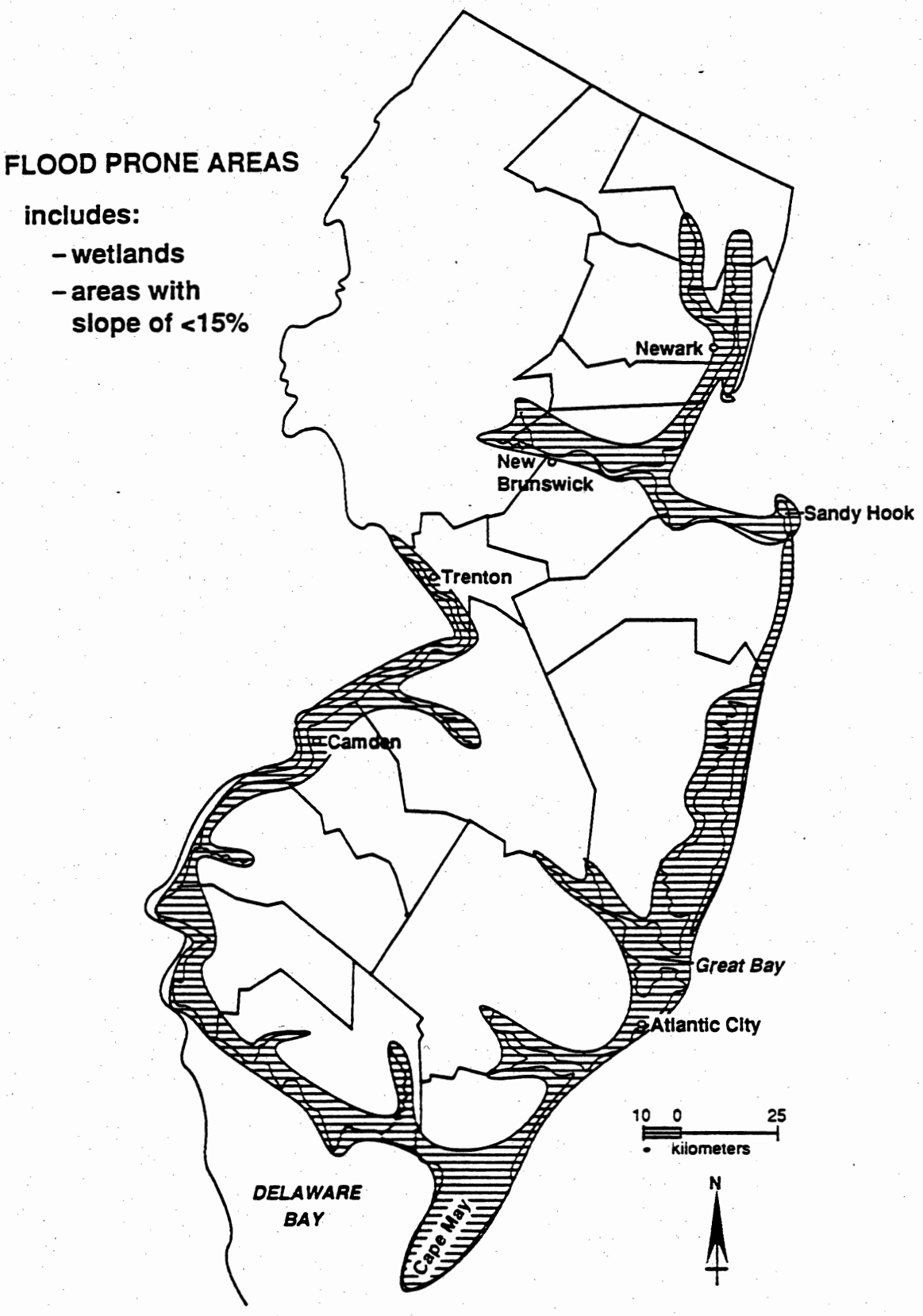

FLOOD PRONE AREAS
includes:
– wetlands
– areas with slope of <15%
Newark
New Brunswick
Sandy Hook
Trenton
Camden
Great Bay
Atlantic City
10 0 25
kilometers
N
DELAWARE BAY
Cape May

Figure 5

16X

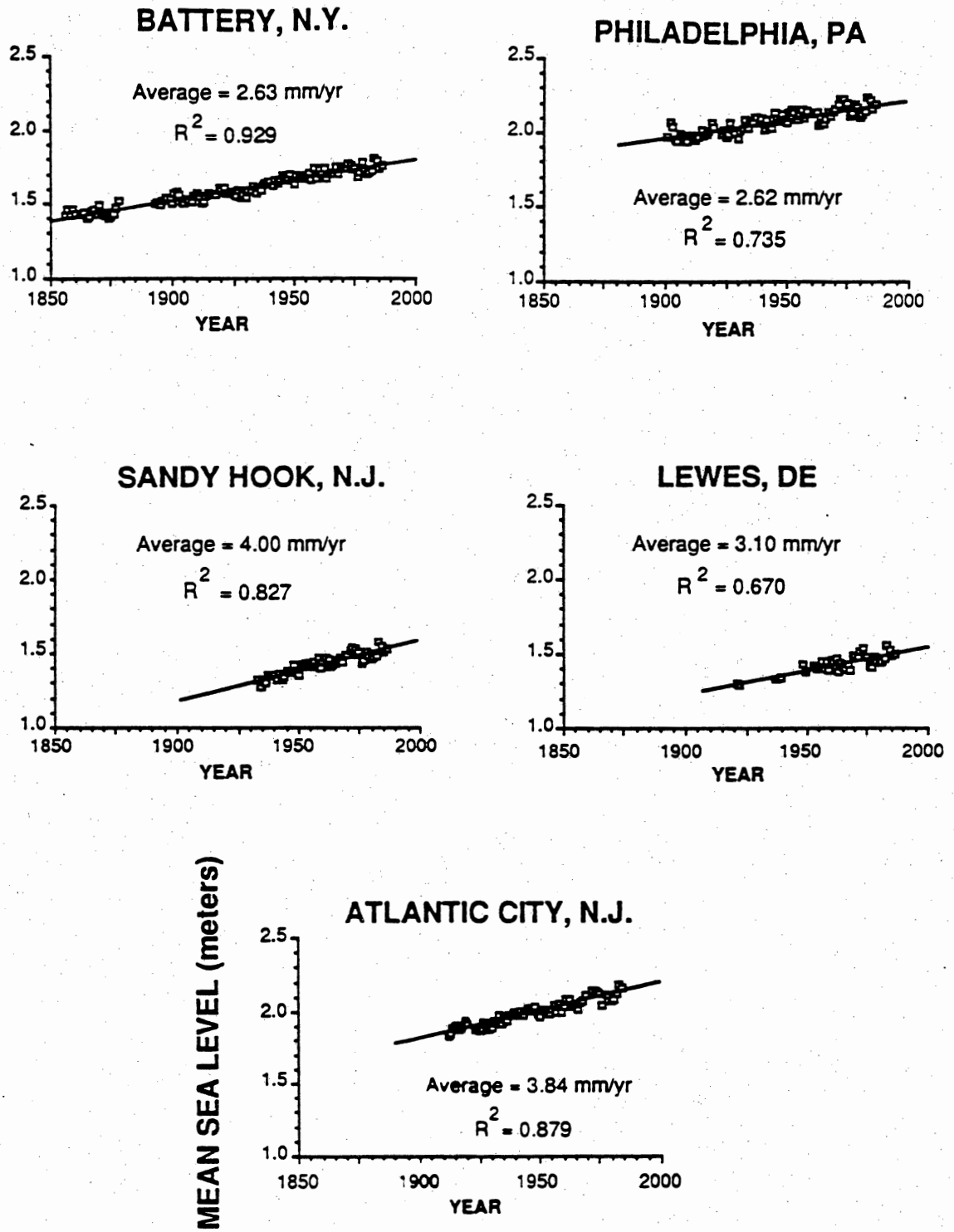


Figure 6. Average sea-level rise for tide gauges along or near the New Jersey Coast (NOAA, 1988)

19X

Table 1

Hurricanes (Tropical Cyclones) Affecting New Jersey		Significantly Northeasterly Storms Affecting New Jersey
1.	October 8, 1783	December 27, 1913
2.	August 19, 1788	January 3, 1914
3.	October 9, 1804	February 13, 1914
4.	August 23, 1806	April 15, 1914
5.	September 23. 1815	January 13, 1915
6.	September 3, 1821	February 2, 1915
7.	September 3, 1825	August 14, 1919
8.	August 25-26, 1830	January 11, 1922
9.	August 29, 1839	February 18, 1827
10.	October 3, 1841	November 9, 1832
11.	October 13, 1846	November 29, 1945
12.	July 19, 1850	December 26, 1947
13.	August 19, 1850	November 6, 1953
14.	September 7-8, 1850	March 5-7, 1962
15.	September 9-10, 1854	November 10, 1962
16.	October 3, 1869	November 30, 1963
17.	September 17, 1876	October 14, 1977
18.	October 23, 1878	February 18, 1978
19.	August 18, 1879	October 25, 1982
20.	September 23, 1882	March 29, 1984
21.	November 24-25, 1888	January 2, 1987
22.	September 10-11, 1889	
23.	August 23-24, 1893	
24.	September 16, 1903	
25.	August 26, 1924	
26.	December 3, 1925	
27.	August 23-24, 1933	
28.	September 8, 1934	
29.	September 31, 1938	
30.	August 19, 1939	
31.	September 1, 1940	
32.	September 14, 1944	
33.	August 31, 1954, Carol	
34.	September 11, 1954, Edna	
35.	October 15, 1954, Hazel	
36.	August 13, 1955, Connie	
37.	September 12, 1960, Donna	
38.	October 21, 1961, Greta	
39.	August 27-28, 1971, Doria	
40.	June 22, 1972, Agnes	
41.	August 9, 1976, Belle	
42.	September 6, 1979, David	
43.	September 30, 1983, Dean	
44.	October 13-14, 1984, Josephine	
45.	September 7, 1985, Gloria	

18 X

Wetlands are an important part of the coastal unit. We know that tidal marshes have numerous practical functions, such as filtering impurities from the water and acting as sinks for sediments and heavy metals. They are biologically very productive, and can aid in absorbing impinging energy during storm events. Historically, however, these wetland areas were considered to be wastelands and were extensively modified. Although it is not possible to determine the exact amount of wetland area that has been destroyed since colonial times, estimates suggest that over half of all coastal marshes in the northeastern United States have been lost during the last 100 years (Gosselink and Baumann, 1980). In New Jersey, about 25% of the total coastal wetland area was destroyed or modified between 1954 and 1973 (Tiner, 1985). Wetland loss can be tied directly to urbanization, which has varied across the state (Table 2). For instance, between 1925 and 1975, approximately 75% of northern New Jersey's tidal wetlands were destroyed or modified while areas to the south recorded losses from under 10% to about 25% (Tiner, 1985). Today many of the remaining marshes are either tidally-restricted and/or highly fragmented. In many cases, urban expansion has encroached on the marshes from all sides and severely limited their areal extent. The urbanized upland border further limits the ability of the marshes to expand laterally during periods of submergence.

Finfish and shellfish industries have always been important in the State. Among the 23 states in the commercial marine fishing industry, New Jersey ranks near the middle in total weight of landings (Gordon,1988). Along the Atlantic Coast, before 1963, New Jersey ranked in the top three. After 1963, New Jersey has ranked between third and seventh along the Atlantic Coast. During the last 50 years, many finfish and shellfish catches have declined due to such factors as overfishing, habitat destruction, diseases, and pollution. For instance, the striped bass and the American shad once spawned extensively in the Delaware River Basin. However, at present the population of striped bass is approaching zero and the American Shad is on the State's threatened species list (NJDEP).

Many industrial centers and recreational facilities are located along the coast of New Jersey (Fig. 7). Power generating stations, including two nuclear power plants, oil refinery, and storage facilities are also common along the coast.

Although it is difficult to assign an exact dollar value to the coastal zone, there are some important factors that must be considered. New Jersey's commercial fishery earned about $447 million in 1987, of which about $300 million were from harvests within three miles of the shore. Estimates suggest that the recreational fishing industry may generate as much as $1.5 billion in expenditures annually (Gordon, 1988). Thus the fishing industry is important to the State's economy.

Table 2. Losses in marsh area between 1953 and 1973 (Tiner, 1985)

County	1953 Marsh Acreage	1973 Marsh Acreage	Marsh Acreage Lost	% Lost
Atlantic	48141	43157	4984	10.4
Bergen	4986	2438	2548	51.1
Burlington	8980	8428	552	6.1
Camden	553	29	257	46.5
Cape May	50204	41921	8283	16.5
Cumberland	54018	43018	11000	20.4
Essex	613	0	613	100.0
Gloucester	7118	3674	3444	48.4
Hudson	4171	1623	2548	61.1
Mercer	796	796	0	0.0
Middlesex	5355	3374	1981	37.0
Monmouth	3811	2021	1790	47.0
Ocean	37007	26078	10929	29.5
Salem	34877	24549	10328	29.6
Union	2420	0	2420	100.0

20X

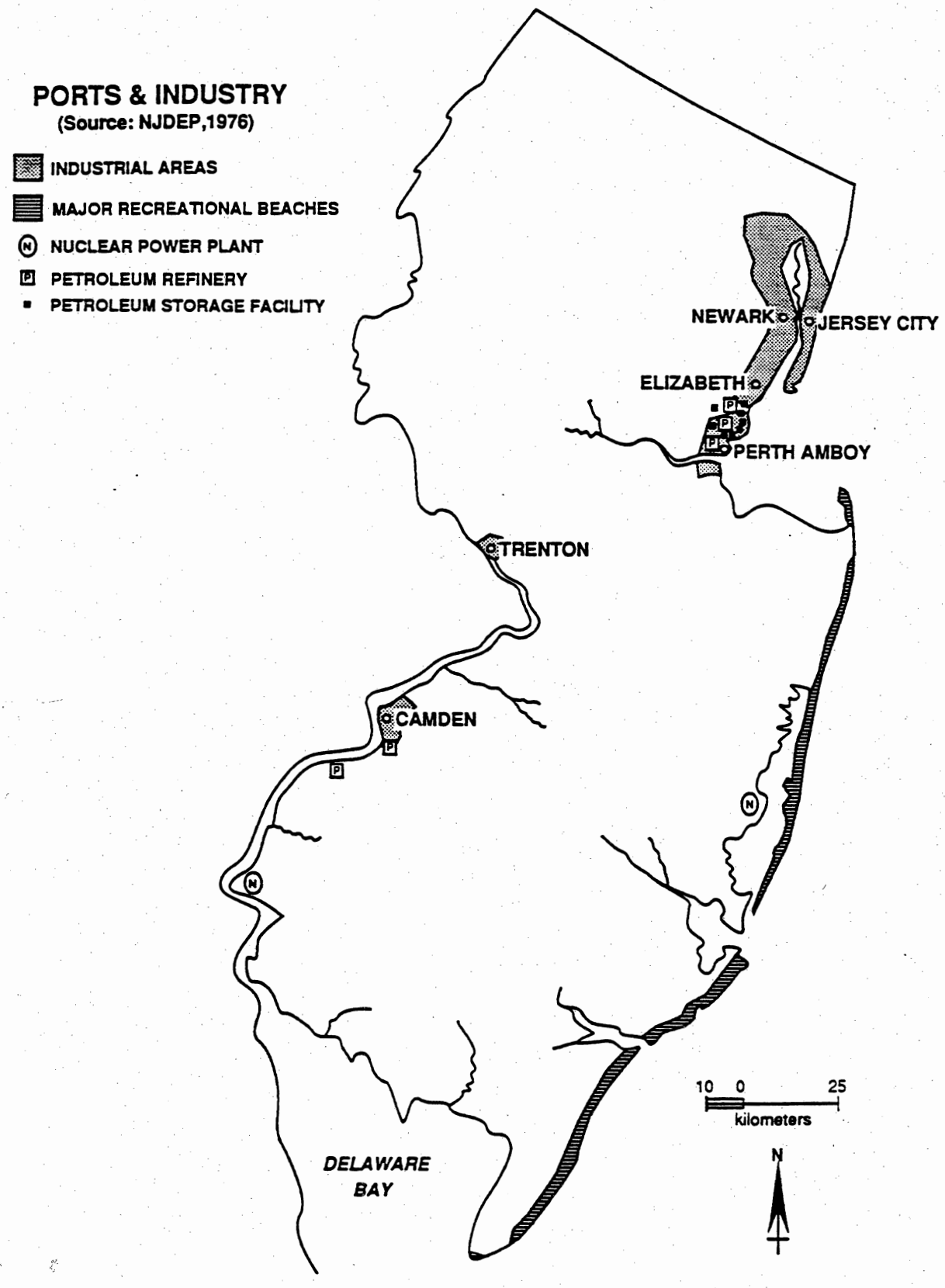

PORTS & INDUSTRY
(Source: NJDEP,1976)
INDUSTRIAL AREAS
MAJOR RECREATIONAL BEACHES
NUCLEAR POWER PLANT
PETROLEUM REFINERY
PETROLEUM STORAGE FACILITY
NEWARK
JERSEY CITY
ELIZABETH
PERTH AMBOY
TRENTON
CAMDEN
DELAWARE BAY
10 0 25
kilometers
N

Figure 7

21X

One of New Jersey's largest industries is tourism, generating over $13 billion per year in expenditures (Bodman,1988). This industry is concentrated along the 127 miles of beach located along the Atlantic barrier chain between Sandy Hook and Cape May. Between May and September, 1987, four shore counties (Ocean, Monmouth, Atlantic and Cape May) took in over half the total tourist dollars generated throughout the entire state, $7.7 billion (Bodman, 1988). Because of this economic importance, real estate becomes an important asset to many communities (an acre of land in Atlantic City can sell for more than $500,000) and can drive protective responses to a rising sea level.

IMPACTS ON THE COASTAL ZONE

It has been estimated that by the year 2100 sea level along the continental United States will rise between 50 cm and 350 cm (Hoffman, et al., 1986; Thomas, 1986). For purposes of this report, three working estimates will be utilized: (1) a low scenario in which sea level rises 50 cm, (2) a moderate scenario where the seal level rises 100 cm, and (3) a high scenario with increases of 200 cm or more.

Theoretically, as sea level rises the coastal unit, consisting of beaches, lagoons, marshes, tidal flats, and upland transition forests, will be displaced landward. In undeveloped areas, this displacement may cause the inland migration of all elements of the coastal system, depending on the rate of rise. Along developed coastlines, however, the potential migration of the coastal unit is limited and many features along the leading edge are unable to transgress, thus many upland transition forests and salt marshes can be lost. As sea level rises and the coastal unit is spatially restricted, losses will increase until the unit is all but destroyed.

The loss of coastal habitats is difficult to assess. Interactions between all parts of the coastal unit are necessary if the coastal zone is to remain a healthy and diversified area. For instance, the entire shellfish and recreational finfish industry and two-thirds of the commercial fishes are dependent on salt marshes and estuaries for their development (McHugh, 1966). If this habitat is lost, there will be major declines in fish catches over time.

Nationally, cost estimates for protecting developed areas along the coast could run as high as $73 to $111 billion (Smith and Tirpak, 1988). The cost of protecting the nation's barrier beaches could reach $50 to $75 billion (Smith and Tirpak, 1988). In New Jersey the cost for beach repair ranges from $902 million for the low scenario to $3.4 billion for the 200 cm scenario (Titus, 1988).

22X

Responsibility for protection of the coast lies with a variety of federal, state, and local agencies. Laws and regulations that protect the coast include but are not limited to the following (Dovey and Fowler, 1988):

Federal
Coastal Zone Management Act (1972)
Clean Water Act (1977)
National Flood Insurance Act (1968)
State
Coastal Area Facility Review Act (1973)
Wetlands Act (1970)
Freshwater Wetlands Protection Act (1987)
Municipal
zoning ordinances
master plans

An important aspect of sea level rise on coastal communities will be the availability of freshwater in the groundwater aquifers (McCann, 1988). In coastal New Jersey much of the water supply comes from the Potomac-Raritan-Magothy aquifer system which is recharged with freshwater along the Delaware River near Philadelphia/Camden. In times of drought, the salt wedge moves up the estuary and eventually reaches the areas of recharge, causing an increased salinity in the groundwater. This situation may be considered to be an analogue for the effects of a rising sea level which could cause salinity contamination of a major groundwater resource. A major difference between the drought analogue and sea-level rise is that when the drought ends the aquifer is slowly flushed and the effects of the drought are diminished. However, a rising sea level will not reverse itself and the aquifer will not have the opportunity to reduce salt concentrations. Thus, a rising sea level will cause an increase in the occurrences of salt water penetration up the Delaware River and the intrusion of higher salinities into the recharge area of the coastal aquifer.

CASE STUDIES

To best describe the impacts a rising sea level will have on the coastal zone of New Jersey, representative case studies are presented. These case studies are examples of major coastal situations found throughout the State. The information being presented for each case study can be applied to other areas with similar features. Impact scenarios in following sections have used the flood prone area maps and the topographic maps of the locations to determine slope conditions and the areal measurements of flooding. This methodology assumes no structural changes because of dikes, walls, or other barriers that might restrict the areal extent of flooding. The estimates, therefore, may be viewed as the magnitude of change under a no-action response to particular sea-level rise scenarios.

23X

Accompanying each study is a generalized table of sea level impacts for quick assessments of the different coastal features.

LOWER PASSAIC RIVER BASIN and HACKENSACK MEADOWLANDS

The lower Passaic and Hackensack Rivers (Fig. 1) represent moderate-sized river systems flowing through highly urbanized watersheds. This is one of the most economically-productive industrial areas in New Jersey. Along the Passaic River flood plain, development has eliminated most of the natural features once located there. much of the river itself is channelized and water flow is contained within specific boundaries. The Hackensack Meadowlands are located along the Hackensack River and contain the most extensive expanse of estuarine marsh remaining in northern New Jersey. Considered a wasteland by early developers, the Meadowlands have been diked, dammed, ditched and filled for urban development. Newark International Airport, a large sports facility, and many major transportation arteries pass through the Meadowlands District.

The population in this area is still growing and is expected to reach 3.6 million by the year 2020, representing about a third of the total population for the State (USACOE, 1968)(Fig. 8). Employment and industrial output are also increasing at a high rate making this area of New Jersey important to the State's future economic base.

Because these systems are highly urbanized, flooding will become the most important impact as sea level rises. The Passaic River Basin has a long history of flooding (Table 3) and flood control efforts. Its average annual flood damage has been cited at $13,000,000; the bulk of which occurs in the lower valley region.

The most severe flood of recent history occurred in September 1971, when Hurricane Heidi passed 48 (km 30 miles) offshore. Record peak flows were estimated at 106.754 m^3/sec (3,770 cfs) in the lower Passaic River Basin and 69.09 m^3/sec (2,440 cfs) in the lower Hackensack River Basin where the effects of urbanization are greatest (Stankowski, 1972). It has been estimated that a recurrence of the largest flood ever recorded (the 1903 flood) would inundate 140 km^2 (35,000 acres) of urbanized flood plain lowlands affecting over half the population in the area and most major industrial sites.

Utilizing flood prone area maps and topographic profiles, it is predicted that the results of a 50 cm rise in sea level would flood an additional 10% of the land surrounding the Passaic River. Flooding in the Hackensack Meadowlands could reach 25% under the same scenario. Under the high rise scenario, 40% of the lower Passaic River valley and 90% of the Meadowlands could be flooded.

24X

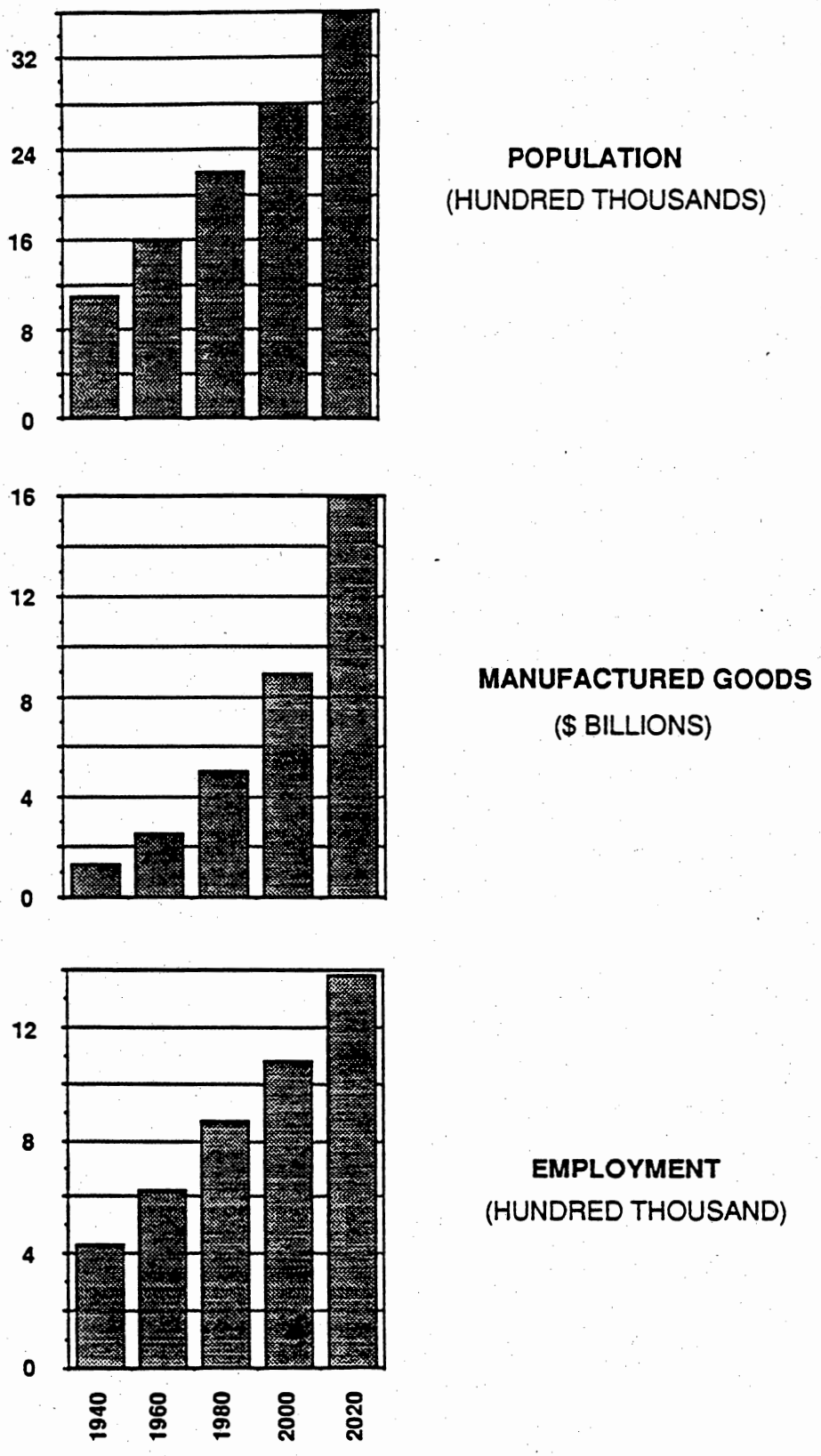


Figure 8. Estimates of growth for the Passaic River Valley (USACOE, 1986)

25X

Table 3. Historical floods in the Passaic River (USACOE, 1968)

Flood at Paterson	Oct. 1903	July 1945	Mar 1936	Aug.&Oct. 1955	May 1968
Discharges (CFS)	34000	19500	19200	11600	13200
Frequency (years)	166	33	29	5	7

AREAS INUNDATED BY LARGEST FLOOD OF RECORD

Locality	Maximum Depth (Feet)	Area Inundated (Acres)	Swamp Area Included (Acres)
Mouth to Dundee Dam	14.5	1520	
Dundee Dam to Great Falls	9.9	846	
Great Falls to Little Falls	10.2	761	
Little Falls to Two Bridges	11.1	1564	538
Two Bridges to Chatham	14.2	16100	11240
Above Chatham	12.0	11000	6500
Two Bridges to Pompton Lakes	14.5	3200	1022
Total Valley		35000	19300

POTENTIAL RECURRING DAMAGES UNDER PRESENT CONDITIONS IN MILLIONS OF DOLLARS AND PERCENTAGE OF TOTAL

Floods	Oct. 1903	July 1945	Mar. 1936	Aug.&Oct. 1955	May 1968
LOWER VALLEY	233.0 (86%)	60.0 (82%)	37.0 (79%)	0.7 (33%)	3.9 (16%)
CENTRAL BASIN	37.0 (13%)	12.5 (17%)	9.4 (20%)	1.2 (57%)	15.5 (64%)
HIGHLAND REGION	1.0 (1%)	0.5 (1%)	0.6 (1%)	0.2 (10%)	4.7 (20%)
TOTAL	271.0 (100%)	73.0 (100%)	47.0 (100%)	2.1 (100%)	24.1 (100%)

26X

A vital part of this region is the extensive transportation network that extends throughout the area. This network is not only important economically but also represents major evacuation routes should the need arise. At present. highway flooding is common during major storms and many rail systems experience interruptions in service. Under the low scenario changes to these systems would be minimal. However, under high sea level conditions, roadways, rail lines, and airports could all experience flood related problems.

Under the high scenario, subway systems could be effected by seepage and flooding. The increased water pressure would place additional loadings on tunnels and other submarine structures. Newark Airport may require extensive diking and pumping stations to maintain proper drainage, especially during storms. Roadways would require extensive drainage systems and many bridges and overpasses would have to be raised (Brail, 1988).

27X

SUMMARY OF EFFECTS OF SEA LEVEL RISE;
PASSAIC RIVER BASIN AND HACKENSACK MEADOWLANDS

INCREASE IN MEAN SEA LEVEL	EXPECTED EFFECTS
50 cm	--increased urban flooding by 10% to 15% --flood damage expenditures increase --major transportation lines effected during major storms --little loss of natural features as area is already highly developed --backup of sewer discharge
100 cm	--urban flooding common during most storms --urban flooding increases by 20% to 25% --major transportation hindrances on PATH, highways and airport; loadings on tunnels increased --Port facilities will have to raise docks and waterfront surfaces --some sewer lines require pumping --pumping of low lying areas will be required --increased frequency of bridge openings
200 cm	--urban flooding could increase by 40% --additional loading on tunnels and submarine structures --tunnels strained, airport diked --longer storm retention time increases damage --90% of Meadowlands are flooded and 30% could become open water habitat --sewer lines/drainage systems require pumping --diking will be necessary along low lying areas --increased frequency of bridge openings

28X

SANDY HOOK and HIGHLANDS

The Sandy Hook-Highlands (Fig. 1) area represents a low-lying barrier island spit (Sandy Hook) and a barrier-protected upland (Highlands) area utilized extensively for recreation but only moderately developed.

Sandy Hook is part of the Gateway National Recreation Area and is administered by the National Park Service. Many of the natural features of this coastal resource have been preserved and/or restored. Ecologically, Sandy Hook provides habitat for numerous species of wildlife, including the endangered osprey. A long established holly forest located in the central portion of the spit is protected behind sand dunes.

Sandy Hook was originally a barrier island, created when sea level was much lower. It migrated shoreward as sea level rose and has probably been attached to the mainland at times and detached at other times. The spit extended northward by the addition of sediment transported by waves and longshore currents. The southern connection at Long Branch, which provides the only direct road access to the spit, has a history of dynamism and is at present stabilized by a stone seawall. The narrow beaches along the seawall and northward into the Park have been identified as a critical hazard zone (Nordstrom, et al. 1986) (Figs. 9a,b). In recent years storms have flooded the area beyond the wall and caused severe infrastructural damage There is little beach for storm protection along this zone due to the seawall and the groins which prevent the alongshore drift of sediment. A number of beach nourishment projects in this vicinity have met with variable success. In addition to being sand-starved, continental subsidence and sea level rise have further served to render this area vulnerable. This area displays classic symptoms of long-term sea level rise along a culturally manipulated coastline. In many areas the beach has disappeared and the seawall is the only barrier between the ocean and the land. Small storms cause flooding and damage to the surrounding communities as well as to the basic structure of the wall itself.

Farther north as the spit widens, areas of both accretion (Sandy Hook Point) and erosion (segment 5 in Fig. 9b) exist. However, because of the lack of development the latter is not considered to be hazardous. Maximum dune dimensions in this zone have been estimated at 5.0 ft in height and 250 ft in width. Natural vegetation stabilizes the dunes and aids in limiting erosion. Because it is not restricted by development and is able to respond morphologically to changing ocean conditions this northern area will be altered but not likely destroyed by a rise in sea level.

30X

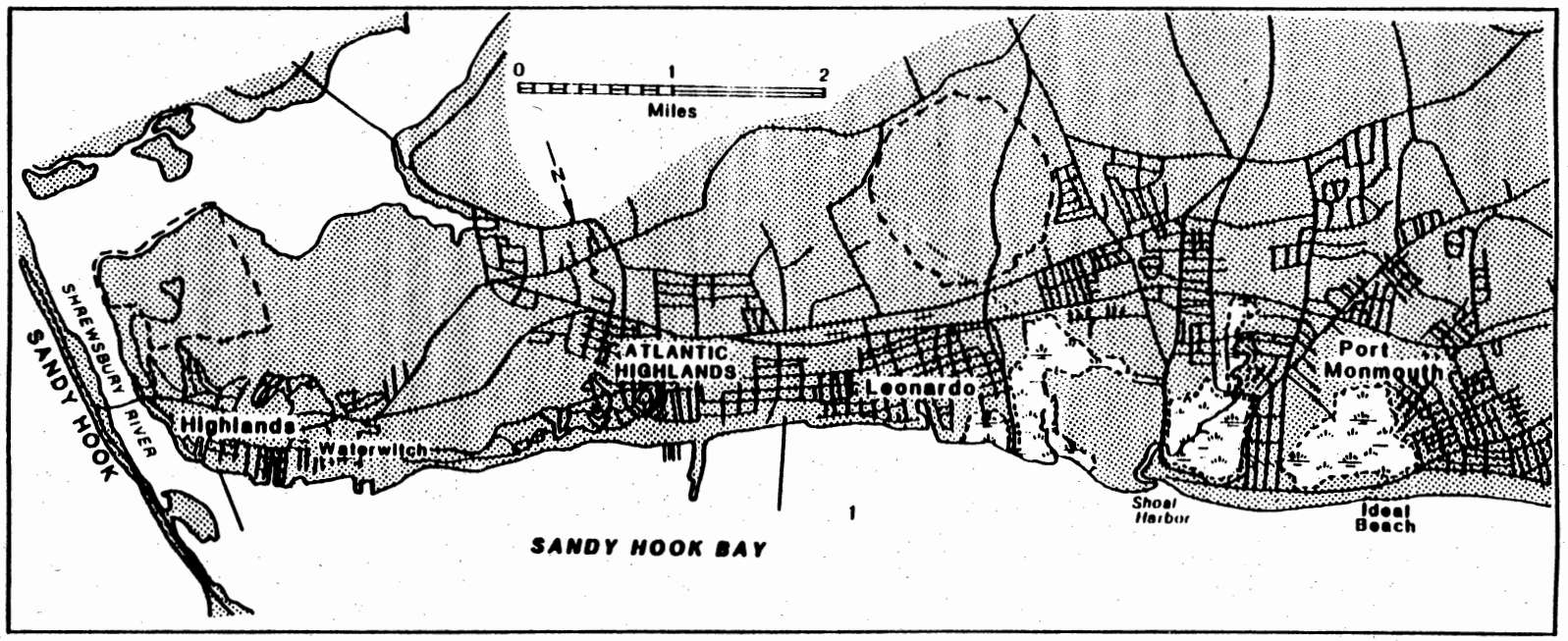


Figure 9a. Sandy Hook and Highlands, (Nordstrom, et al. 1986)

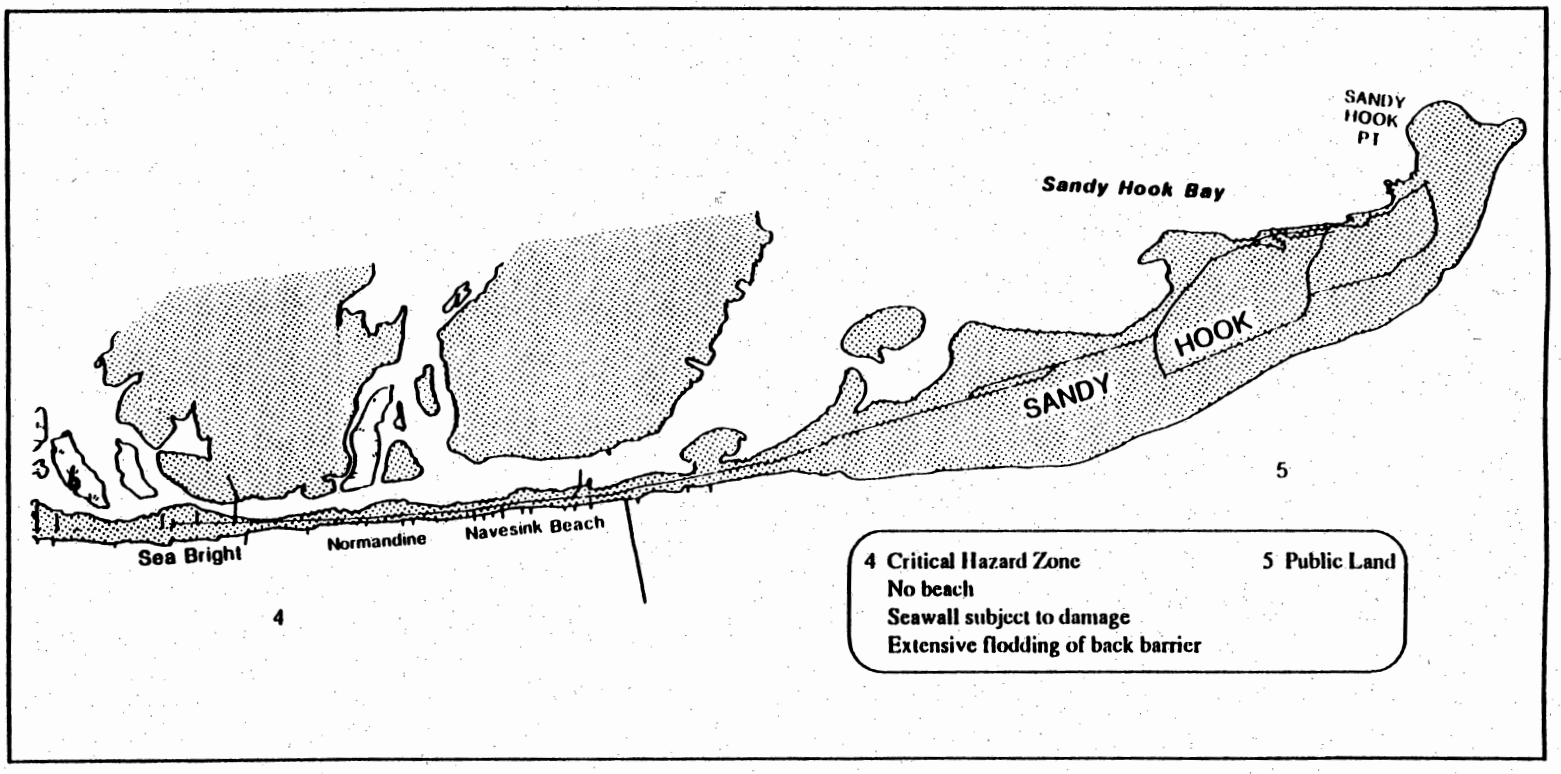


Figure 9b. Critical erosion zones for Sandy Hook, (Nordstrom, et al. 1986)

As sea level rises, the beach width will narrow. erosion will increase, and inlet breaching will begin. Under the high scenario the spit could break away from the barrier chain and migrate towards Raritan Bay. This would result in a reduction in island size and the loss of marshes and holly forest.

The southern portion of Sandy Hook spit will also be impacted as sea level rises. Under the low scenario the spit will erode and narrow, eventually allowing the formation of inlets. Under the high scenario the seawall would most probably collapse and flooding would increase on the mainland side of the spit. Sands from the beach would be redistributed and form new smaller spits at the margins of the promontory. The Highlands would be exposed to the sea and access to Sandy Hook would be by boat or bridge.

Behind the Sandy Hook-Sea Bright barrier island lies the Highlands (Fig. 9). This formation consists of consolidated and partly consolidated sandstone deposits which are relatively resistant to erosion. Figure 10 shows the topography of the region which at a maximum is over 240 ft (73 m) above sea level. The economy of the area is dominated by tourism, fishing, and water-based recreation. A relatively large residential population is concentrated in the lower-lying regions, along the slopes and streams, and a U.S. Army reserve installation occupies a portion of the eastern upland. Along the Shrewsbury River, which separates the Highlands from the barrier beach, are many recreational and commercial piers. Storm vulnerability is low in the Highlands due to protection by the remaining barrier island and slope of the topography. Marsh area is still present along the Navesink River and areas west of Sandy Hook Bay.

Under the low scenario the Highlands will be little effected. Under the high scenario the Highlands themselves will be eroding along the base of the cliffs. However, overall effects will still be minimal. The areas surrounding the Highlands will be greatly impacted under the high scenario. Flooding will be extensive along the Bay borders and along the Navesink River and Many Mind Creek.

32X

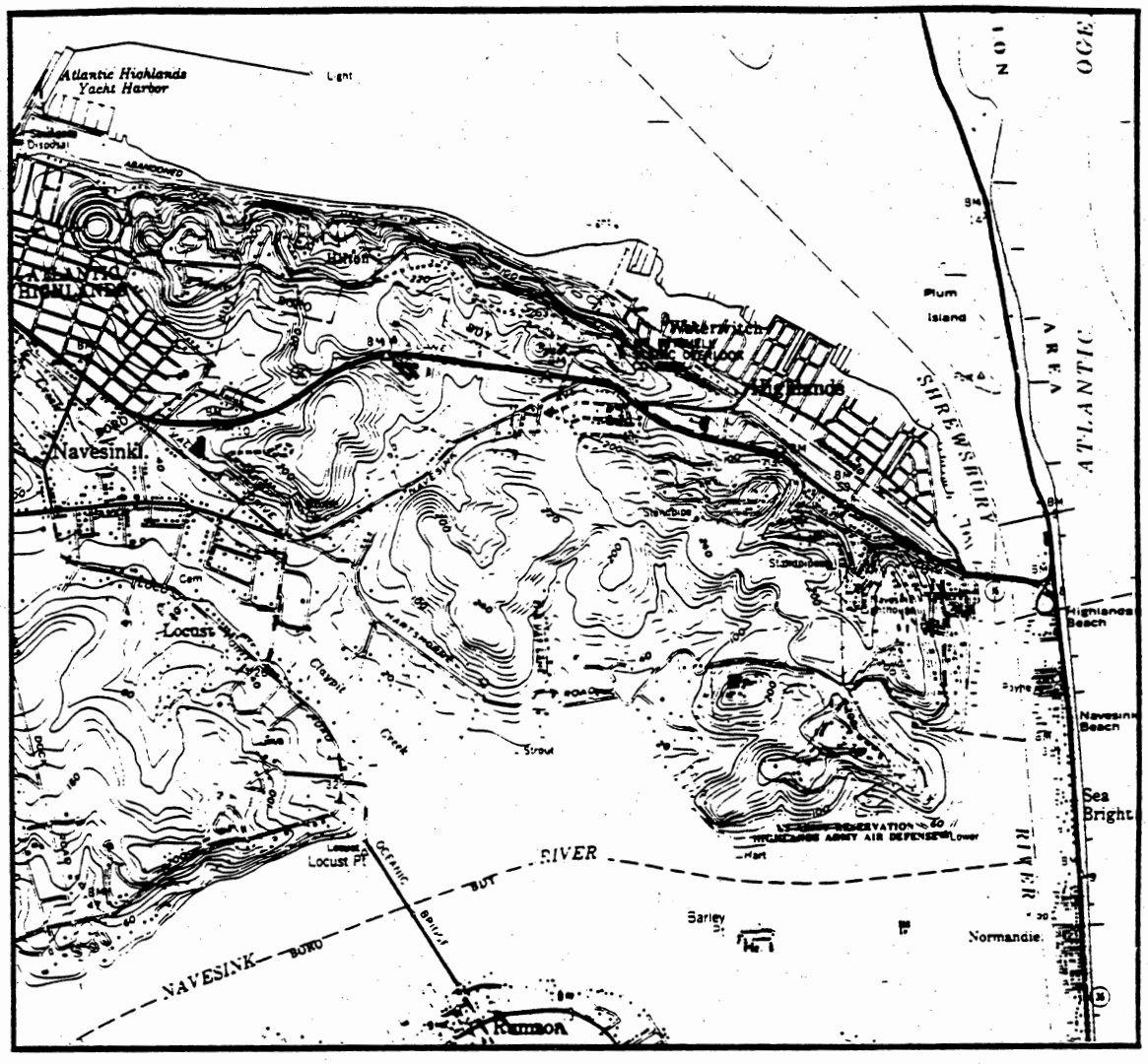


Figure 10. Map of Sandy Hook and Highlands showing topography and relief

33X

SUMMARY OF EFFECTS OF SEA LEVEL RISE;
SANDY HOOK AND HIGHLANDS

INCREASE IN MEAN SEA LEVEL	EXPECTED EFFECTS
50 cm	--reduced beach width on spit --extensive inlet breaching --increase erosion at present sea wall --access to Sandy Hook limited --Highlands remain intact --erosion of shoreline could reach 100 ft (30.5 m)
100 cm	--barrier seawall overtopped by storm surge --beach becomes segmented as erosion increases and access roads must be upgraded --loss of bay habitat, marshes, and fish nursery grounds --mainland begins to erode
200 cm	--ribbon beaches if any against mainland --open water surrounds spit --much erosion against base of hills --increased flooding along bay front and stream channels

34X

GREAT BAY-LITTLE EGG HARBOR

Great Bay and Little Egg Harbor (Fig. 1) are part of an extensive and relatively pristine salt marsh-estuarine system. Great Bay has direct marine influence from the Atlantic Ocean and is fed freshwater from the Mullica River. The river's salt wedge reaches to the vicinity of Hog Island, and the brackish waters downstream are excellent oyster breeding grounds. Little Egg Harbor at Tuckerton has only a few small freshwater streams and is semi-protected by the Long Beach Island barrier. There is tidal exchange between Little Egg Harbor and Great Bay through numerous channels. The estuary is heavily utilized for water-based recreation; e.g, boating, fin- and shell-fishing. Tourists are also attracted by the variety of resident and migratory water birds which occupy the marsh habitat.

The salt marsh intertidal zone is dominated by both tall and short form Spartina alterniflora. Spartina patens is the dominant plant in the high marsh and species such as Phragmites australis, occur in the transitional zones. Tidal mudflats occur in parts of are common throughout the Bay and are important to the productivity of benthic organisms which serve as a major food source for many larger commercially important fish species.

A recent study conducted by the U.S. Department of Environmental Protection (Titus, 1988) examined the effects of rising sea level on the salt marsh vegetation occurring in marshes at Tuckerton, N.J. (Fig. 11). Three sea level rise scenarios were projected for the year 2075: baseline (present conditions), low (+87.2 cm (2.9 ft)), and high (+163.4 cm (5.36 ft)). Results are shown in Table 4 and Figs. 12a and 12b. The study assumed that under baseline conditions, the marsh sedimentation rate exceeds that of sea level rise, allowing it to continually transgress and maintain its spatial extent (this assumption may not be a realistic representation of this system. Psuty (1986) suggested that this area is presently in a period of sediment deficit). Under the low-rise scenario (+87.2 cm (2.9 ft)), it was estimated that 90 percent of the high marsh would be replaced by low marsh as surface elevations are out-paced by sea level rise. Under the high-rise scenario, 85 percent of the marsh would convert to open water habitat as sea level rise overwhelms surface accretionary processes.

These scenarios were developed under the assumption that marshes would be able to migrate inland as sea level rises. In the future, however, ongoing residential development may limit the extent of migration and cause the loss of marsh habitat entirely. The consequences to both the recreational and commercial fishing industry in New Jersey are obvious; productivity and revenue will decline (Gordon, 1988). At the low-rise scenario the commercial fishing industry could lose as much as $15 million annually due to marsh degradation in

35X

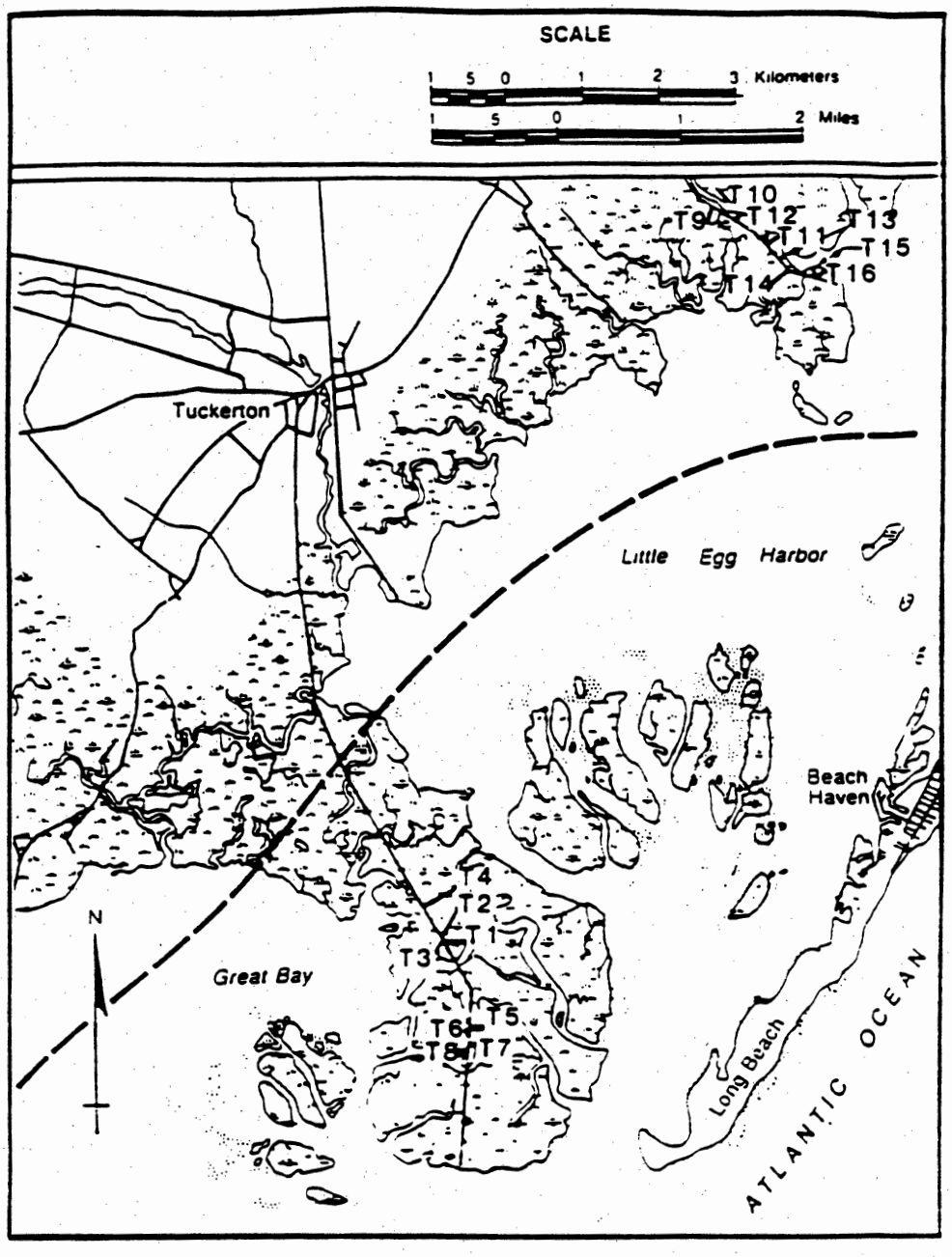


Figure 11. Area of study for sea level rise impact modeling (Titus 1988)

36X

Table 4. Results of sea-level impact modeling study (Titus, 1988)

SEA LEVEL RISE SCENARIOS TO THE YEAR 2075

Scenario	Sea Level Rise by 2075	Average Annual Rise
Baseline	+26.6 cm (0.87 ft)	2.8 mm
Low	+87.2 cm (2.36 ft)	9.2 mm
High	+163.4 cm (5.36 ft)	17.2 mm

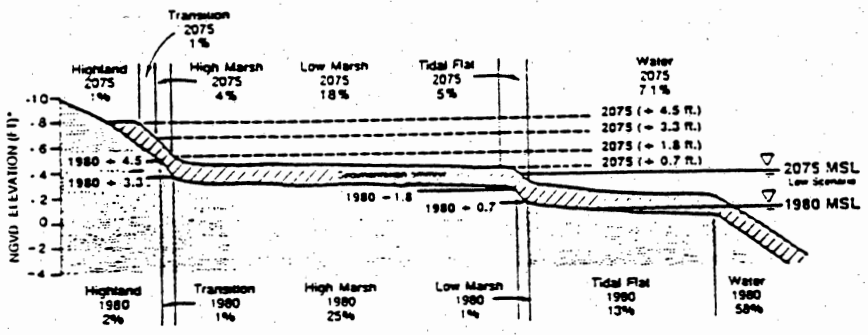
NET CHANGES IN ACRES (AND PERCENTAGE) BETWEEN 1980 AND 2075 FOR PRINCIPAL ZONES UNDER VARIOUS SCENARIOS, ASSUMING 5MM/YR SEDIMENTATION RATE

GREAT BAY BOULEVARD MARSH (TIDAL RANGE = 96.9 CM [3.18 FT])

Highland	+200	(67)	-100	(33)	-270	(90)
Transition	+1800	(900)	0	(0)	-170	(85)
High Marsh	-1900	(41)	-3900	(85)	-4570	(99)
Low Marsh	+1300	(650)	+3100	(1550)	0	(0)
Tidal Flats	0	(0)	-1500	(63)	-2200	(92)
Water	-1400	(13)	+2400	(23)	+7200	(68)

37X

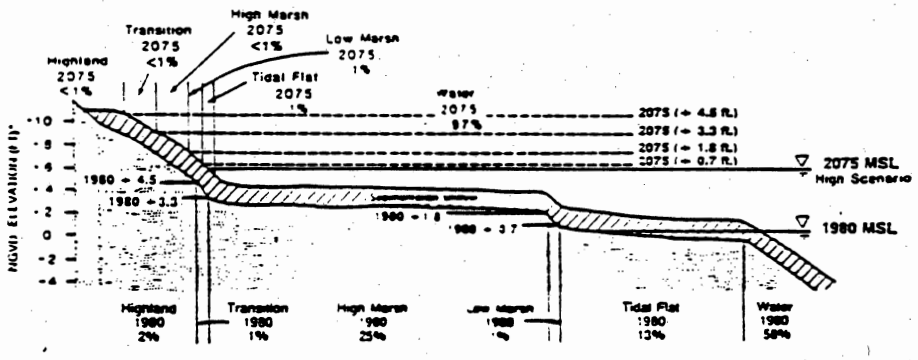
CONCEPTUAL MODEL OF A LOW-SCENARIO SEA LEVEL RISE IN THE GREAT BAY BOULEVARD MARSH (Tidal Range=3.18 ft)



*Axis on left shows NGVD elevation: spot elevations are relative to 1980 or 2075 mean sea level.

Figure 12 a. Model of the effects of a low sea-level rise scenario on the marshes at Great Bay, New Jersey (Titus, 1988).

CONCEPTUAL MODEL OF A HIGH-SCENARIO SEA LEVEL RISE IN THE GREAT BAY BOULEVARD MARSH (Tidal Range=3.18 ft)



*Axis on left shows NGVD elevation: spot elevations are relative to 1980 or 2075 mean sea level.

Figure 12b. Model of the effects of a high sea-level rise scenario on the marshes at Great Bay. New Jersey (Titus. 1988).

38X

the area. Under the high-rise scenario these losses could range between $20 and $30 million annually. Estimates for New Jersey's recreational fishing industry range about $1.5 billion annually, much of which is contributed by communities located in Monmouth, Ocean, Atlantic and Cape May counties. Although dollar estimates for recreational fishing in Great Bay are unavailable, it is one of the most popular fishing spots in the State and its loss could adversely effect the income of the area as well as the industry in general.

The adjacent upland areas would also be substantially impacted. Among the changes would be a general intrusion of saltwater into the groundwater zone and contamination at the local level. A related change would occur as local ground water levels are elevated and septic systems become inundated. This would lead to another form of ground water contamination.

SUMMARY OF EFFECTS OF SEA LEVEL RISE;
GREAT BAY-LITTLE EGG HARBOR

INCREASE IN MEAN SEA LEVEL	EXPECTED EFFECTS
50 cm	--10% loss in marsh and change to low marsh plants --salt water intrusion up Mullica beyond Hog Island --shellfish beds decline --systems altered to more open water and displaced --minor loss in fishing industry
100 cm	--marsh losses about 80% --shrinking biological community --flooding common along adjacent uplands --much more open water --losses of habitat affect fishing industry --septic tank systems encroached upon by raising water table
200 cm	--marsh loss over 95% and limited to upland fringe --most of bay now open water --major loss of fish and shellfish population --reduction of recreational fisheries --salt water influences an additional 20% of the Mullica Basin --residential developments experience increased flooding --elevated water tables polluted by septic fields

40X

ATLANTIC CITY

Atlantic City (Fig. 1) is an example of a densely populated, highly-developed barrier island. It encompasses a little under 12 square miles of the northern portion of Absecon Island in Atlantic County (Fig. 13). The city supports an estimated permanent population of 36,219 and a high peak summer population of 683,596 and is the most highly-developed of all of New Jersey's barrier beach municipalities (Bureau of Govt. Research 1988).

The northern margin of Absecon Island is protected by stone jetties and riprap and the beach is protected by a wooden bulkhead. Beach nourishment is used to maintain the beach width and for further protection from storm damage. Beyond the main commercial and residential sections, beach protection is minimal and the shorefront property in those areas remains relatively unprotected.

Since the 1800's, Atlantic City has been a popular seaside resort and has traditionally built close to the water. By 1878, nearly all natural dunes had been destroyed for commercial development including the famous Atlantic City Boardwalk. Numerous storms, including severe winter northeasters and hurricanes, have struck the City. The Boardwalk has been destroyed or partly destroyed a number of times. In September 1903, a hurricane hit the area killing 7 people and resulted in $30,000 (1903 dollars) in damage, including the destruction of a major railroad line. Another September hurricane passed 48 km (30 miles) offshore in 1944 and raged for 6 hrs. At the Steel Pier, storm surge was recorded at 2.3 m (7.6 ft) above mean sea level. Damages were estimated at $5 million (1944). The last and one of the worst storms to strike Atlantic City occurred in March of 1962. A northeaster that combined with high spring tides resulted in two days of unusually high water which flooded the Inlet section of the city and exposed most of the shoreline to large waves. Several people were killed, 1200 ft of Boardwalk were destroyed and an estimated $16 million (1962) damage was done.

In 1976 the city obtained licenses for legalized gambling, and by 1988 eleven high-rise casinos had been constructed (all but three were built along the Boardwalk). By 1987, annual revenues generated by the casino industry were about $3.0 billion, a factor which contributed significantly to a rise in employment for New Jersey residents in the area. Thus, this area is now one of the primary economic zones in the State.

About 70% of New Jersey's federal flood insurance is allocated to coastal communities. Of this total, 25% is allocated for Absecon Island. This amounts to about $1.2 billion which is only about one-quarter of the total value of the six

41X

Figure 13. Map of Atlantic City, New Jersey

42X

local municipalities. The percentage of exposed risk areas without insurance guarantees ranges between 38% for Brigantine to 97% for Atlantic City.

The situation at Atlantic City is already precarious and rising sea level can only increase shore protection expenditures and damages sustained under storm conditions (NJDEP 1985). Between 1960 and 1984, over $17 million were spent on shore protection for the area. Between 1984 and the present an average of about $5 million has been spent annually to maintain shore protection. In 1985, $7.5 million was spent on beachfill alone.

The National Flood Insurance Program uses 100-yr frequency flood or storm surge standards to assess flood hazard zones. It has been projected that under conditions of a 100-yr storm with a 2.9 m (9.5 ft) storm surge, nearly the entire island would be covered with water. Safe zones in a vulnerable area are generally designated for emergency housing at higher than 3.05 m (10 ft) above mean sea level. Atlantic City has two such areas, however, they are so close to the shorefront and subject to surge that they should not used as safe zones. There are three direct escape routes from Atlantic City (Fig. 14). However, a 1984 assessment noted a number of factors which render them less than satisfactory in the event of an emergency (Mitchell, 1984). An approaching hurricane can cause low lying roads to flood two to five hours before its arrival and warnings for evacuation can be hampered by the unpredictable nature of these storms. The lowest elevation on the Black Horse Pike is about 1.52 m (5.0 ft) above MSL. White Horse Pike traverses a low-lying marsh zone. Flooding of access roads to the Atlantic City Expressway, which itself is not as vulnerable to flooding because its lowest elevation is 2.74 m (9.0 ft) above MSL, is of additional concern. The tremendous summertime population could lead to a disaster as the people attempt to flee the island on these limited access roads (Division of Water Resources, 1983).

Given that the beachfront block of the casino district has been assessed at $170 million and the casino industry generates $3.0 billion per year, it would be difficult to convince the casino owners to abandon the island. Officials have met with some difficulty in convincing residents to evacuate prior to storm events. Casinos have developed storm warning and sanctuary plans which are geared toward letting the people play as long as possible. However, (Mitchell, 1984) suggested that even with optimal routing and scheduling plans it would take 7 to 14 hours to evacuate Atlantic City. The National Hurricane Center can only give a 12 hour warning period before the approach of a storm. Since storm surges can precede the hurricane by as much as 5 hours and Mitchell's plan does not include early road closings, the potential for loss of life in these areas increases greatly. Under the low scenario, these pressures will be felt dramatically. Under the high scenario, evacuation of Atlantic City would be almost impossible to achieve.

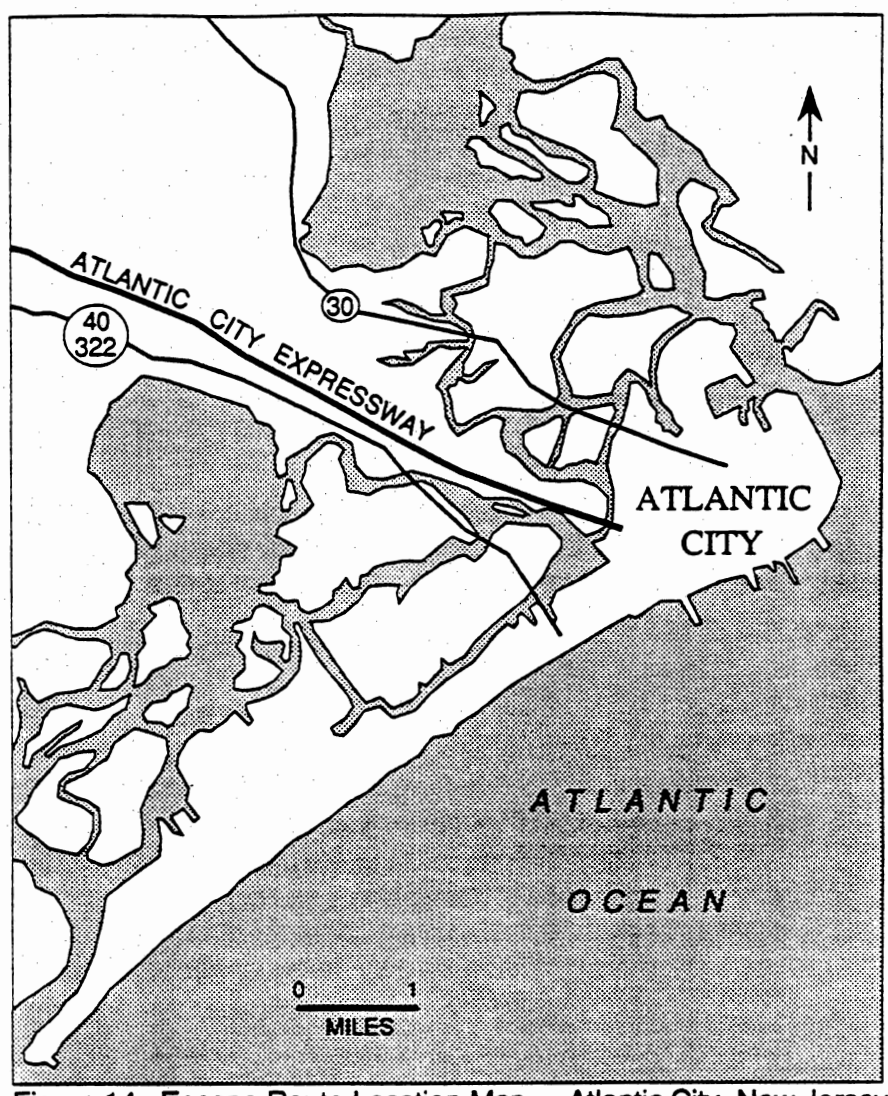


Figure 14. Escape Route Location Map - Atlantic City, New Jersey

44X

SUMMARY OF EFFECTS OF SEA LEVEL RISE;
ATLANTIC CITY

INCREASE IN MEAN SEA LEVEL	EXPECTED EFFECTS
50 cm	--shoreline retreats over 20 ft. --additional shore protection costs over $5 million annually --major evacuation routes submerged at high water --no change to casino industry --evacuation would take at least 7 to 14 hours
100 cm	--erosion of shoreline over 45 ft --shoreline protection could reach $8 to $10 million --increase of damage to Boardwalk --major overland evacuation routes flooded at peak surge --evacuation takes over 14 hours at best --beach losses are significant
200 cm	--erosion of shoreline about 100 ft --island width decreases, area subject to increased hurricane damages --island may have to be diked --casino industry remains unaffected --freshwater difficult to obtain due to brackish intrusion into aquifer

45X

TRENTON

Trenton, the state capitol of New Jersey, is located just below the fall line of the Delaware River (Fig. 15). It is an example of a highly urbanized area along a major river system. The tidal range here is nearly twice that at the mouth 1.8 m (6.0 ft) vs. 1.0 m (3.3 ft) due to basin morphology and river channelization. Many important industries are located on the river's edge including electrical power plants, oil refineries, and food processing plants. Due to the dense population, 500-13,000 inh/km^2 (200-5000 inh/mi^2), sewage treatment and water supply facilities are extensive.

At Trenton, urbanization extends to the waters edge where railroads and major highways parallel the riverside and traverse the flood plain. However, the Delaware shore is not as developed as it once was. In 1955, a major storm and flood occurred at Trenton reaching a peak elevation of 8.7 m (28.6 ft) above sea level; the highest ever recorded there. Additionally, water from the Delaware-Raritan Canal was reported to have overflowed causing damage inland. (Table 5). Following this disaster, a number of Trenton's industries moved to the suburbs. Many commercial and state government buildings were flood-proofed and urban redevelopment provided more open space on the riverside. Whereas industry accounted for a large percent of jobs in a prosperous Trenton prior to 1955, today 1/3 of the population is employed by the State; the remaining population is largely low-income and unemployed (Council on Environmental Quality, 1975).

In 1971, Trenton became eligible for the National Flood Insurance program and under its guidelines the city has in large part retreated from the Delaware flood plain. Therefore, the Delaware river is not so great a threat to life and structures during a moderate sea level rise regime, although a number of archeological and historic sites would be lost. The tributaries, along which a number of industries have settled, however, have become prone to flash flooding due to the impermeability of urban ground cover. In August 1971, the passage of Hurricane Doria flooded the Assunpink which showed a peak discharge of 111 m^3/sec (3,920 cfs) and a peak flood elevation of 3.32 m (10.9 ft). Severe damage was sustained throughout the watershed and industrial damage in Trenton was estimated at over $5 million (USGS, 1979; Burt and Eisel, 1973).

Under the low sea level rise scenario, urban flooding would increase by about 10%. Under the high rise scenario urban flooding could increase by about 40% and reach many of the areas once thought to be safe. Under the high scenario as much as 50% of the areas industrial centers would be directly affected.

46X

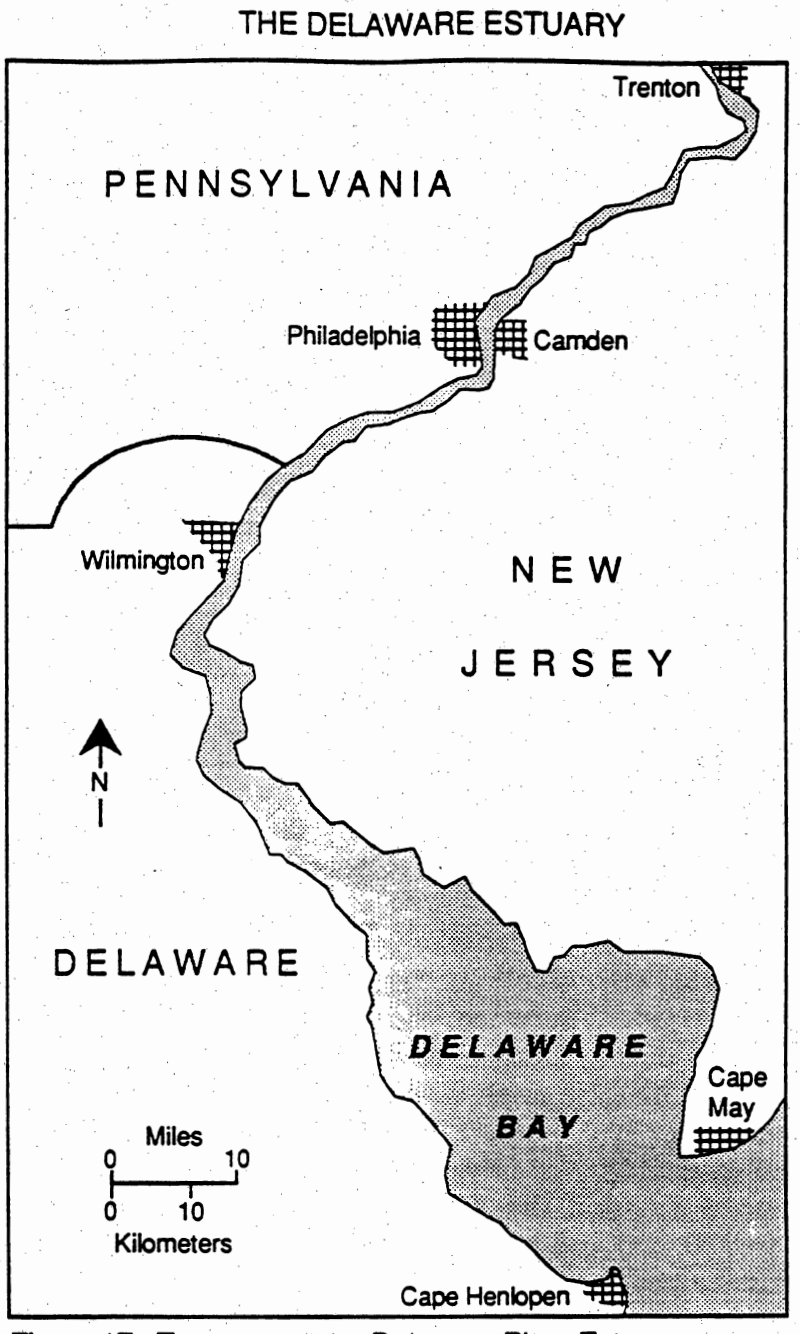


Figure 17. Trenton and the Delaware River Estuary

47X

Table 5. Flood damage at Trenton from the 1955 Hurricane in 1972 dollars (Burt and Eisel, 1973)

	Structures Inundated	Estimated Physical Damage ($1000)
Residential	358	2705
Commercial	46	1110
Industrial	9	467
Total	413	4282

48X

It has been estimated that as of 1972 the market value for structures built along the Delaware River floodplain had reached over $8.5 million at Trenton. Under the low scenario, flood damage would include this entire area. Today, a flood of the magnitude of the 1955 event occurring under the high rise scenario could cost the city of Trenton $50 million in damages.

49X

SUMMARY OF EFFECTS OF SEA LEVEL RISE; TRENTON

INCREASE IN MEAN SEA LEVEL	EXPECTED EFFECTS
50 cm	--increased urban flooding by 10% --flood damage to Trenton floodplain ~ $8.5 million --major transportation lines affected during major storms --port facilities not affected --about 10% of the population affected
100 cm	--urban flooding increases by about 25% --flood damage as much as $20 million --due to channelization of river, flooding increases greater than rates of sea level rise --Port facilities will have to allow docks and waterfront to rise
200 cm	--flooding increases by 40% --sewerage and drainage systems fail, require pumping stations --salt wedge located in the vicinity of Camden --refit docks and port facilities --dike waterfront areas and tributaries

50X

GENERAL IMPACTS

Although, impacts of a rising sea level will vary from site to site there are some general assessments that can be made from the data. One of the primary differences between the low, moderate, and high rise scenarios is the change in quantity of storm events capable of causing wide spread flooding. As the sea level rises the total number of storms capable of causing damage increases exponentially. Under present conditions, wide scale flooding occurs only during major hurricanes or coastal storms (northeasters). Under the low scenario, moderately-sized hurricanes and coastal storms would cause the same amount of flooding. Under the high scenario, flooding would occur during all hurricanes, most coastal storms, and during rainy seasons. Under the high scenario, damage from a small northeaster may be comparable to damage sustained at present during a hurricane minus the wind effects.

A statewide 50 cm increase in sea level may result in losses in marsh area of about 10%. The remaining marshes would be converted from high marsh to low marsh dominated systems, effectively reducing the nutrient flux into the adjoining waters. Under the moderate rise scenario, New Jersey could lose as much as 60% to 80% of its coastal marshes. Under the high rise scenario, losses in wetland area could reach in excess of 95% with marshes forming only along the leading edge of the marine transgression. One of the main problems these marshes will face will be the limits imposed on landward transgressions due to adjacent development along the upland fringe. Because of this factor, many coastal communities could lose 100% of their tidal marsh area.

The loss of marshes will severely impact the fishing industry in New Jersey. Under the high rise scenario annual losses in the commercial and recreational fishing industries could reach over $300 million and $1 billion, respectively. Such losses could impact the economic stability of many coastal communities as well as the entire State.

Changes to the barrier island beaches will be numerous. Erosion will increase and eventually inlet breaching will become more common. Barrier island width will narrow until it reaches a critical minimum dimension which will then cause the unit to migrate landward. In many areas, the beach may not migrate but rather the sands may be redistributed along the coast forming new spits and shoals. Because of the economic importance of many of these barrier beaches, groins and beach nourishment programs will attempt to maintain the integrity of these systems. Many coastal communities will construct seawalls and dikes to further protect their interests. Roads and bridges will have to be upgraded to compensate for the rising water levels and maintain links between the barrier islands and the mainland areas. Expenditures will increase and the fiscal foundation of many coastal communities will be strained.

51X

The costs for protecting the New Jersey coast will range from $904 million under the low scenario to $3.4 billion under the high scenario (Titus, 1988). Even with these expenditures a major storm event will still cause significant flood damage. A flood similar to the one that hit the state in September, 1971, occurring under the high scenario could cause damage in excess of $1 billion across the state.

RESPONSES

Community response to sea-level rise and its attendant effects is varied throughout the state, ranging from serious concern to complete skepticism. The vastness of the issue and the futility of a patchwork response cause the separate communities to look for leadership in the development of an integrated management plan that transcends the spatial individualities. The cost and required cooperation of responding to the threatened impacts will necessitate a statewide planning and management effort to make the most effective use of the financial resources and to integrate the many phases of the response.

REGIONAL RESPONSES

Primarily for the purpose of identifying different types of responses related to coastal situations and level of development, this portion of the report is segmented into several units. However, there is really a broad continuum of natural and human responses. The final portion of the response discussion reviews the areas of responsibility and current actions of most of the institutions and agencies operating in the affected zone.

Urban Riverine Watersheds

Along many urban rivers, bulkheads have been installed to reduce erosion of the banks. Although originally designed to eliminate erosion, these structures may also enhance erosion at their base or in adjacent areas. The channeling of water may also have consequences on the river environment. Since the late 1800's, the tidal range at Trenton has doubled partially due to river channelization.

Understanding that floods are both expensive and inevitable, many cities are now redesigning their waterfront properties to allow for open space. Following the flood of 1955, Trenton re-located industries out of the flood zone and created waterfront parks. Since such an approach is expensive. An option such as this will be limited to areas with a strong economic base.

In urban areas where re-location is restricted, other approaches will have to be found. River diversion efforts have been attempted. However, they have met with only limited success. Levees and dikes have also been utilized with a much greater rate of success. In densely populated areas, dikes may be the preferred response because land is already at a premium. Other responses include building more water storage areas, the installation of pumping facilities, and the upgrading of drainage systems. In addition to holding flood waters back, some communities have begun to build flood resistant structures. State offices located near the waterfront in Trenton have been designed and rebuilt to withstand floods.

A major concern for most urban areas are the effects flooding will have on transportation systems. Newark Airport, Amtrak, PATH, and N.J. Transit will all have to deal with increased flooding as sea level rises. For the airport and train systems, diking or raising of beds will have to be implemented. Although no official policy has been instituted to deal with sea level rise, all agencies are at least aware of the problem. Roadways will have to be raised and drainage systems improved. Bridges will have to be maintained with a reduced clearance over the water level and abutments will have to be reinforced to handle the additional stresses.

Low to Moderately Developed Riverine Areas

Many parts of the Delaware River are still only low to moderately developed. In many of these areas agriculture is still a major industry and urban flooding will be of little consequence. Dikes have already been in place since colonial times and continue to be used. However, as sea level rises and groundwater tables are locally drawn down, the threat of brackish intrusion will become more prevalent and dikes alone will not be sufficient. Work is now underway to use genetic engineering to create crops tolerant of moist ground conditions and saline waters. Some success has already been found in corn, tomatoes, and tobacco varieties (pers. comm. J. Gallagher, Univ. of Delaware, 1989). As sea level rises, farmers may be able to incorporate these crops and remain productive.

In many areas where development and agriculture are not threatened, the river can widen its banks and spread its flood plain. This will be important in maintaining a diverse habitat so that the river can maintain a productive system.

Coastal Communities (except barrier islands)

Communities located along the coast but not in major urban areas or on barrier islands will have a slight advantage in dealing with sea level rise. Where housing densities are low, it may be possible to re-locate members of the

53X

community toward higher ground. Indeed, many communities already have parks and open space along their waterfront limiting the effects of rising sea levels in their area. If the community were small, it would be possible to surround the area with a dike and use gates and pumps to control water levels. This approach has been utilized at Keansburg with success. As sea level rises, the dike and gates can be adjusted upward.

Coastal Barrier Island Communities

Because barrier islands are subjected to direct ocean influences, these areas will require extensive programs in order to respond properly to sea level rise. The response of these areas is complicated because sea level rise will occur on both the ocean and bay sides. The cost of beach property and its value as an investment cause people to be unwilling to re-locate. Beach communities have already begun to utilize many techniques in protecting their shoreline and will continue to do so into the future.

Groins are one of the most common responses to beach erosion and migration. They were designed to limit alongshore drift and to maintain the beach width and profile. However, their effects on the shore has been all but optimal. In many cases the interruption of sediment transport downshore has created sediment deficits in many areas and initiated or enhanced beach erosion. As sea level rises, these structures will become inundated and lose their effectiveness. They will have to be constantly raised and elongated as the island drowns and displacement of both the ocean and bay margins occurs. Only the barrier islands that are low in elevation and at a minimum height and width will migrate.

Inlets are a natural feature of the coast allowing water to escape during high storm events. These features are also utilized extensively as entrances and exits for boats and are important to many communities. Since the 1930's, the U.S. Army Corps of Engineers (ACOE) has maintained inlets through the construction of jetties and dredging activities. As sea level rises, these structures will also have to be raised and elevations maintained according to changes in water levels. As of today ACOE has no plans to allow these inlets to become closed.

Where erosion or inlet breaching has been a major problem seawalls have been constructed. These walls are designed to repel energies from waves and reduce erosion and to prevent flooding from the sea. However, all too often these walls cause erosion at their base and in adjacent areas. At Sea Bright the seawall

54X

is the only reason why the spit has not breached. Under the high scenario, however, the wall at Sea Bright will be overtopped, its base eroded, and its effectiveness limited. The wall will have to be reinforced and its upper elevation raised in order to maintain its function.

Some communities are now employing breakwaters and artificial reefs in order to reduce wave action and erosion. A pilot study is now being conducted off the coast of Ocean City using cement reefs lowered by helicopters and placed by divers. These systems are designed to enhance sedimentation onshore. However, in many cases they have been found to block alongshore drift and create shoals, botn of which can impede navigation and create sediment deficits downshore.

A common response to erosion along the beaches has been to restore or build dunes. Dunes can be created using sand fences and plantings. The results are protection against wave surge and maintenance of the beach face. The dunes must be allowed to shift inland or they will be destroyed. These dunes have been shown to be effective for beach protection. However, they are sensitive to disturbance and do require regular maintenance.

Another response to beach erosion is the nourishment of beaches using an offshore source of sediment. This requires the pumping of sand onto the beach face to maintain surface elevations and beach width while supplying a source of sediment for alongshore drift. These methods may also be employed in raising the elevation of the entire island. As sea level rises many of the more developed areas will not be willing to relocate. In order to remain in place it is believed that raising the elevation of the island in conjunction with sea level rise will make this possible. Houses can then be elevated and roadways adjusted. The advantage in such a program is that it can be accomplished in increments thereby spreading out costs over a longer period of time.

In those communities where retreat is not an option and smaller structures are no longer effective, dikes or levees can be constructed around the perimeter and water level maintained by pumps. This may be an option for a place like Atlantic City where the cost of protection will be less than the loss of the casino industry.

Another option for coastal communities, particularly low- to moderately-sized developments, would be to retreat landward. The bay side can be filled to create lots and houses and roads can be moved back. The bay area is owned by the State and use of the space would have to be negotiated. Although this is an option it is important to remember that rising sea levels affect both the ocean and bay sides.

55X

In those shore communities where relocation is not an option, problems facing support services will have to be addressed. Sewer lines and drainage systems will have to be upgraded to handle the additional stress. Dumps, quite often built along the shore will have to be moved or protected from erosion. Obtaining freshwater supplies will be a major problem as well. As sea levels rise and aquifers become saltier, freshwater will be a limiting factor. Piping in freshwater supplies or desalinating the water are both expensive options that might have to be considered.

Along undeveloped areas of the barrier chain a no-action scenario would be the prevalent response. In these areas, erosion would be rapid and with sufficient narrowing the beach would migrate landward. Although the beaches would ultimately be destroyed, the migrating system would allow for habitat diversity and help maintain the natural system of the coast, something that will be increasingly important as we further manipulate the barrier chains.

RESPONSES OF AGENCIES

It is important to note that most agencies have not yet developed a policy for dealing with sea level rise. The costs and personnel have been a limiting factor. The agencies are, however, aware of the problem and are now beginning to address it.

State of New Jersey, Department of Environmental Protection, Division of Coastal Resources - No official policy. The question is now being addressed and research into planning is being initiated. Plans are now underway to review the Shore Protection Master Plan to incorporate sea level rise. Revisions are also being considered for permit applications in High Hazard zones and the rules that determine them. Attempts are now underway to try to coordinate efforts between agencies. For instance, FEMA will issue permits to develop in dune areas while the State wants to protect them. Plans are also being considered to incorporate sea level rise in the Coastal Zone Management Act.

State Department of Energy - No official policy. They are looking at energy efficiency and environmental quality. Plans are being formulated dealing with power plants along the coast, which includes the two nuclear power plants, but as of the present no policy has been initiated.

State Department of Transportation - No official policy. Plans are being discussed for raising roadways, reinforcing bridges and improving drainage systems.

Port Authority of New York/New Jersey - No official policy. They have served as a catalyst in initiating and contributing to discussions on sea-level rise.

There is a decision to consider the effects of a rising sea level on major capital improvements on a case by case basis. There is currently in-house discussion on the effects of a rising sea level on rail facilities.

U.S. Army Corps of Engineers - No official policy. Nationally, a sea level rise impact study is being prepared. However, this is just now in the problem identification phase. Local offices of ACOE are in the phase of considering the effects of sea-level rise on coastal structures, but do keep informed as to the latest research developments coming out of the Universities. Financial constraints are limiting the formation of plans at present.

Local Municipalities - No official policy. Each community is aware of the problem and is waiting for the State to establish guidelines and financial assistance.

National Oceanic and Atmospheric Administration - Although not directly involved with land-use decisions, they will continue monitoring tide gauges and ambient CO_2 levels.

SYNOPSIS

The impacts of a rising sea level have been causing changes to the New Jersey shoreline and estuaries for centuries. The changes are part of the natural system that have been occurring and will continue to occur. The impacts of the current global changes are to increase the rates of the alterations and to modify the dynamic processes that are involved. The built landscape is not so mobile as the natural system and thus there will be areas that will not be able to adjust or absorb the impacts of a rising sea level without major modification.

It does not matter whether the rates of sea-level rise are great or small. The fact that the changes are occurring is sufficient justification to be alert to the impacts of the sea-level rise and to incorporate it as a variable in the management of our coastal resources. The resources are finite and are being stressed by the combination of the human impacts as well as the changing natural system. We must manage the coast as a dynamic system which is subject to change and which will require continuing attention to the modifications which will be occurring as future sea levels impinge on our coastal zone and alter the existing dynamics and equilibriums. Management must be accomplished with a view to the new equilibriums.

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AMERICAN LITTORAL SOCIETY

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Statement of D. W. Bennett, Executive Director, American Littoral Society, before the State Beach Erosion Commission, October 6, 1993, Asbury Park, NJ

We would ask that the final report of the State Beach Erosion Commission address the following questions:

(1) How much will it cost to treat beaches in New Jersey over what period of time?

Our position is that it will cost an enormous amount of money and a permanent commitment of funds. We believe it is very important for realistic estimates be made and be made public.

(2) Who will pay the costs? And, who will announce who pays the costs?

Our position is that those who benefit most from beach money should pay the most -- shore real estate owners and interests, shore towns, and beach users. We also believe that this news should be delivered by those urging the expenditure of beach protection funds.

(3) Who gets to use the beaches?

Our position is that the public should get true, equal access to beaches. This means that access should be clearly and universally marked, that residents and non-residents should have equal access, that visitors should be made to feel welcome. True access means parking, bathrooms, changing facilities, and food places.

(4) If the decision is made to defend the shoreline, pump and preserve beaches where they are now, and this plan fails, then what?

Our position is that any plans to hold beaches in place should be tempered by the realization that many such projects won't work. Every hold-the-beach project should be accompanied by or paired with a back-away-from-the-beach plan, and beach money should be matched dollar for dollar with buyout, setback, and retreat money.

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(5) What are the alternatives to beach replenishment and defense? And, how much will they cost?

We believe that this Commission should recommend that alternatives to beach replenishment and stabilization should be addressed with special attention to the relative costs or the alternatives.

(6) What is the state's plan for the aftermath of the next major coastal storm?

Our position is that New Jersey should provide a post-storm management plan, so that future reaction to coastal storms is not more of the same scratch and patch.

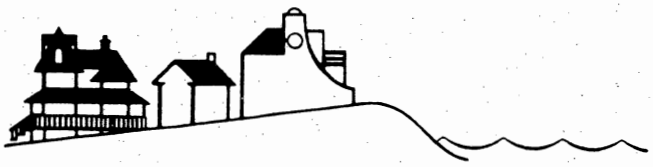
(7) What are the environmental impacts of various beach fixing plans?

We believe more attention needs to be paid to these impacts. To the offshore dredging of sand. To the seasonal bulldozing of beaches. To the construction of narrow high sand dunes to replace broad dune systems.

Much of what is being proposed to cure New Jersey's beach woes won't work long-term and it will cost more than originally estimated. Consider that sea level is rising, no new sand is being added to the state's barrier beach systems (in fact storms cause net loss of sand), and barrier beaches will only survive if left alone, and NJ's beaches can't be left alone as long as attempts are made to protect shore real estate.

This Commission can do New Jersey a real favor if it winnows through all the proposals that come before it while keeping in mind the basic questions we have asked: How much will it cost? How long will it last? Who pays? Who benefits? Are there alternatives?

COASTAL ADVOCATE, Inc.



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TESTIMONY

OF

KENNETH J. SMITH, PRESIDENT

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BEFORE THE

STATE BEACH EROSION COMMISSION

September 6, 1993

Asbury Park, New Jersey

Mr. Chairman and Members of the Committee:

Thank you for the opportunity to testify again before your committee on the protection of our coast. In addition to my constituency, I am speaking today on behalf of the New Jersey Alliance for Action and the American Shore and Beach Preservation Association.

I commend this committee on the frequency of your meetings and the work you have done on the issue of shore protection. As you know, there is a more to it than many people realize. Shore protection is not simply a matter of picking the sand up here and depositing it there. The coastal processes involved are quite complex, as are the technics, the environmental pre-and-post project monitoring, and of course, the funding.

As the cost of pumping sand escalated in the 1980's, the search was intensified for innovative and inexpensive technologies to either retard erosion, or even better, to provide some accretion to eroding beaches. You will hear testimony on a number of devices today, and the three organizations I represent strongly support continued research and the possible utilization of new technologies.

My only caution would be that we consider carefully any suggestions of implementing the new technologies as a replacement for beach nourishment. As Dick Creter will attest, the best use of his offshore breakwater will be in conjunction with a beach nourishment program. We may find that the Breakwaters International reef, or another installation, can work independently in some areas. Off-shore breakwaters oriented parallel to the shore often accumulate sand in their lea. But even if it only serves to lengthen the period between required renourishments it will save a lot of money for the State of New Jersey and its coastal communities.

We will need to coordinate the installation of new devices with the Corps of Engineers in areas where a Federal project has been authorized. The Corps is initiating a program for innovative technology transfer in their Washington office, and we will have more information for you on that in the near future.

In as much as the methods discussed today can fit into the Federal program, we support them. As we've learned from hard experience, however, we must be careful about installations along the shore. Field testing requires adjacent control areas, proper siting, monitoring and patience.

Some devices may be adaptable to the heavy wave attack of the Atlantic coast, others better suited to lower energy environments. We will work to secure the needed funding for wave tank and field test research that will

lead to their potential application.

In conclusion, I want to recommend strongly that we do not depart from the program of study, permitting and construction of beach restoration projects which is proposed by the Corps for the State of New Jersey. The Corps program is not only the most cost effective plan of protection, it is the only program which will save the beaches of New Jersey for the next 50 years.

We offer the services of my firm, the expertise within ASBPA, and the full cooperation of the New Jersey Alliance for Action to your committee, as we work together to protect our coast.

Thank you.

Kenneth J. Smith, President
Coastal Advocate, Inc.

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