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OFFICE OF MANAGEMENT BUDGET AND

DELAWARE COASTAL MANAGEMENT PROGRAM,

U. S. DEPARTMENT OF COMMERCE NOAA  
COASTAL SERVICES CENTER  
2234 SOUTH HOBSON AVENUE  
CHARLESTON, SC 29405-2413

**PROCEEDINGS OF THE  
GOVERNOR'S WORKSHOP ON THE  
MANAGEMENT OF SHORELINE  
EROSION AND FLOOD PRONE AREAS**

MARCH 6, 1978

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STATE OF DELAWARE  
EXECUTIVE DEPARTMENT  
DOVER, 19901

PIERRE S. DU PONT  
GOVERNOR

PHONE: (302) 678-4101

February 13, 1978

Dear Delawarean:

Coastal erosion and storm flooding have been common in Delaware for many years. This fall the State's coastal areas were again impacted by two destructive storms which buffeted the shoreline in October and December and caused significant erosion and damage to beachfront structures. While these storms were considered by experts to be only moderate, they nevertheless underscore the continuing vulnerability of Delaware's coast.

Recent research conducted under the auspices of the Delaware Coastal Management Program has raised a number of questions about our governments' abilities to deal with these natural processes. The issues involved are complex, and the problems transcend political boundaries. Ultimately, all citizens of the State are affected by the physical and financial consequences of coastal damage. In the past several years the State alone has invested \$3 million to repair eroded beaches, and current estimates for "permanent" protection run into the hundreds of millions.

The State's Executive Branch cannot develop and implement a sound policy for proper management of coastal areas without the help of other branches and levels of government and without the understanding and support of the taxpaying public. In order to share some of these problems with those most immediately affected by coastal damage, I am convening a Workshop on The Management of Shoreline Erosion and Flood Prone Areas to which you are cordially invited. The Workshop is being co-sponsored by the Office of Management, Budget and Planning and the Department of Natural Resources and Environmental Control, as part of the Delaware Coastal Management Program. It will be held in the Rehoboth Beach Convention Hall on March 6, 1978 between the hours of 9:00 and 5:30. Please respond by telephone (678-4271) or mail the enclosed card to OMBP by February 24. I look forward to seeing you there.

Sincerely,

A handwritten signature in cursive script that reads "Pierre S. duPont".

Pierre S. duPont  
Governor

18524

A G E N D A

GOVERNOR'S WORKSHOP ON THE MANAGEMENT OF SHORELINE EROSION AND FLOOD PRONE AREAS

9:00 - 9:15 INTRODUCTORY REMARKS - Governor du Pont Page 1

9:15 - 12:00 THE PROBLEMS OF EROSION AND FLOODING

- a. Coastal Erosion Process-Dr. John Kraft, Chairman, Dept. of Geology, U. of D. Page 5
- b. Coastal Storm Experience-Mr. Robert Henry Department of Natural Resources and Environmental Control Page 25
- c. Corrective Approaches, Pro & Con - Dr. Robert Dean, School of Engineering University of Delaware Page 35

12:00 - 1:30 LUNCH AND WALKING TOUR TO SOUTH BETHANY

(Weather permitting conducted by Dr. Kraft) Page 51

1:30 - 3:00 CURRENT APPROACHES TO THE PROBLEM

- a. Overview of the State Program - Operations and Regulations-Sec. Austin P. Olney, DNREC Page 53
- b. Fiscal Issues in Beach Erosion Control - Nathan Hayward III, Director, OMBP Page 57
- c. Federal Shore Protection Programs - Colonel Harry Dutchyshyn, Phil. District Engineer, U.S. Army Corps of Engineers Page 61

3:15 - 4:30 DISCUSSION PERIOD

Panel - Moderator. Sec. Olney (with Messrs. Dean, Ratledge, Henry and Hayward; Senators Zimmerman and Knox; and Representatives Miller and Vernon) Page 65

This document is financed in part through a federal grant from the Office of Coastal Zone Management, NOAA under the provision of Section 305 of the Coastal Zone Management Act of 1972 (Public Law 92-583)

Third Year Grant

04-7-158-44037

Document #1003-78-08-06

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## Acknowledgements

On behalf of Governor du Pont and Delaware's Coastal Management Program, I would like to express our sincere appreciation to the workshop participants for taking the time to come to Rehoboth Beach and impart their valuable knowledge on the problem of storm flooding and beach erosion. I would also like to offer special thanks to those who worked behind the scenes and made the workshop a success.

To Mayor Miriam Howard, Mary Fitzpatrick, and the City of Rehoboth Beach for making Convention Hall and the staff available to us;

To Ernest Smith and his crew for their work in preparing the hall;

To May Felerski and the Town of South Bethany for arranging our visit; and

To Ralph Williams of the College of Marine Studies, whose help with transportation and lunch arrangements proved invaluable.

Again, thank you very much.

Benjamin Coston  
Office of Management, Budget and Planning  
Workshop Coordinator

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Produced by: Delaware Coastal Management Program  
Office of Management, Budget and Planning  
Townsend Building, Dover, DE  
July 1978.



*Delaware Coastal Management Program Office of  
Management, Budget and Planning*

INTRODUCTORY REMARKS

Governor Pierre S. duPont IV

It is my pleasure to welcome you this morning to hopefully add some emphasis to the need for coming to grips with one of the most difficult problems that is plaguing coastal Delaware, and that is what to do about the fact that as the years go by the shoreline is changing; in some places very rapidly, and in other places more slowly, but nevertheless changing. That change is putting some difficult burdens on State government, on the Army Corps of Engineers, on private property owners along the beach, and on the general public that uses our beaches. It was 16 years ago today that we had the tremendous storm of 1962. It was not as nice that day as it is this morning. The ravages of that storm in many areas are still with us, and I think that was the first time the people of Delaware had come to focus on the problem that the ocean was causing us. Of course, even though we do not have a storm like that every year, the problem of beach erosion and shifting coastlines continues every year, though in not such a dramatic fashion.

Ever since the beginning of time, the coastline of Delaware has been changing. It has been changing with the tide, with the wind, with the storms, indeed with the level of the ocean. But, until recent years that did not cause a problem for people in Delaware, because it was not until the last 50 or 60 years that the build-up in coastal floodplains really began. Until that time we had undeveloped areas; and, if the beach shifted a little, nobody really cared. But now as more and more houses have been built, as civilization has advanced to the water's edge, the problem of beach erosion has become very severe. In 1972, the General Assembly passed the Beach Preservation Act. The purpose of that Act was to regulate development of the area and guard against man-induced increases in beach erosion or dune damage. In addition, that Act established a one million dollar revolving fund to protect the beaches. The fact is, of course, that a million dollar revolving fund is nowhere near adequate to protect us from the problems we face. Nor, does that Act address itself to the problem of storm damage. No act of the legislature could ever do that; and it is, of course, storm damage that causes the major problems along our coastline. Delaware's Coastal Management Program has recently completed a study which indicates that expenditures in the range of a million dollars a year are totally inadequate to do the job.

In the last few years, we've spent about 3 million dollars in State funds on coastal protection, but if we were to do a complete job and build groins or bulkheads or make significant improvements along our coastline all the way from Cape Henlopen to the Maryland line, or indeed all the way from Cape Henlopen north to perhaps the Dover area, it would cost us tens of millions of dollars just in State funds. In fact, the estimates are that over a ten-year period, adequate beach protection efforts would cost in the hundreds of millions of dollars. I think we all recognize we do not have hundreds of millions of dollars to spend, and so the question is, what are the alternative management policies. Since 1843, beach erosion in Delaware has ranged from three to 12 feet per year, depending upon the location. In some areas, the Lord has created land and the beach has moved out into the ocean, but by far most of our shoreline has experienced erosion between 3 and 12 feet per year, and that is the problem we are addressing this morning.

The purpose of the Workshop is to try to develop a new and comprehensive policy that is both effective and affordable. Before we decide on what that policy should be, it seemed to us that we ought to ask the interested people of the State and shore communities to come together to spend a day looking at the problem, and listen to those people in Delaware who have devoted their lifetimes as professionals to study of the problem. It is my hope that out of the meeting will come a new beach erosion policy for our State. A policy that the homeowners, the taxpayers, and the Department of Natural Resources can all live with simultaneously. That is not an easy task, but I believe we have to try. Let me just lay out for you four or five of the questions that are facing us which are indicative of the difficult problems we face in managing this area. First, should the State allow new construction or rebuilding along beaches that are subject to storm waves and repeated damages? If the answer to that question is "No", how are we going to protect the rights of private property owners along the shorefront? Second, is it physically and economically feasible to protect shoreline property? Third, what responsibility, if any, do state taxpayers have to protect private beachfront property? Fourth, should those who locate in hazard areas bear the risk and the financial burden for that decision? Fifth, if the state undertakes protective measures that benefit flood prone property owners, should the state recoup some of all of those costs from those property owners? If the answer is no, we must ask why not? If the answer is yes, we might ask how are we going to do it? Finally, is the present state authority adequate to deal with these problems; and if not, what kind of statutory action should be taken in our General Assembly to give the state

the necessary power to do the job? The answers to those questions are difficult; in fact, some of them make you uncomfortable just thinking about them, but that's the nature of the beast. We have a very difficult problem in front of us and we have to bring the best analytical tools we have to bear on that problem. To help us, we have six distinguished individuals with us who are going to talk about various aspects of the problem. We have with us Dr. John Kraft, Chairman of the Geology Department of the University of Delaware. He is a nationally recognized expert in the coastal processes. We have Dr. Robert Dean with the Department of Ocean Engineering at the University of Delaware. He is a leading authority on engineering approaches to beach erosion and flood control. Robert Henry, a geohydrologist with the Division of Soil and Water Conservation is here and he is responsible for the administration of the Beach Preservation Act. Nathan Hayward is the Director of the Office of Management, Budget and Planning, which has jurisdiction over the Coastal Management Program and the Federal Flood Insurance Program. His office is responsible for analysis of the problem and recommendations for its solution. Austin P. Olney is Secretary of the Department of Natural Resources and Environmental Control. Before becoming Secretary, he was Minority Counsel to the House Committee on Merchant Marine and Fisheries in Washington and there helped to draft many of the federal coastal protection acts that we have in place today; the Ocean Dumping Act, the Coastal Zone Management Act, etc. Finally, we have Colonel Harry Dutchyschyn of the Philadelphia District Army Corps of Engineers. The Corps is the federal agency which actually helps us build the structures we decide to put in place. So, it is my hope that with this distinguished group of people, we can bring to bear all the expertise we have in Delaware on this difficult problem. In addition, we have invited everyone from the public sector who might be interested as well as town councils from coastal communities, environmental groups, and property owners.

The first thing we need, of course, is some understanding of the problem. It is my hope that the panelists this morning will provide us with that understanding. Second, we have to understand that you cannot solve the problem at one level of government alone. No one would suggest, I suppose, that the town of Bethany Beach or Fenwick Island try to undertake the financial program to stabilize the shorefront in front of their own communities. They obviously do not have the resources to do that. Well, it's just as absurd to suggest that the State of Delaware can do it alone, or that the Federal Government can do it alone. We must have the cooperation of local, state and federal officials, if we are to get the job done. And most importantly, we need the cooperation of the General Assembly. Our objective this morning is to come up with a solution that is workable, affordable and politically practical. That sounds very simple to say, but very difficult to achieve. Thank you very much and have a good day.



PHOTO 1

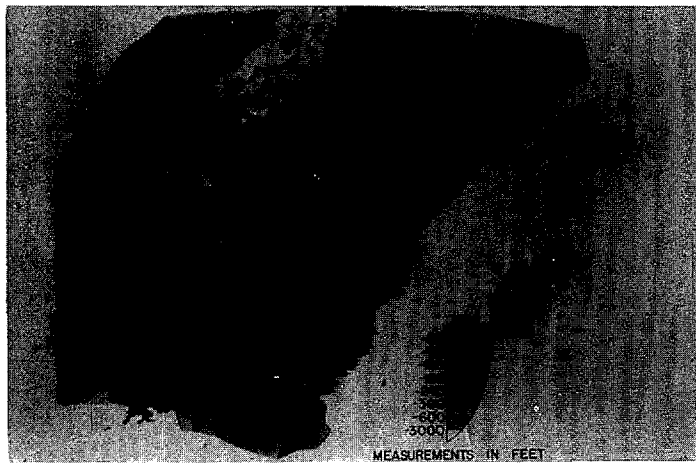


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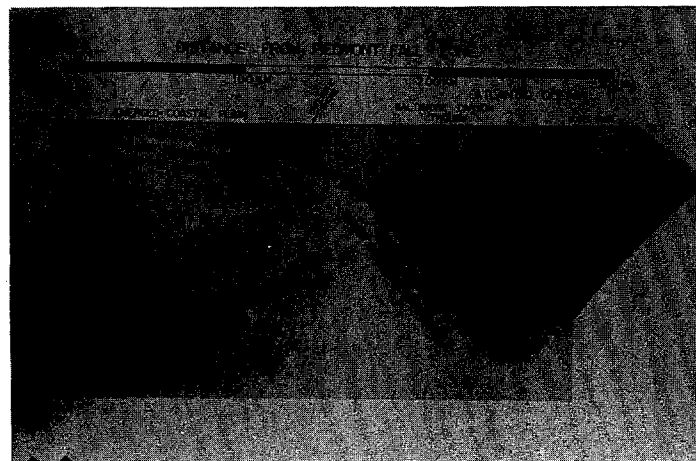


PHOTO 3

## COASTAL EROSION PROCESSES

Dr. John Kraft, Chairman  
Department of Geology, University of Delaware

1. First of all, let us examine the Delmarva Peninsula and its relationship to the so called "ice age" in which we still exist. About 14,000 to 18,000 years ago, the continental ice sheet covered part of North America and is shown in gray on the slide. At that time, sea level was about 350 to 500 feet below its present elevation. In other words, 14,000 to 18,000 years ago the sea shore was near the edge of the continental shelf. Since that time, continuous melting of the polar ice caps has caused sea level to rise to its present position. The same geological processes which have caused this rise in sea level are continuing today.

2. This is a topographic map which shows elevations both above and below sea level. About 14,000 to 18,000 years ago the configuration of the Atlantic Shoreline approximated the minus 600 foot contour. As sea level rose, the shoreline at various times approximated these other contours. Note the configuration of the minus 90 foot contour. It approximates the shape of the present shoreline with the existence of a deeply incised river valley which has evolved to the present Delaware Bay.

If the present rate of rise of sea level continues over the next 5,000 to 10,000 years then, based upon the best geological evidence, the shore of the Delmarva Peninsula will approximate the plus 50 foot contour and the Peninsula will become a series of isolated islands.

3. Most geological cross section maps of the coastal plain are distorted vertically, so that vertical detail is more readily apparent. This is a cross section of a profile across the Delmarva Peninsula to the Atlantic Shoreline and out into the submarine area to a depth of 600 feet below sea level. This profile is drawn to scale and is meant to show the flatness of the Delmarva Peninsula. A rise of 25 to 30 feet in sea level would flood across to the Chesapeake Bay. Based upon past trends, such an event should be anticipated in the future.

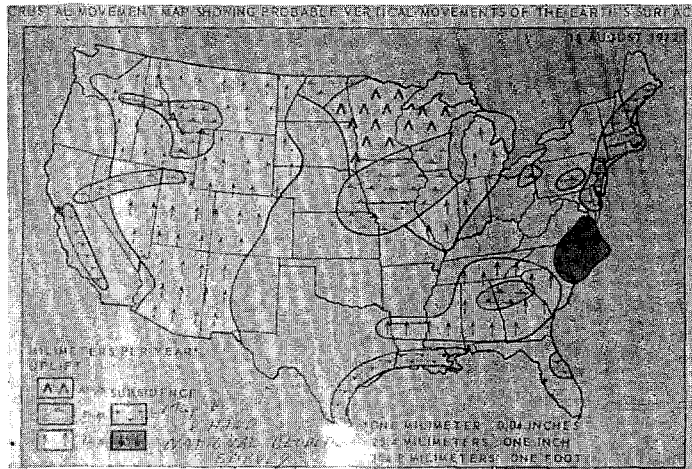


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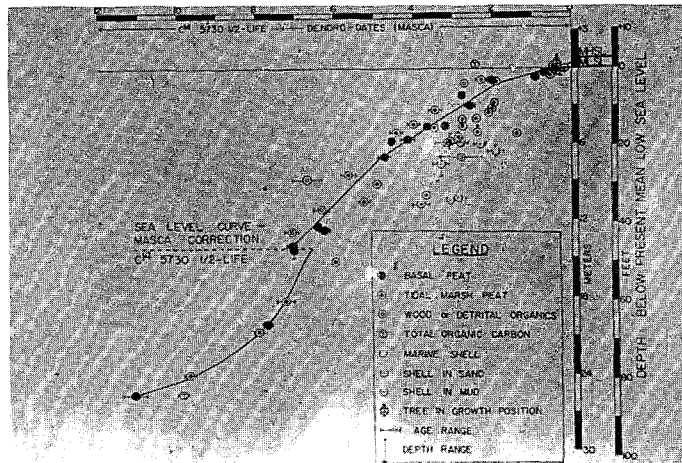


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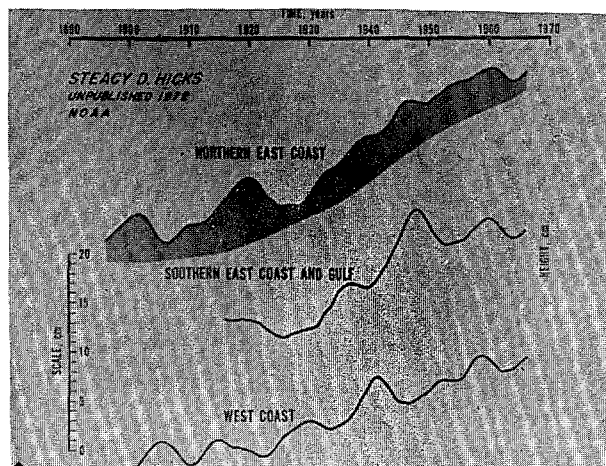


PHOTO 6

4. In addition to the absolute rise in sea level, there is another geological phenomenon affecting coastal change in Delaware. This map shows areas of the United States which are subject to various rates of tectonic rise and fall of the land surface. Delaware happens to be "blessed" with the fact that it is located in one of the sinking or subsiding areas. The entire Northeast coast is subsiding at a rate of about 5 to 10 millimeters per year. Therefore, it is not just the absolute rise in sea level that is of concern, but rather it is the relationship between absolute sea level rise and land subsidence. This is commonly referred to as the relative rise of sea level.

5. Studies of coastal Delaware have developed very precise evidence as to how sea levels have risen over a period of time. This is a curve based upon radiocarbon dates of marsh peats which have been found at various levels beneath the surface. It shows the position of sea level from 10,000 years ago, when the level was about 80 feet below the present, and gradually rising to the present. For the past 7,000 years, the sea had been rising at a decreasing rate. Over this period of time, the rate of sea level rise has averaged about one-half of a foot per century. This may not seem like a substantial amount, but it should be remembered that this rise in sea level is responsible for significant retreat of Delaware's coastline.

6. There is another factor that has been measured by Stacy Hicks with the National Ocean Survey. He noted by studying tide gauge records, the long term geological rate of sea level rise was not quite correct at all locations. As a matter of fact, along the Northeast coast, the rate of sea level rise has been measured at about one foot per century. This curve shows the average sea level rise between 1900 and 1970. One of the more interesting observations made by Hicks, although it does not show up very well on this curve, is that in the decade of the 1960's, sea level took a jump in the area of Breakwater Harbor of about 3 inches. That is catastrophic! The point of the matter is that we know that sea level is rising, we know that it is probably rising at an irregular rate, but we cannot precisely know what that rate is or how it will fluctuate in the future.



PHOTO 7

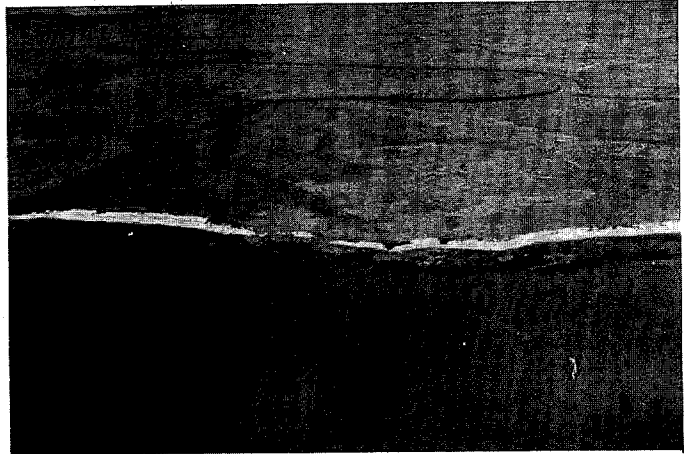


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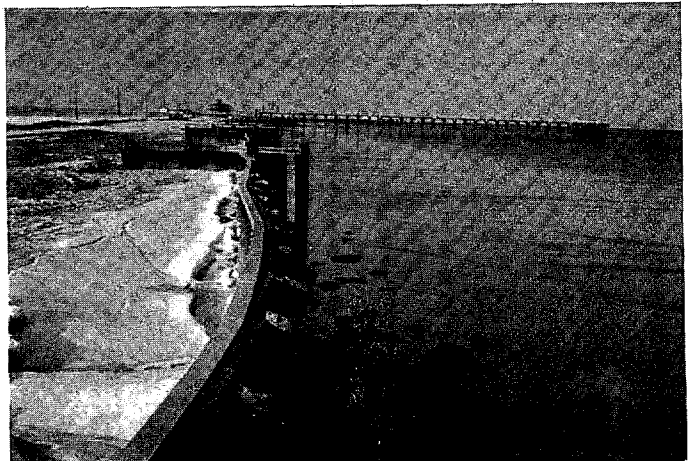


PHOTO 10



7. The shoreline processes which were described earlier are also observable over periods of time considerably less than a millenia. This is a map of the Bombay Hook area showing the shoreline as it existed in 1848 and again in the early 1970's. You can see that there has been a catastrophic rate of coastal erosion along this Delaware Bay shoreline; nearly half a mile in the last 120 years. In fact, this area has one of the highest erosion rates in Delaware.

8. The shoreline of this area is characterized by broad marshes against the open waters of Delaware Bay. There is not much of a beach in this area, because of a general lack of sand from eroding highlands. As a result, the wash-over barriers are very small and they erode quite rapidly.

9. The shoreline erodes too rapidly for some people in some places. This is Port Mahon. A road paralleling the shore serves a State boat ramp, a fishing pier, a jet fuel unloading terminal and commercial fishing facilities. The erosion situation here is desperate as is evidenced by the material dumped here to attempt to stop coastal erosion. When I first came to Delaware, there was a macadam road with a marsh to the right, which has since been claimed by the Bay. This area happens to have the highest erosion rate in the State of Delaware.

10. Desperate measures have been taken here by constructing a bulkhead to stop this erosion, but as is evident from this past winter's damage, the bulkhead has not been effective. Failure has been caused by two things: 1) Storm waters have washed across the bulkhead and built up a head of water behind it, which pushed it back out to sea; and 2) at the same time, erosion occurs in front of the bulkhead, because of wave scouring. In some cases, these pilings slip or rotate in the mud that they are driven into. This is a very difficult situation to remedy. Obviously, what has been done here, has not handled the problem properly. One thing that one could do here, is to drive these pilings into firm sediment underneath the mud, but it will be very expensive, since the muds are over 40 feet deep. This is a case of man trying to hold the coast against very severe odds. It is the most rapidly eroding coastal area in Delaware Bay and there is a serious question of whether or not the shoreline can be maintained in this position.

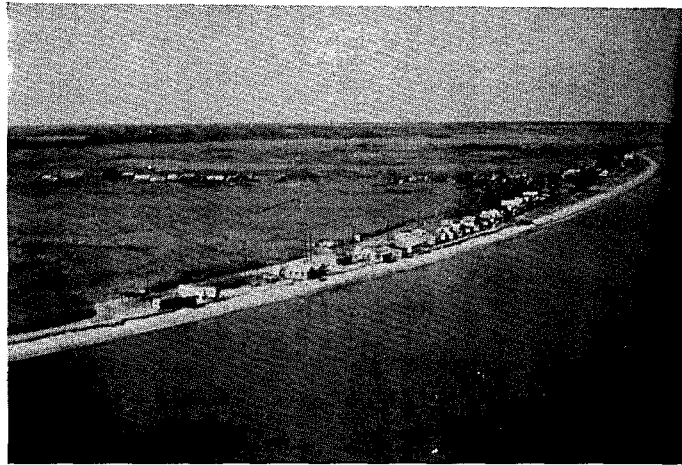


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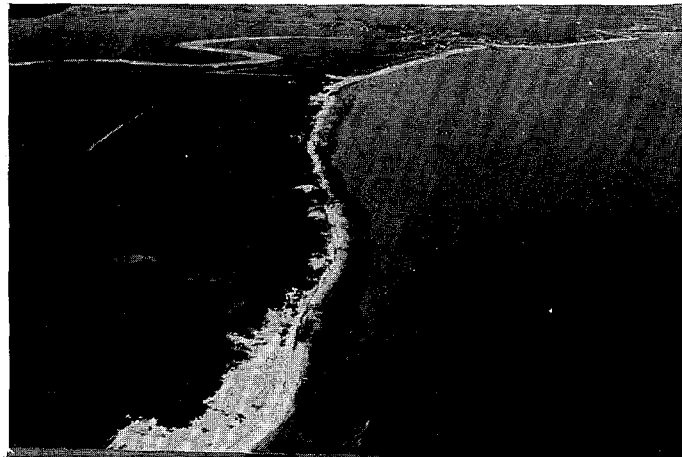


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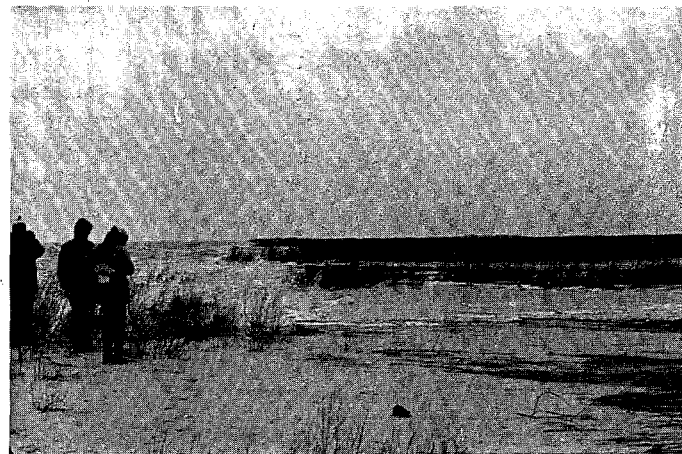


PHOTO 13

11. Here is a village along Delaware Bay. Both Kitts Hummock (Photo) and Pickering Beach are cases of small Delaware Villages that are built on low-lying, washover barriers with tidal marsh behind them and the Bay in front. There is a small quantity of sand here, because highlands protrude into the Bay in this area and are subject to erosion. Erosion of these highlands supplies the sand to these beaches. That is one of the fascinating things about coastal erosion. If you do not have an erodible highland, there is no sand to form the beaches. Highland erosion, therefore, should be considered a normal process to maintain the beaches. These people, however, do not see it that way. This village is in considerable trouble. There has been an earthen dike constructed here in an attempt to stop coastal erosion, but it will not stop it indefinitely. (Note the erosional scarp in front of the houses). It is also known that any major northeaster moving through this area will flood across this barrier, because of its very low elevation in relation to sea level.

12. This is a view of the barrier just south of Bowers. The sand barrier seen here is what is called a washover barrier, where storm waves from the Bay wash across it into the back lying marsh. If one constructs a house in such a location, one will have a problem. If one does not build a house here, one has no problem. It is a normal function of this beach to move landward as a result of storm waves washing sand across the barrier. A living, growing marsh can be seen behind the barrier and in front of the barrier the muds of a dead marsh from just a few years before the present can be observed. This is indicative of the normal landward migration of all barrier beaches.

13. One of the interesting things about these washover barriers is that the barrier is so low at South Bowers, one can go there during a storm and watch the washover process. This photograph was taken during a minor northeaster. The beach is off to the left. The storm surge is high enough so that very low waves are able to wash across the barrier and into the marsh. If this were a major storm with 10 foot waves, it would be chewing the beach up and moving it landward a considerable distance. Even during this storm, the beach is gradually moving in a landward direction. Unfortunately in Delaware, houses are still being built on barriers like this.

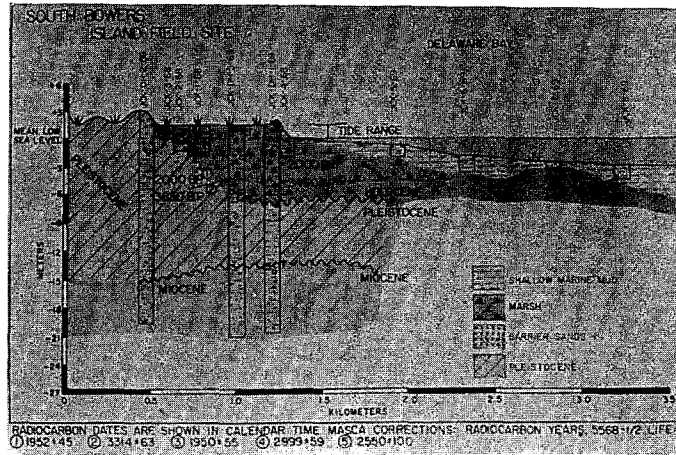


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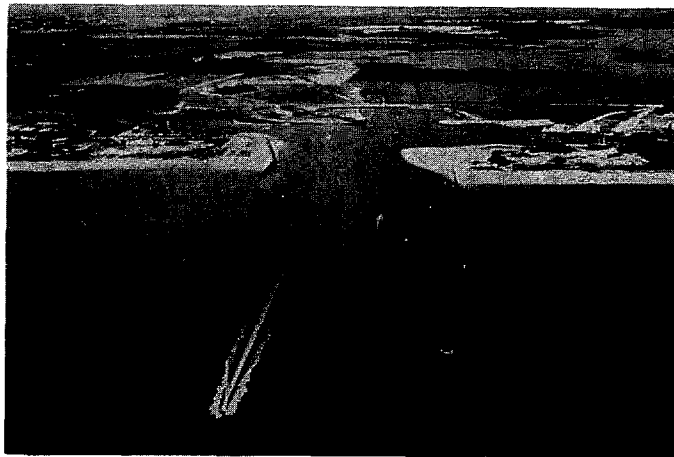


PHOTO 16

14. A considerable number of geological studies have been conducted of the sub-surface or the area under the coast. This is an example of the results of one such study at South Bowers. From these studies and from radio-carbon dates, the rate of coastal change can be determined. For instance, 12 feet under the Bay surface and 16 Kilometers seaward of the shoreline, marsh peat has been found dated at 2700 years before the present. That means that this marsh surface was in this location 2700 years ago and the sea level was below that. The shoreline of the sand barrier, if it existed, was even somewhat further seaward from there. So in several thousand years then, movement in terms of miles has occurred in this area.

15. This a view of Broadkill Beach. Broadkill Beach is an anomaly along Delaware's coastline. An examination of the maps of this area made 150 years ago show that this Beach did not even exist. The remnants of dunes along the old shoreline are visible in the lower-center of the photograph and the slough to their right is the channel of the old Broadkill River. Years ago, before Cape Henlopen had extended into Lewes Harbor and construction of the breakwaters, sand from the Atlantic Shore moved in the littoral drift stream around the Cape up to Broadkill Beach. This process created the formation of a spit at the mouth of the Broadkill River and continually deflected the River to the North. (Slide 21 shows the progression of this spit over time). The change in littoral drift, which resulted from the advance of Cape Henlopen and construction of the breakwaters, eventually cut off most of the sand supply which created Broadkill Beach and a cycle of erosion set in.

A portion of the Town is protected by a groin field. This groin field, however, is causing increased erosion at both the north and south ends of the Beach. This is shown in the upper portion of the photograph where the shoreline suddenly curves inland. Eventually the ends of the barrier will migrate in the slough and Broadkill Beach will become an island. Maintenance of the Beach in its present position will require, in spite of groins, the replacement of hundreds of thousands of cubic feet of sand on a 2, 3 or 4 year basis forever. The frequency of replacement, of course, depends upon the magnitude and frequency of storms. Despite these storms, however, sand will continue to be eroded from this beach every day of the year.

16. Roosevelt Inlet is a man-made Inlet that provided a new outlet for the Broadkill River and Lewes Creek. It was stabilized with a pair of jetties, which have since become severely corroded. Despite this corroded condition, the west (right) jetty still traps a considerable amount of sand moving in the littoral drift stream in an easterly (right to left) direction. Sand which is washed over the jetty on the flood tide is forming an Inlet shoal which can be seen on both sides of the Inlet mouth.

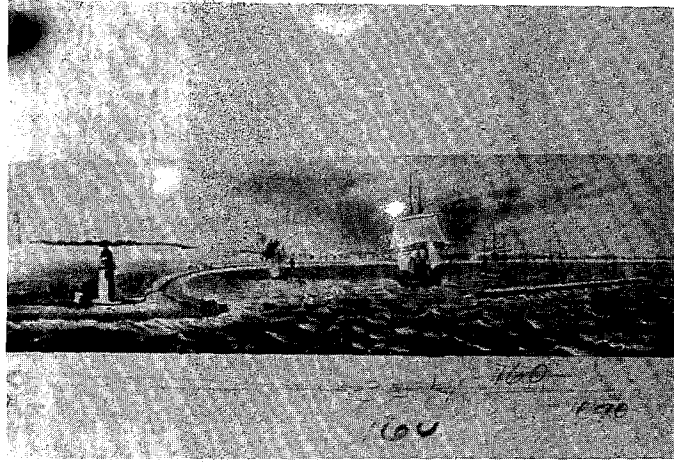


PHOTO 17



PHOTO 18

On the ebb tide, there may be a minor ebb tidal shoal at the seaward end of the jetties, but it has not presently been identified. As a result of the entrapment of sand at the west jetty and inside of the Inlet, there is a deficiency of sand on Lewes Beach and strong erosion occurs. This erosion problem is aggravated because of the corroded nature of the jetties. Strong winds blowing out of the north and northwest are able to travel over the jetties largely unimpeded. These waves, now devoid of their normal sand content, are responsible for severe erosion. This problem is wellknown and frequently action is taken to pump sand from the inlet shoals onto Lewes Beach.

17. This is the way Lewes Harbor was seen by an engineer named William Strickland who designed the first breakwater at Lewes Harbor. He drew this picture about 1829. At that time, the breakwater was built to protect sailing ships from northerly winds until they could make the trip up the Delaware Bay to Wilmington, Philadelphia and Camden. Cape Henlopen Lighthouse is visible at the extreme left in the background and another beacon that was constructed on the spit is seen in the foreground. This spit had been advancing to the north and eroding westward ever since man arrived here. As a result, this beacon had to be moved repeatedly because of the erosion until it was finally rebuilt on the breakwater, where it is today. At the time the breakwater was constructed, the Harbor was 30 to 35 feet deep. That is considerably deeper than it is today.

18. Looking at a modern photograph of Cape Henlopen, several things can be observed. First, is the relationship between Cape Henlopen spit and the inner breakwater. Note the difference between this photograph and the previous one. The Spit has moved between the inner and outer breakwaters and cut off the eastern end of Lewes Harbor. Massive erosion has been occurring along the Atlantic Shore and is documented to average about 10 feet per year over the long term. A massive amount of sand is disappearing from this shoreline. Some of this sand is going into the development or building of this spit in a northwesterly direction; some of it is moving offshore onto Hen and Chickens shoal; some of it is entering Lewes Harbor; and some of it is moving directly offshore. This picture, more than any other, shows the effects of coastal erosion. Ancient shorelines can be seen as white lines intersecting the Atlantic Coast and then being sharply cut off. These shores are the tips of old recurved spits and are lined by trees going into Lewes Creek marsh. It is known from studies of this area that these spit tips confined a small bay where Lewes Creek marsh is today. A great amount of land has been added to the area of the State of Delaware by this process in the past few thousand years.

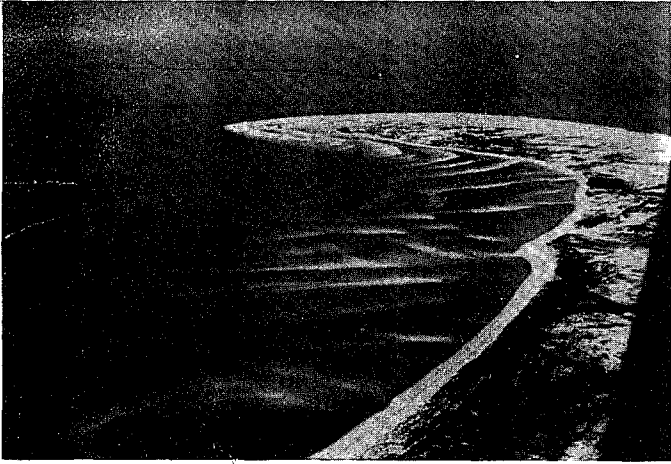


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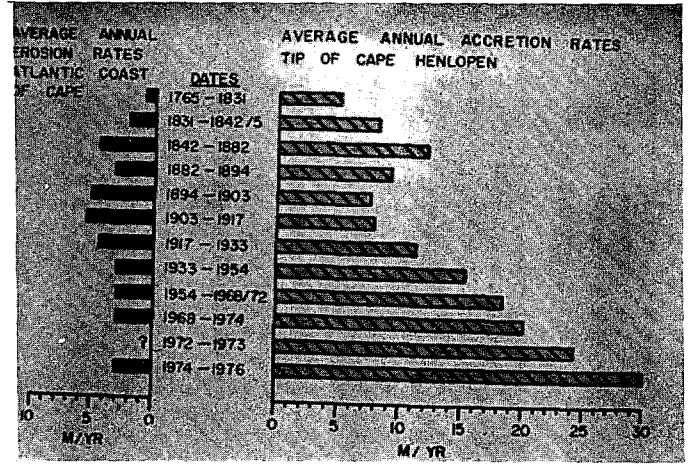


PHOTO 20



PHOTO 21



PHOTO 22



In fact, this new land area encompasses the entire triangle from Lewes to the tip of Cape Henlopen and southeast to the vicinity of North Shores.

19. This photo is a very good illustration of a spit moving between two breakwaters and tending to infill or recurve. It has been estimated that this spit will someday curve around to join the breakwater and shoal up the harbor. The timing is the only thing that is in doubt, not the process.

20. Precise knowledge of the rates of erosion of the Atlantic Coast and the advancement of Cape Henlopen spit exists from the 1700's onward. Erosion along Cape Henlopen has been as high as 6 meters per year from 1903 to 1917. The rate of advancement of the Cape has been as high as 30 meters per year. Where does this sand come from? The primary source of sand is definitely Atlantic coastal Delaware and it is moving from South of Bethany Beach northward in a continual stream to this location.

21. This is a map which shows Cape Henlopen when the Dutch first came to this area. It shows a broadly rounded cape that is about in the position of the great dune of Lewes and, of course, with the shoreline much further eastward. Next is a map of the area about 1801 in which there was broadly-blunted cape. This is important because there was a lighthouse built at the Cape in the 1750's. The lighthouse was built a quarter of a mile from the sea, but has since been destroyed because of erosion. This provides a very good measure of coastal erosion in this area. In 1842, the lighthouse is closer to the sea; the Cape is starting to evolve; sand is starting to move into the region of Broadkill Beach; and Broadkill Beach, as we know it today, began to evolve. In 1882, the lighthouse was very close to the shoreline. In 1910, the lighthouse was on the beach and in the present map the lighthouse would have been out to sea a slight distance at the edge of the great dune. What this lighthouse has done is to provide a very precise measure of rates of erosion, since it is a surveyed site.

22. This is a photograph of Cape Henlopen Lighthouse in 1910. It should be remembered that when this lighthouse was built it was constructed about a quarter of a mile from the sea. This photograph provides an idea of what was instore for the lighthouse. This dune is eroding very rapidly landward and there were primitive attempts to trap sand here with a groin.

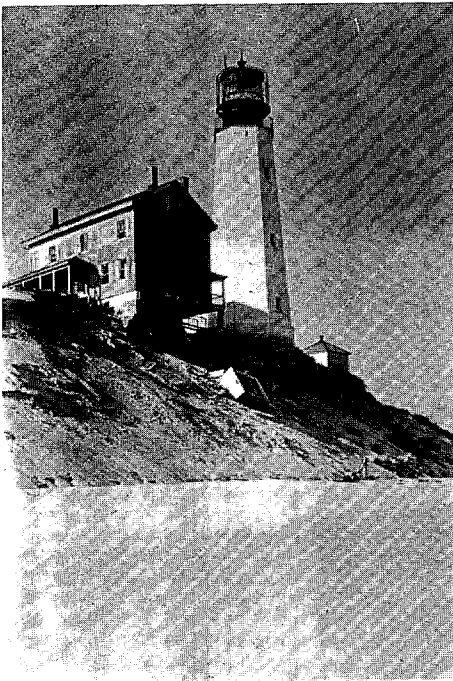


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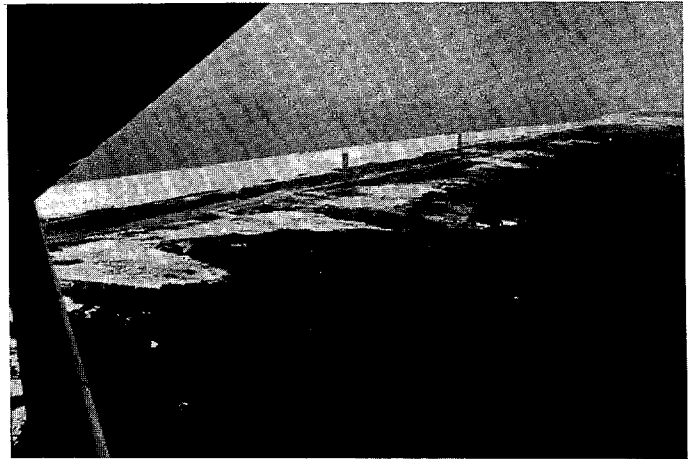


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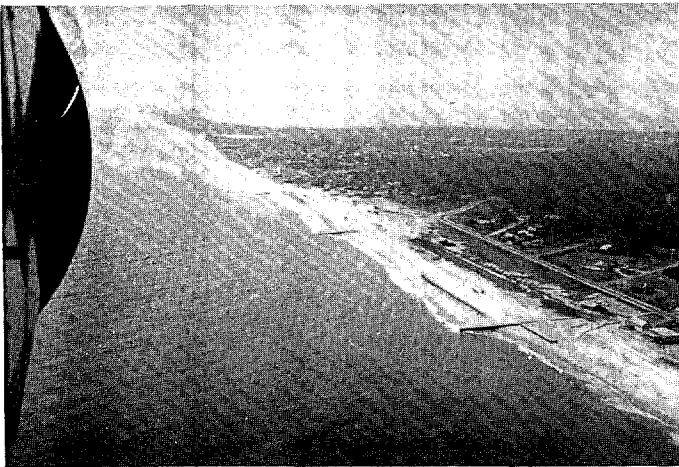


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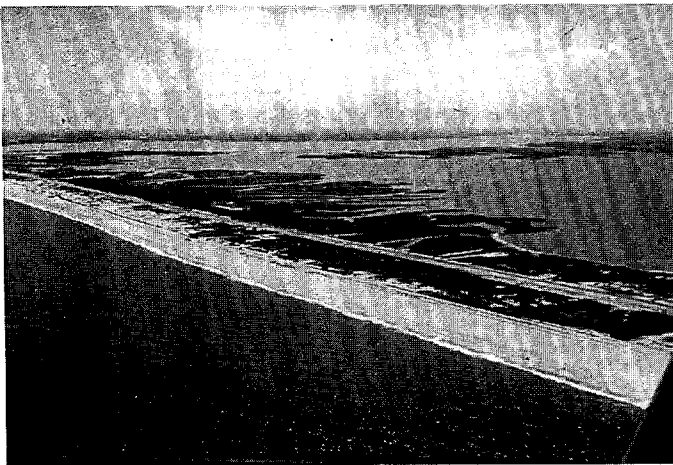


PHOTO 27

23. This is a view of the Cape Henlopen Lighthouse in 1926, the year it fell into the sea. Comparison of this photograph and the previous one provide ample evidence of the rapid rate at which the Atlantic shore of Cape Henlopen was eroding.

24. This is a view of the washover barrier at Whiskey Beach. During storms, waves removed sand from the beach and washed it across the barrier. The washover of fans just west of the road are evidence of this process. Such washovers are the result of the combination of storms and a continuing rise of relative sea level and are a part of the process which results in landward retreat of the shoreline and the build-up of the surface of the barrier.

25. Unlike most of the Atlantic Coast of Delaware, Rehoboth Beach is situated on a highland adjacent to the sea, rather than on a barrier beach. Here, a groin field has been constructed to hold the shoreline in position and a slight bulge in the coastline is evident as a result of it. Had this groin field not been built, the shoreline would have been fairly straight and the beach would have been somewhat landward of its present position.

26. This is an aerial view of the results of the washover process following the March 6, 1962 storm. It illustrates dramatically the landward retreat and upward build-up of barrier islands. Here, sand has been removed from the beach and primary dune and thrown across the barrier into the back barrier marshes.

27. This is a view of Delaware Seashore State Park between the Indian River Inlet and Dewey Beach. The large back barrier marshes are indicative of the existence of an inlet at this location in times past. These marshes were created on flood tidal shoals which are characteristic of inlets. Inlets are known to open, close and re-open in other locations. They also tend to migrate up and down the coast unless they are stabilized by a pair of jetties.

The elements of a linear barrier can also be observed in this photograph and consist of the beach face and berm, dunes and a few washover fans seen as light patches extending across and behind the dune line. Dunes provide major protection during storms. Natural breaks in dunes on a wide, low-dune washover barrier allows some water to flow through during storms preventing major water build-up on the seaward side. Maintenance of a high, narrow dune can lead to catastrophic flooding during storms. Removal of dunes guarantees a washover.

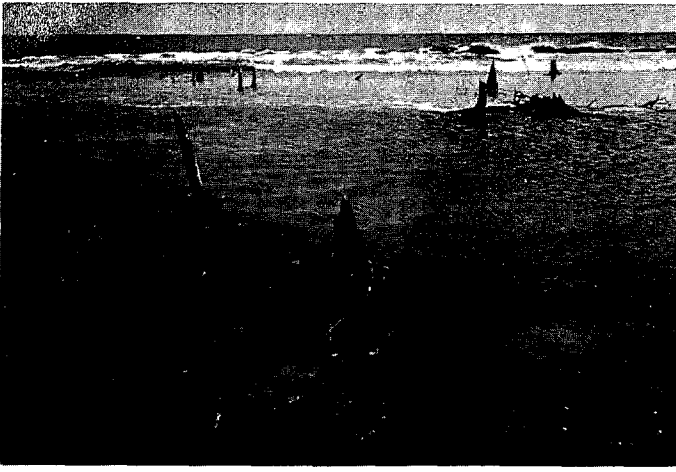


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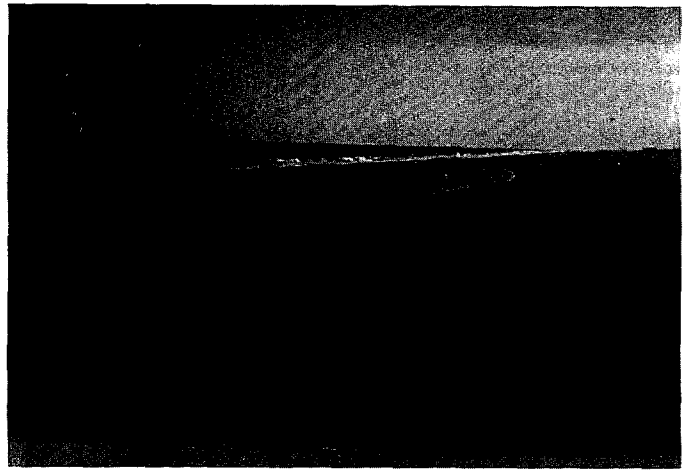


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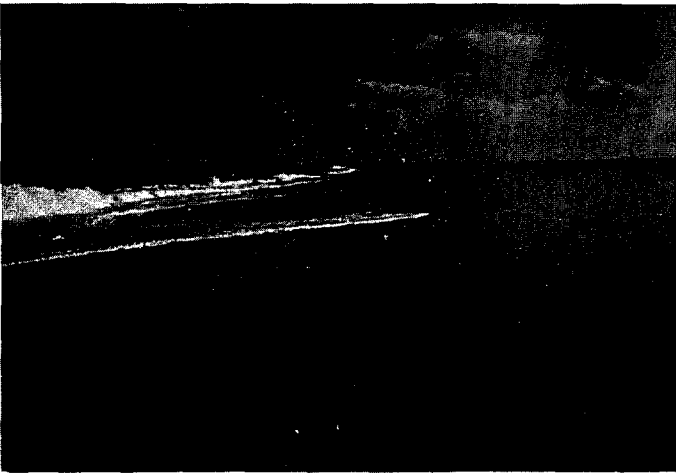


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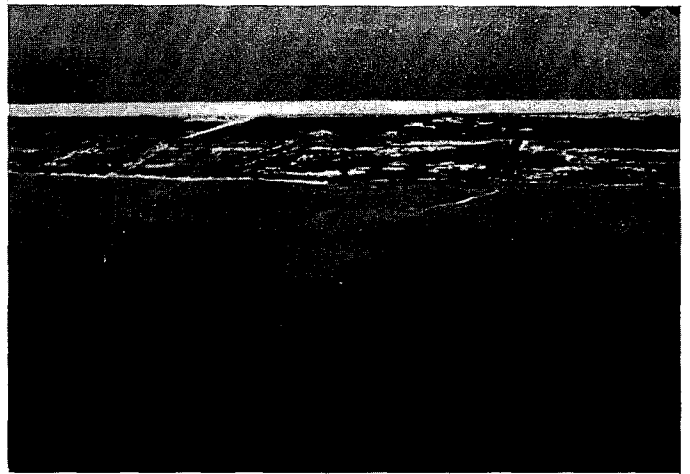


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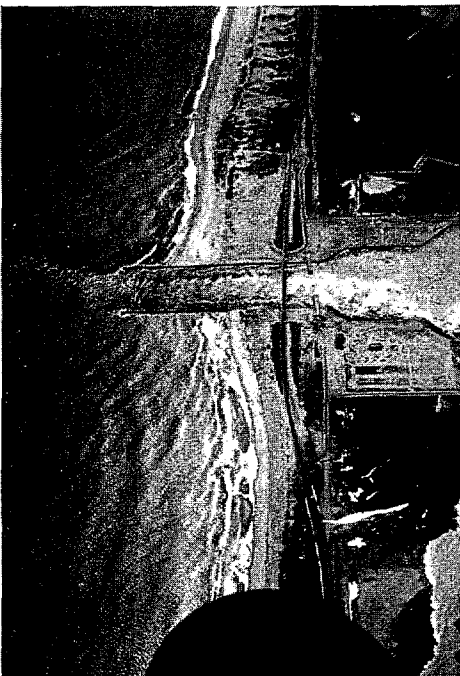


PHOTO 32



PHOTO 33

28. Many of the storms that erode the Atlantic Coast of the State uncover tree stumps in the surf. Using the radio carbon dating technique, these trees have been determined to be about 250 to 300 years old. Such trees, however, can only exist on the backside of a barrier, and of course, must be above sea level. This photograph was taken in Delaware Seashore State Park, south of Dewey Beach at low tide. This indicates that the sea level has risen relative to the level of this barrier and it also indicates that the sand barrier was much further seaward of this at one time.

29. Following any storm, which has resulted in beach erosion, there is an almost instantaneous repair process which begins. Some of the sand that is transported onto the offshore bar migrates landward and it can be seen happening here. This sand ridge is gradually migrating landward.

30. Completion of this repair process results in the re-establishment of a normal beach.

31. This is a view of the backside of the barrier just south of Dewey Beach. After the 1962 storm washed across this barrier, a dredge was used to dig up material to place on the beach and repair the road bed. The project was conducted on an emergency basis and created the trenches visible on the nearshore area. Several people have drowned in these trenches while clamming. This emergency project has cost as many lives as were lost during the storm of 1962. It indicates some of the problems of acting to hastily to repair the beaches. These holes have since been filled in.

32. This is a view of the Indian River Inlet and illustrates the so-called jetty effect. In this area, the net littoral drift is from south to north (top to bottom in this photograph). The updrift jetty traps a massive quantity of sand and prevents it from reaching the north beach. Moreover, sand bypassing the south jetty on the flood tide is swept into the inlet and deposited as a flood tidal shoal. Upon reversal of the tide, sand bypassing the jetty is swept offshore and deposited in an outer bar. The cut off of sand supply to the north beach causes massive erosion, as is evident in the photograph. Without the nourishment of the large quantities of sand on this beach, it would have eventually retreated and undermined the foundation of the bridge approach and highway.

33. This is Indian River Inlet after the 1962 storm. The barrier has been deflated or lowered by storm waves which washed across the highway and then into the marshes just north of the Indian River. This should be considered a normal event for storms of this magnitude and it should be expected to happen again. The old Indian River Inlet Bridge, shown here, was structurally damaged during the 1962 storm. It has since been replaced by two new bridges; which have been constructed seaward of this location. If we were to experience another 1962 type storm,

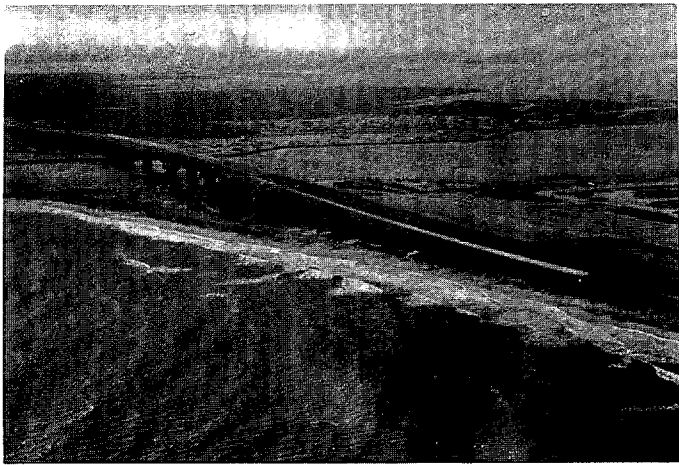


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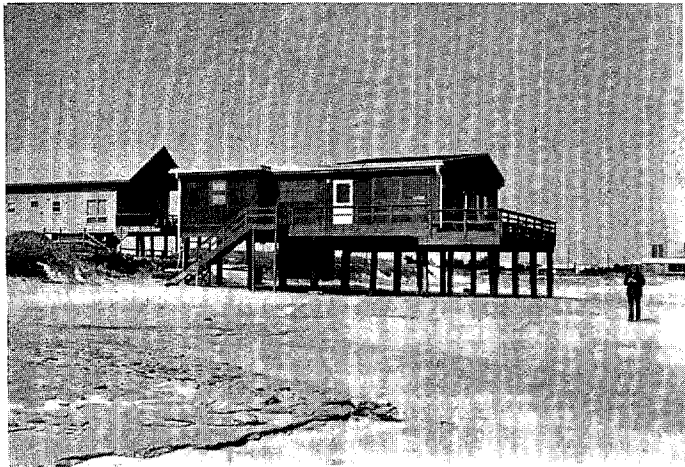


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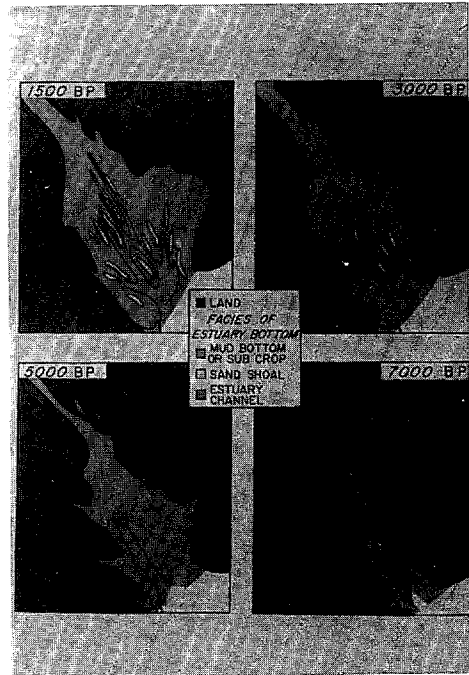


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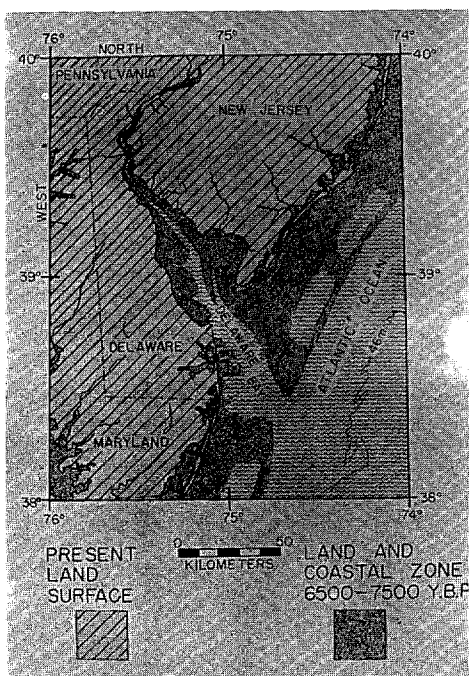


PHOTO 38



it is evident what will happen, because serious erosion problems have been experienced here even during very minor storms. No one has considered what might happen if a hurricane would hit the coast here. It can safely be said that a hurricane with maximum force winds from the northeast would destroy the footings of the bridge and take the highway away.

34. This is another view of Indian River Inlet following the recent storms of the fall of 1977. Note the proximity of the dune scarp to the bridge approach.

35. Another major problem facing some residents of Delaware is illustrated in this photograph at South Bethany. These houses have been constructed on what is called the berm or beach face and remnants of the dune can be seen landward of the first row of houses. The 1962 storm destroyed the entire front row of houses on this beach, and even though the beach retreated substantially, the houses were reconstructed in the same location.

36. This is another recent photograph taken in South Bethany Beach. It illustrates severe beach and dune erosion and the vulnerability of beachfront structures to storm damage.

37. In summary then, rising sea level has caused a continuous landward retreat of the shoreline. There was a time about 7,000 years ago when the present Delaware Bay was a river estuary. About 5,000 years ago, the Delaware Bay became larger, about half of its present size as shown by the light gray. Around 3,000 years ago, Delaware Bay looked similar to its present configuration, but the shoreline was still miles from its present position. What this illustrates is that there is an inevitable continuous motion of the shoreline in a landward direction. These processes can be expected to continue into the indefinite future.

38. If one examines the configuration of the Mid-Atlantic Coast 6,500 to 7,500 years ago, one finds that the Atlantic Coast of Delaware was much further seaward than at present and was located on the shores of Delaware Bay. Since that time, the shoreline has retreated 25 to 50 kilometers.

The purpose of my presentation this morning is to illustrate the continuing advance of the sea over the land. This rate of advance is not uniform all along the coast. At Cape Henlopen, the retreat of the shoreline averages about ten feet per year. Along the remainder of the Atlantic coastline, erosion averages about 3 feet per year and occurs at highly variable rates along the Delaware Bay. If I leave you with one idea, then it is that coastal erosion is really not a problem; it's a very normal thing and the only problem is man's intrusion into the coastal zone.

## COASTAL STORM EXPERIENCE

Robert D. Henry, DNREC

Erosion of coastal areas in Delaware is generally caused by one or a combination of the following:

1. Longshore or littoral drift currents generated by waves striking the shoreline at an angle to the beach.
2. A relative rise in sea level caused by melting of polar ice masses or gradual settling of the land or both, and
3. Storms generating high waves combined with high tides.

Certainly all three contribute to the erosion that plagues Delaware's beaches, but none is more obvious or dramatic and of such an immediate concern to the user of the coastal zone as are storms.

The subtle changes in the shoreline caused by less dramatic, but unceasing normal wave action and slight changes in sea level often set the stage for the rapid changes noticed during a storm.

Storms of two basic types combine with high tides to promote flooding and create serious erosion problems in coastal areas. Tropical storms formed over the warmer ocean waters of the Gulf of Mexico and Atlantic Ocean are best known. Hurricanes, which are tropical storms characterized by winds of 75 mph or greater, usually are accompanied by heavy rains, and are mostly limited to summer and fall.

It is interesting to note that, in the last fifty years, the coast of Delaware has not experienced a direct hit by a hurricane; most such storms pass by offshore as they move northward. Virtually none of the present coastal dwellers of Delaware, therefore, have experienced the damage and destruction of a severe hurricane.

Extratropical storms, often called "northeasters", present a particular problem to the Atlantic Seaboard. Such storms may develop as strong, low pressure areas and move slowly offshore into the Atlantic Ocean. The winds, though not of hurricane force, blow onshore from a northeasterly or easterly direction for sustained periods of time. The damage wrought by these storms may ultimately far exceed the destruction from a hurricane. The March 1962 "northeaster" proved that point decisively. Flood height and duration for extratropical storms have equaled or exceeded those of hurricanes brushing Delaware. Although hurricanes are significant to Delaware, the extratropical storms are equally



important as damage and flood producing events.

The major causes of erosion and flood related damage to coastal areas during storms are storm surge and wave action.

In shallow coastal waters, the storm winds can produce a surface current that flows in the direction of the wind. The wind-produced current produces a "piling-up" of water against the exposed coast and produces considerable flooding of low-lying areas. This is a simplified description of a storm surge. A significant rise in water level also accompanies the marked reduction in atmospheric pressure that occurs with tropical hurricanes. It has been determined that a one-inch drop of mercury in the barometer results in a 13-inch rise in sea level. A two-inch difference from normal barometric pressure is not uncommon for the eyes of tropical storms and hurricanes. Thus a 26-inch rise in sea level can result from this factor alone.

The term storm surge, when associated with a hurricane, includes the rise of water level due to both the wind stress on the water and the rise due to atmospheric pressure reduction. The effect of the storm surge on the coast depends on the interaction between normal tidal action and the storm-produced water level rise. For example, if the time of normal high tides coincides with the surge, the overall effect will be greater. If the surge occurs at low or falling tide, the impact will likely be lessened. Slowly moving "northeasters" may continue to build a surge that lasts through several lunar high tides. Such a condition occurred during the March 1962 storm. That storm lasted for five high tides with a devastating effect on the coast.

Storm damage to a shoreline is primarily the result of wind-generated waves riding landward on the elevated water surface of the storm surge. Storm waves develop from the high velocity winds blowing over open stretches of the water. Huge destructive waves can be generated by extreme storms. As waves move into the shallow waters long the coast, they steepen and "break", and expend a tremendous amount of energy against whatever is in their way. Waves traveling at thirty to fifty miles per hour in storms are not uncommon. One cubic yard of seawater weighing in excess of a ton and a half and moving at thirty miles per hour presents an obvious destructive potential to beaches, houses, bridges, roads and other structures in its path.

The erosion of Atlantic beaches and damage to property during the storm of March 1962 left no doubt of the forceful action of winds and waves. Storm damage to the shoreline was dramatic both in its intensity and in the short time in which the destruction was wrought.

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The entire mid-Atlantic coast suffered an estimated \$200 million in damages and a loss of 22 lives.

While no trend has been found to indicate an increase in the actual number or severity of coastal storms in Delaware, there has been apparent increase in the frequency of damaging storms. This is probably related to the increased coastal development combined with more accurate reporting.

While the loss of life from hurricanes and other coastal storms has been greatly reduced over the past few decades, largely as a result of better storm warning systems, communications, and transportation routes, property losses from such storms have greatly increased as a result of the building boom that has occurred in the coastal area.

During the period from 1960 to 1970, the population of the United States increased by about 12 percent, while the population of beach subdivisions increased by some 42 percent. Such a trend is likely to continue, at least in the near future, as incomes and leisure time increase.

The natural response of the coastline, as Dr. Kraft pointed out, is one of landward retreat. Unless the present trend of sea level rise stops or reverses, this landward retreat ultimately collides with the more or less fixed line of human development with obvious consequences.

Storm waves and surges punctuate the normal slow coastal erosion with periods of intensive energy, and bring major changes to the coast regardless of whether man's works are present or not. Thus periodic devastation of portions of the Atlantic coast is a certainty not just a probability. When the situation is viewed over the long-term (50-100 years), storms will likely have an increasingly profound effect as encroachment by the sea continues.



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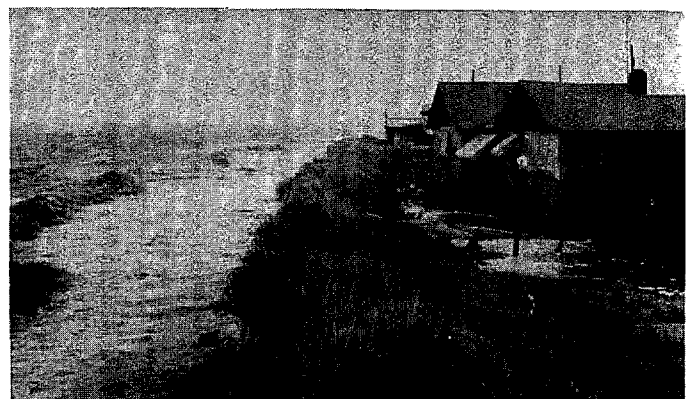


PHOTO 2

1. View of the Delaware Bay just north of Kitts Hummock during the storm of October 14, 1977. The elevated storm surge has completely removed the beach and is eroding the base of the dune.

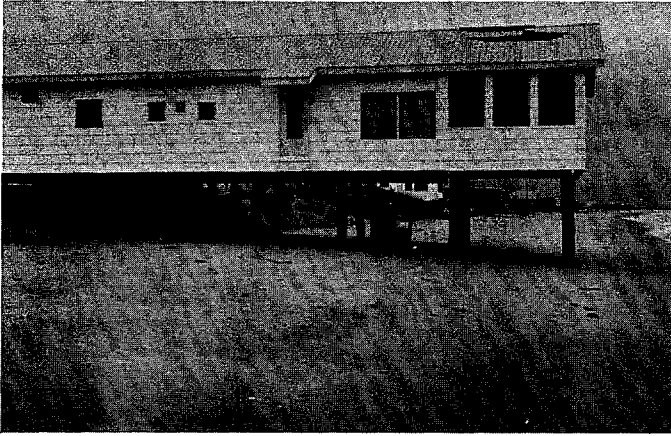


PHOTO 3



PHOTO 4



PHOTO 5



PHOTO 6

2. View of the southern end of Kitts Hummock during the October storm. This beach was nourished in 1974 and much of that material has been washed away by coastal storms in only three years. Flood waters at the right resulted from a break in the dune.
3. This house in Broadkill Beach was built in an area that underwent rapid coastal change following the December 1974 storm. The beach has been seriously deflated, several feet of beach surface were lost and the shoreline retreated 20 feet.
4. Dune breach at Slaughter Beach during the December 1974 storm. A washover fan and remnant flood waters are evident in the foreground.
5. View of the house shown in photo 2 following the December 1974 storm. A considerable quantity of sand had been pumped onto this beach as a protection measure earlier that year. That sand has been washed over the dune and deposited in the house and on surrounding property.
6. View of the more intense energy situation characteristic of the Atlantic Coast. These are storm waves along Fenwick Island during Hurrican Belle (August 1976). The combined effect of storm surge, tide and waves have covered the beach surface and threaten to breach the dune.

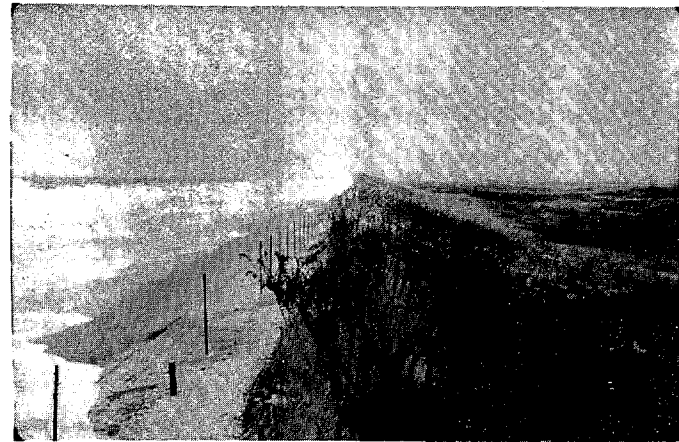


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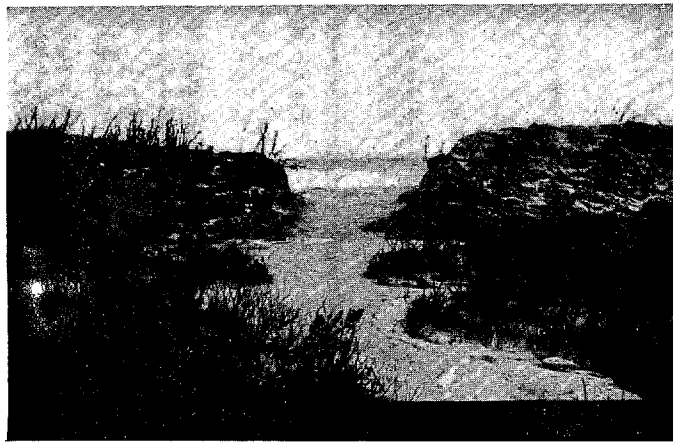


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PHOTO 10



PHOTO 11

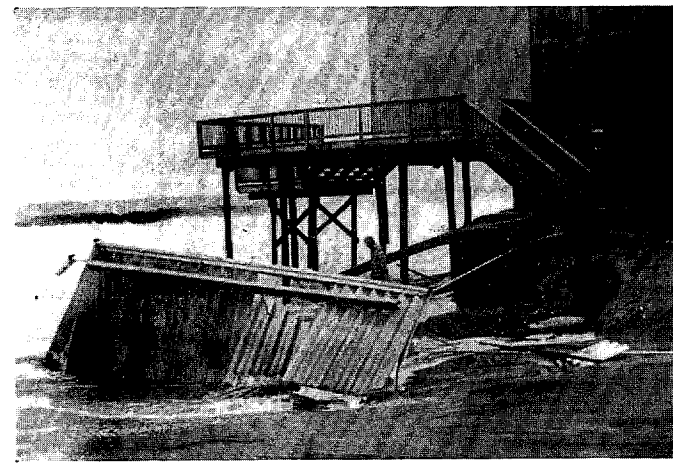


PHOTO 12

7. View of the primary dune just north of Indian River Inlet during the December 1977 storm. The combination of storm waves and reduced sand supply caused by the inlet jetties has created severe dune erosion. The fence posts in the foreground are remnants of repair works following the 1962 storm and were uncovered by storm waves. This illustrates that dune stabilization will not prevent beach retreat.
8. Minor dune breach, December 1977. Such events are common at weak spots in the dunes and are often the result of unauthorized pedestrian crossings which kill the stabilizing vegetation and permit dune "blowout". The potential consequences for back-lying structures should be evident.
9. South Bethany Beach during the December 1977 storm. These houses are now, through shoreline retreat, in front of what remains of the dune.
10. South Bethany Beach during the December 1977 storm. As the tide recedes coastal storm damage is evident; the dune has been severely eroded and the shoreline has retreated considerably. This is a natural process and should be expected. The debris destroyed during the March 1962 storm and has been uncovered by erosive waves.
11. No man is an island, but this house in South Bethany Beach is rapidly becoming one.
12. In South Bethany Beach numerous attempts have been made to protect property from natural erosive and storm forces, but without success. Bulkhead failure is quite common in this area and even though these structures are elevated, debris in the surf is capable of destruction. Note the sheared support pile above the man's shoulder.
13. Remnants of a bulkhead destroyed during the March 1962 storm can be seen in the right-center of the photograph. This provides evidence of shoreline retreat since 1962. This bulkhead approximates the dune crest at that time. The present dune is located out of the picture to the left.

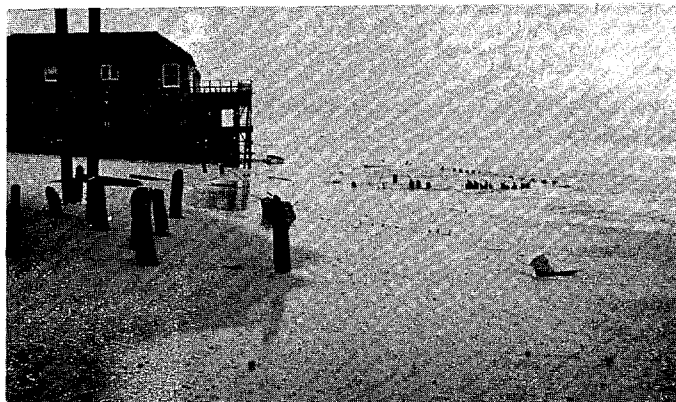


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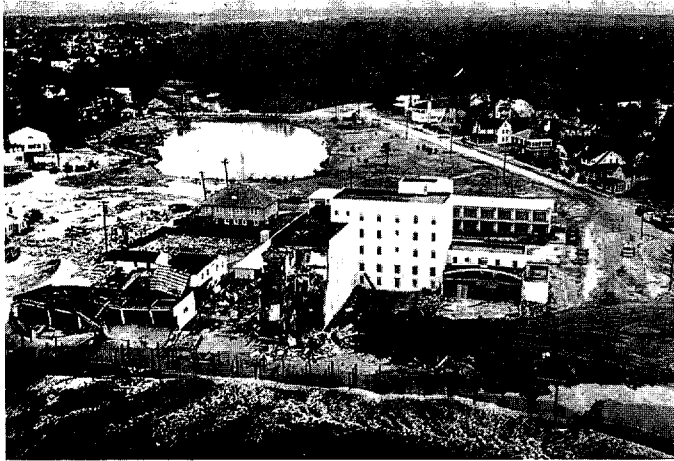


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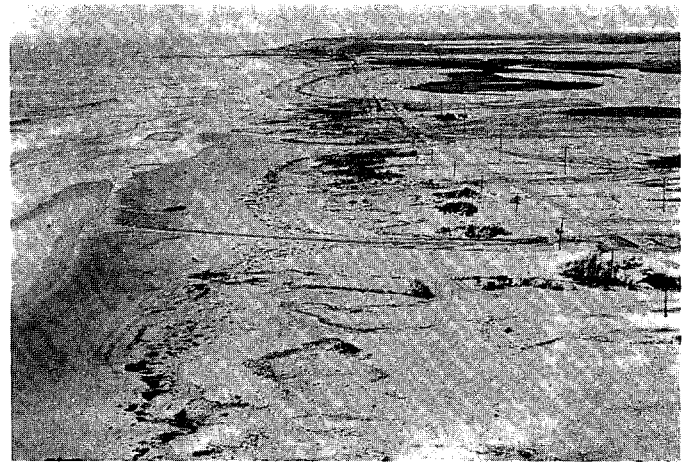


PHOTO 17



PHOTO 18



PHOTO 19

## THE GREAT STORM OF 1962

14. The Henlopen Hotel in Rehoboth Beach.
15. The Atlantic Sands Motel in Rehoboth Beach.
16. Dolle's in Rehoboth Beach. Unlike most of Delaware's coastline, Rehoboth Beach sits on a Pleistocene highland and as a result wave overwash does not occur here. The damage shown in these three photographs is caused not by direct wave action upon the structures, but rather by wave scouring of the foundation material. As this material is removed the weight of the structure causes it to fall forward into the sea.
17. This view of the beach north of Indian River Inlet illustrates the massive amount of washover that occurred during this storm. The dunes have been completely leveled and the sand has been deposited on top of the barrier and in Rehoboth Bay. This is dramatic evidence of the landward and upward migration of barrier beaches in response to rising sea level.
18. When structures are placed in the path of wave overwash, the consequences can be devastating to their owners. This is Nomad Village south of Indian River Inlet. The structures evidently were not adequately anchored and flood waters washing over the dunes carried them from their foundations into the roadway and into the marsh.
19. This is an aerial view of the barrier just north of Indian River Inlet during the peak of the storm and illustrates the massive washover and bay flooding. Delaware Route 1 has been obliterated. Note the numerous small inlets that have been cut through the barrier.



20. This is an aerial view of Fenwick Island and illustrates the extent of washover and flooding. The houses in the lower-center are under several feet of water.
21. This is an aerial view of Slaughter Beach and illustrates the problem of washover, but on a smaller scale vis-a-vis the ocean coast. Flood waters have broken through the barrier and cut new inlet channels into the backlying marsh. Here homes were picked up from their foundations and floated into the marsh. Note the house in the upper left of the picture. One life was lost here.

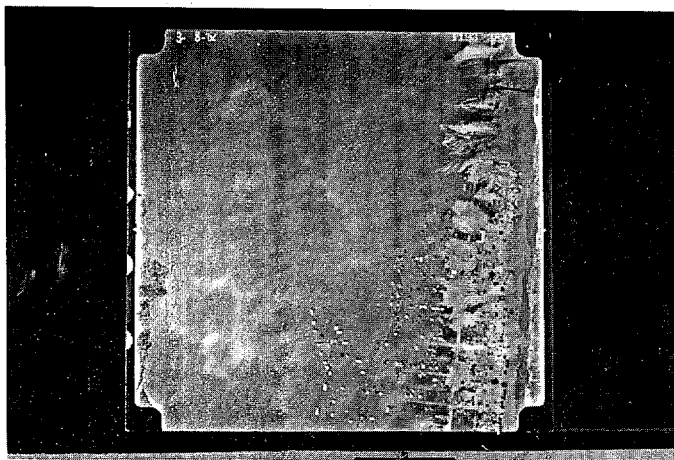


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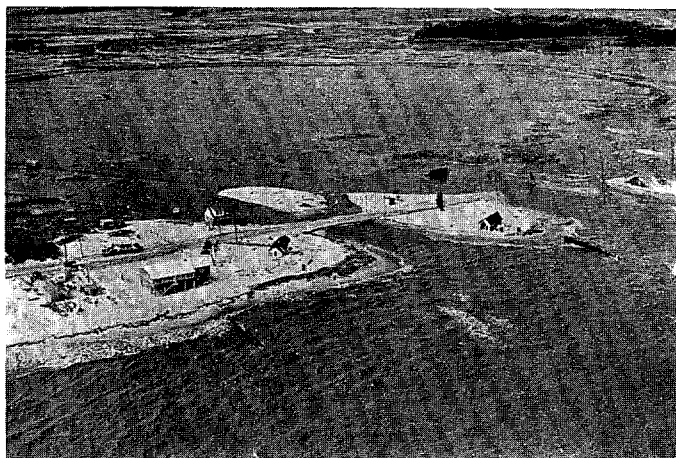


PHOTO 21

## CORRECTIVE APPROACHES - PRO AND CON

Dr. Robert G. Dean  
Department of Civil Engineering  
University of Delaware

Good morning. My name is Bob Dean from the University of Delaware. I am in the Department of Civil Engineering and College of Marine Studies. This morning I would like to continue the discussion which Dr. Kraft and Bob Henry initiated with primary emphasis now on corrective approaches to beach erosion.

### INTRODUCTION

Dr. Kraft and Bob Henry have presented what we might term the "forces" which are active in the coastal zone and which cause beach erosion. If I might summarize these briefly, they are: (1) the very slow and persistent rise in sea level which causes the response in the shoreline to be a landward retreat, and (2) the storms which occur and cause rather sudden shoreline recessions. Today I would like to provide the best information possible relating to both the effectiveness and cost related to beach erosion control. I would like nothing better than to appear here and tell you of an inexpensive and effective solution to beach erosion control. Unfortunately, that is not the case, so I'll try to provide my best perception as to what structures may be effective in certain locations and other approaches, namely, beach nourishment.

Perhaps before starting it would be worthwhile to mention that we are not able to predict, with confidence, the relative merits of a particular methodology or design of beach erosion control. We do have quite a bit of background and information gained, to a great extent through experience, which will prevent spending monies and efforts in wrong ways.

There are a few principles that I'd like to list before looking at some illustrative slides. The first of these is that beach erosion control is quite expensive. I think we'll touch more on that this afternoon. Beach erosion control is not a one-time solution. I think Dr. Kraft and Bob Henry indicated to us the persistence of the forces which are brought to bear on the shoreline and even if we are able to, with large expenditures of money, control beach erosion for some time, we would find that there are maintenance measures also required. Secondly, perhaps an obvious point, but one which may not be adequately recognized: Structures such as groins or seawalls will not somehow "encourage" more sand into the coastal zone. The picture that's been portrayed to us so far this morning really has been one of a lack of sand. The shoreline keeps retreating because of these forces noted, and if we want to stabilize the shoreline, which is one of the reasons we're here today, we need to consider adding more sand to the coastal zone. It is most important to recognize that no

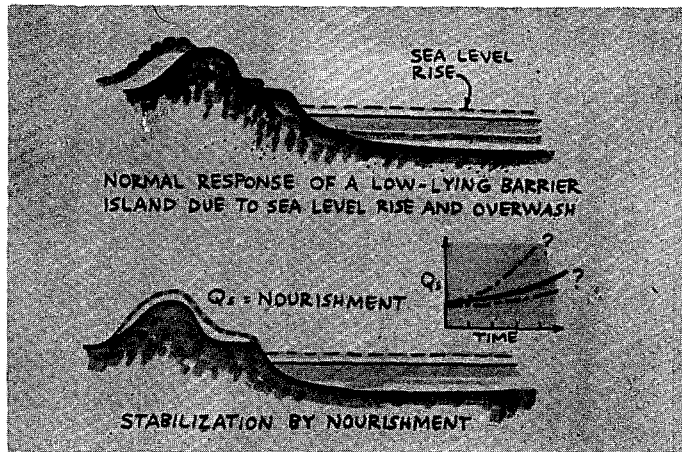


PHOTO 1

matter what structure we put out there, we will not have more sand in the coastal zone. We can, however, control the distribution of the available sand. For example we may put in groins that will collect some sand, but inevitably the sand that is collected by a single groin or a groin field will result in a deficit of sand and, therefore erosion, elsewhere. Thirdly, I think it's worth noting that beach erosion control should not be approached on a piecemeal basis; that is, with the possible exception of emergencies. The overall problems of beach erosion in a city, municipality or county will usually not be most effective if they are carried out by individual homeowners. Rather, the plan which recognizes of the overall longshore sediment transport processes will be most effective. Another point worth noting is that the problems of beach erosion control are more than just finding the best technical solution. The technical solution is an important element, but I think we will find in the program to be presented this afternoon that both economics and, to some extent, politics are important. For example, if the economic basis is strong, as it may be in a very developed area, it could be possible for the local upland owners to completely finance the beach erosion control project. Generally, that is not the case because the costs are quite substantial. With regard to beach nourishment projects, which is one method we'll discuss, the costs generally range from \$1 million per mile upward. The Miami Beach project which encompasses ten miles of beach is probably the most expensive project constructed to date and is a \$40 million project; that is, \$4 million per mile. Generally such projects cost somewhat less--about \$1 million to \$2 million per mile.

The remedial measures to control beach erosion that I'll present will include both structures, such as groins or seawalls, or beach nourishment or a combination of structures and beach nourishment, which is probably the most effective approach. I'd like to attempt to put things in perspective in the following way. This morning the long-term picture of the geologist has been effectively presented, i.e. a picture of a very definite erosive trend. The problem, as I see it posed for me today, is to indicate what types of effects we might expect if we attempt to forestall that trend; that is, hold the line against beach erosion. What types of problems will we encounter both in terms of methods and costs?

1. I will start with a slide which poses the problem reasonably well. This first slide is to some extent an extension of Dr. Kraft's discussion. The upper part of the slide shows the response of a low lying barrier island that normally occurs due to the sea level rise. The sea level rise is shown here, and as a rough rule-of-thumb, the sea level rise amounts to about one foot per century. This may not seem very rapid, but if we realize that the response of the shoreline has to be such that it maintains about the same relative position vertically, then I think we recognize that a foot per century can amount to quite a bit of vertical migration of the barrier island, and even substantially more horizontal migration. A foot per century would amount to something like three feet of horizontal beach recession per year.



PHOTO 2

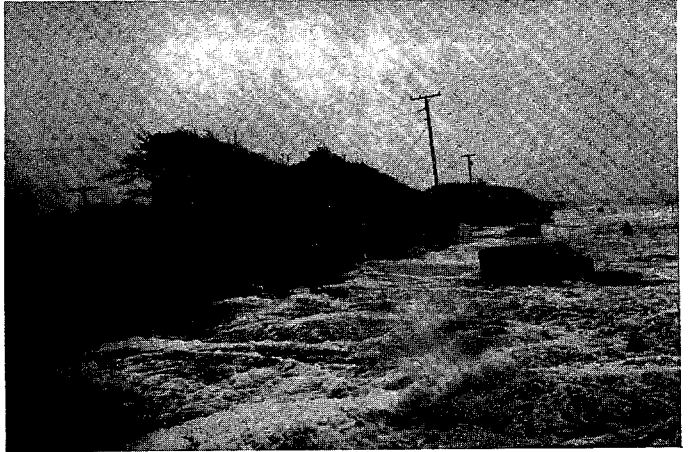


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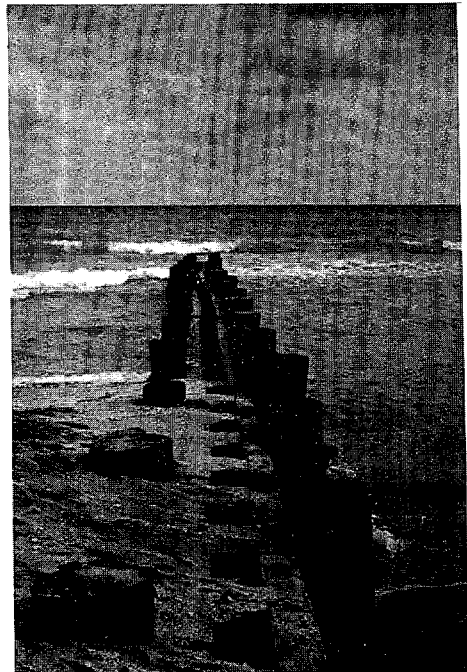


PHOTO 5

This is a natural response; that is, barrier islands tend to migrate upward and landward as a result of the rising sea level. The question which we're trying to answer today is: What kinds of control would we have to exert if we decide to stabilize the shoreline; that is, to hold the beach where it is presently located? There are two types of control that we could consider. One would be beach nourishment, the placement of large quantities of sand on the beach and the sand would, in part, be carried offshore to establish the beach profile that was in accordance with the sea level rise. I think we should also recognize that if we simply tried to stabilize the beach position but didn't allow the barrier island to build in elevation as well, then the susceptibility of that beach to overwash through storms, such as Bob Henry discussed, will be much greater. The second type of control would be through coastal structures.

2. I'd like to show a few slides of beach erosion and storm damage. Most of my pictures will not be of Delaware (I think you've seen quite a few slides of damage in Delaware). This next slide is on the west coast of Florida, and it was taken during Hurricane Agnes, about an hour after the peak of the storm tide passed that area. There was approximately a five foot vertical erosional scarp caused by the storm at that time. In a distance of two miles here, there were roughly 20 summer vacation cottages which were destroyed or severely damaged.

3. The third slide shows more damage due to the same storm. The small structures in the surf zone are septic tanks. There was a horizontal shoreline recession in this area due to that storm of about 100 to 150 feet.

4. This next slide was taken by the State Highway Department following the March, 1962 storm in the Rehoboth Beach area. I think you can see the manhole cover which provides an indication of the substantial lowering of the beach profile.

#### BEACH EROSION CONTROL BY STRUCTURES

5. One of the types of structures that might be considered is the groin, used either singly or in a groin field; that is, a system or series of groins. I will keep mentioning the obvious point that structures such as this do not really add any more sand to the entire system. They can be used as controls in redistributing the sand present in the system or probably more effectively in retaining sand which may be put into the system by man through dredging from offshore sources. Suppose you are involved in a small community project and decide to place significant quantities of sand on the beach for erosion control. If you simply place the sand there, you'll find that it tends to be transported away



PHOTO 6



by waves and currents. Part of the sand will be lost offshore, that's pretty much inevitable, but also quite a bit of that sand will be lost from the ends of the system. If you don't, in a sense, enclose the sand on the ends, it will simply be lost to the adjacent beaches. It's not lost to the overall system, but if relatively large expenditures are made to nourish large segments of beach, then it may be worthwhile adding structures to stabilize the material. Two of these structures could be placed on the ends of these projects, (called "terminal structures") and then perhaps intermediate structures to further stabilize the beach.

I'd also like to indicate what approximate costs might be involved in these different types of structures. This groin would probably cost around \$10,000.00. Some groins that have been built in Galveston, Texas, which are very substantial and nicely built, cost upwards of one hundred thousand dollars when constructed ten years ago. So, substantial beach erosion control structures can be very expensive. This picture of a groin portrays well the principle that sand collected on the left-hand side is really in a sense sand that has been deprived from the upland owners on the right-hand side of the photograph. These structures can only redistribute or retain available sand. They don't cause an additional quantity of sand to be brought into the surf zone.

6. This is a photograph of a series of groins which indicates another important factor, if you are in an area where the sand transport is occurring either up-coast or down-coast, and you decide to stabilize the shoreline by emplacement of one or a series of these structures. Then indeed the groins will probably collect sand, but they will also set the stage for many of these structures being built further down the beach. Even if one is only considering a fairly small geographic area, it's very important to consider the consequences of emplacing a single structure, because, if the structure causes erosion, additional structures may be required, and it is possible that the effect of the structure eventually will cause effects several miles away. In a number of places in the past, structures of this type have been simply installed to aid the immediate area. If an area is going to consider installing groins such as this, then the design of the groins is very important. Also it's important to fill them initially because otherwise they will be filled from the "littoral stream" of sand and in the process will deprive the downdrift area of sand which it normally would receive. The types of groins which appear most reasonable are ones which are of a fairly low profile; that is, they do not represent a severe barrier to the longshore sediment transport processes. Perhaps it's worthwhile noting that many individuals are convinced that if groins or certain types of corrective actions are constructed, a beach will be retained. A very brief story about Miami Beach is relevant. In 1928 a very severe hurricane caused flooding and beach erosion in Miami Beach. It was probably the worst hurricane experienced in recorded history, and it removed a great deal of the sand from the beaches and stored this sand in an offshore bar. Much of the sand that is eroded from beaches and carried offshore is then later brought back by milder wave action.

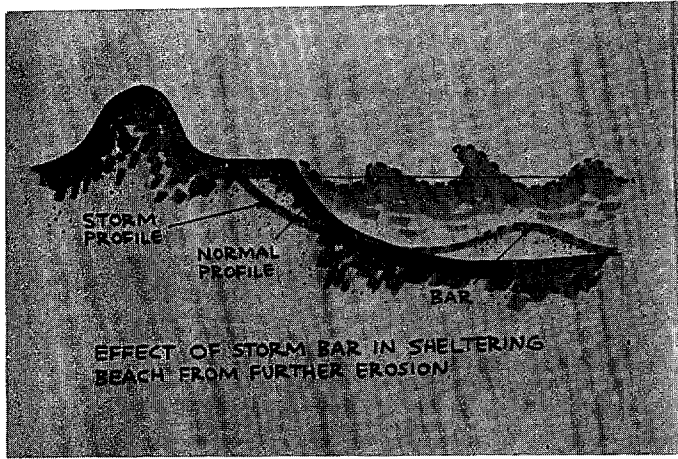


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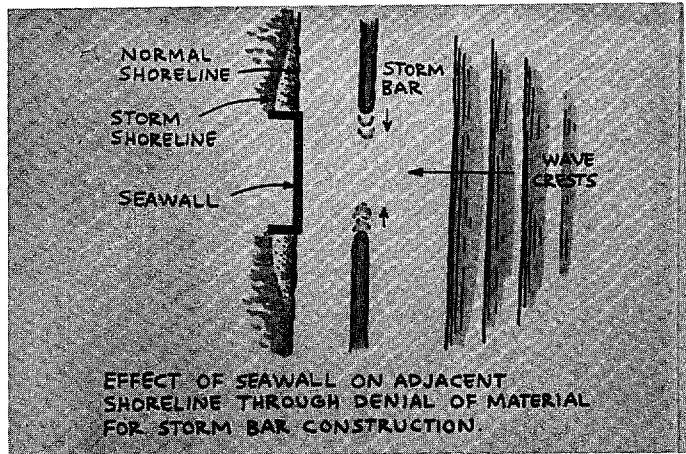


PHOTO 8



PHOTO 9

Shortly after the 1928 hurricane, Miami Beach initiated a groin construction program and built many steel groins. Following the construction of those groins, the beach started its normal, natural recovery process and in a period of about two years most of the sand that had been eroded reappeared on the beach. The interpretation by many individuals was that this was "cause and effect"; that is, the groins resulted in the reappearance of the beach. Sometimes evidence can be very misleading.

7. I'd like also to discuss seawalls and their effects on the coastline. As an introduction let's again look at the natural process. We know that what might be termed the normal profile is fairly uniform and during storms we have both storm tides and waves. These cause the beach to be cut back, and if they're high enough, overwash may occur. Much of that sand is carried offshore and deposited in a bar. The bar is an interesting feature in that it represents sand that was eroded from the beach, but in a sense it also represents a feature which limits further beach erosion, because when the bar builds up to a height such that the waves break on the bar, the wave action on the beach is decreased. After enough sand has been removed from the beach by the waves, carried offshore and deposited as a bar, then the waves tend to break and dissipate a great deal of their energy on the bar rather than on the beach, and eventually the erosion will be limited by the presence of the bar as shown in this slide.

8. Let's suppose that now we are going to install a seawall. One of the immediate consequences of installing a seawall is that, with the slow erosion process illustrated earlier this morning, we can be quite sure that unless we nourish the beach, a beach will not remain very long because it will be eroded back to the seawall. A second important consequence has to do with the bar construction by the storm waves. Here, we're looking down on an area that has a seawall and with the seawall present, of course, there is not material to be carried offshore immediately in front of it to reside in the bar. There are two effects; one is that the beach will tend to erode to a greater depth in front of that seawall, simply because there is a reduced bar formed directly in front of the seawall. Secondly, areas adjacent to that seawall will experience more erosion than they would have had if the seawall were not present. If the storm lasts long enough, these adjacent areas will erode back an additional amount to provide the material comprising the offshore storm bar in front of the seawall. This may seem like just a concept, but in Hurricane Eloise in the panhandle coast of Florida, there was a fairly extensive survey which did illustrate this effect.

It might be mentioned that a substantial seawall costs a minimum of \$200.00 to perhaps \$500.00 per lineal foot. That would be a seawall built out of concrete which could withstand the action of fairly sizeable storms.

9. In this next slide, an attempt to prevent erosion by a rock revetment (a form of seawall) is shown. The purpose of this slide is to illustrate that we are really dealing with a system in which the sand transport processes are very dynamic and that

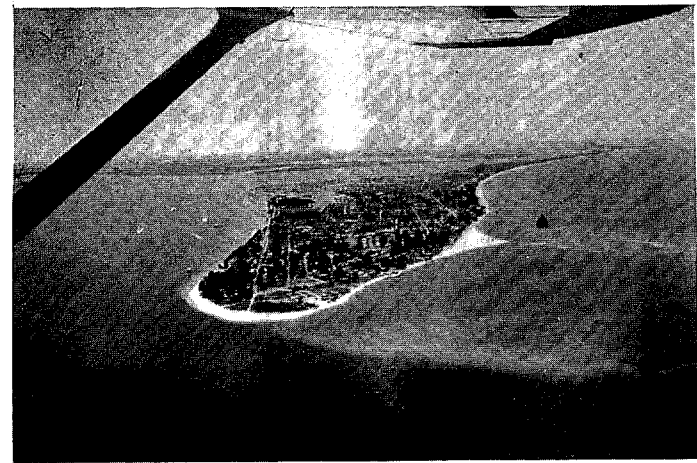


PHOTO 10



PHOTO 11



PHOTO 12

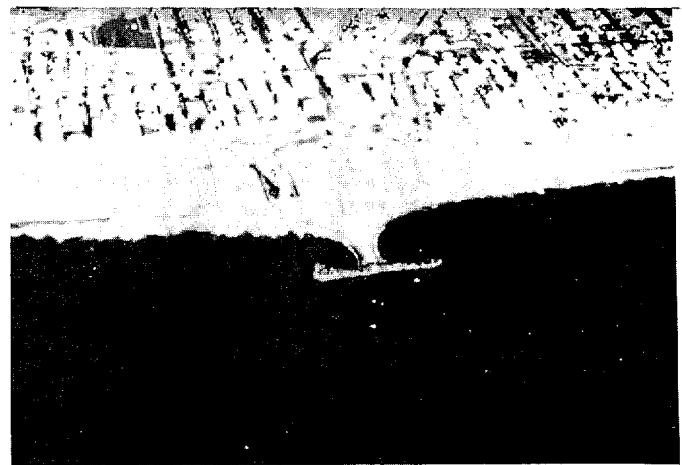


PHOTO 13

the system is very changeable.

10. For example, this is an area on the west coast of Florida where a protuberance or bulge in the shoreline has been built in response to an offshore shoal and part of this sand has been drawn from adjacent shorelines. I think the moral of this is that we should respect the fact that there are natural swings in the shoreline and we should try to regulate our construction in accordance with those natural oscillations in the shoreline.

The house shown in the previous slide is located just north of the bulge in the shoreline. An attempt has been made to protect this structure with a type of seawall that has rock fronting the vertical concrete seawall. I think you can see that this has placed more erosion pressure on the adjacent shoreline, simply because when a storm occurs, there is no sand available here to construct the offshore bar in front of the area which has the seawall.

11. This is another series of structures in the same general area. Because of the clear water we can see some of the effects of the slow encroachment of the sea. Seawalls are visible which at one time protected homes that were located on the shoreline. You can see, I think, that the shoreline has retreated on the order of some 300 feet. This has happened in a 20 or 30-year period. One of the other factors that's very important in considering beach erosion control measures, especially structural control, is that if the structure does fail during a storm, then the shoreline will retreat very dramatically. For example, once the effectiveness of the seawall is lost, usually by waves coming around and flanking from the sides, then the erosion occurs very rapidly. So it's not a gradual effect evident after one or two storms, following which one would have sufficient time to take corrective measures.

12. Discussing further the effects of seawalls, it was noted that building a seawall can also affect the adjacent shoreline. This slide was taken in an area on the east coast of Florida which had a long history of stable shorelines. This is a small town, Golden Beach, north of Miami Beach and the shorelines have been so stable that they had no seawalls, groins, or coastal structures. The structure in the foreground is not a seawall, but a retaining wall for a backyard that used to be located here. The condominium which is in the background was believed to be built illegally; that is, too far seaward in relation to the building code at the time and the effects on the downdrift beaches which are to the south were both immediate and dramatic. Over a period of about three months, the beach profile lowered about five feet vertically and the retaining wall failed within a very short time. The effects were felt some distance to the south.

13. Another type of structure that might be appealing is that of an offshore breakwater. This is being considered quite a bit in this country now, and has been used in other areas of the world, primarily Japan, Singapore, and some of the Caribbean countries.

This slide shows an offshore breakwater and the accumulation of sand that has occurred landward of the structure. It is evident that

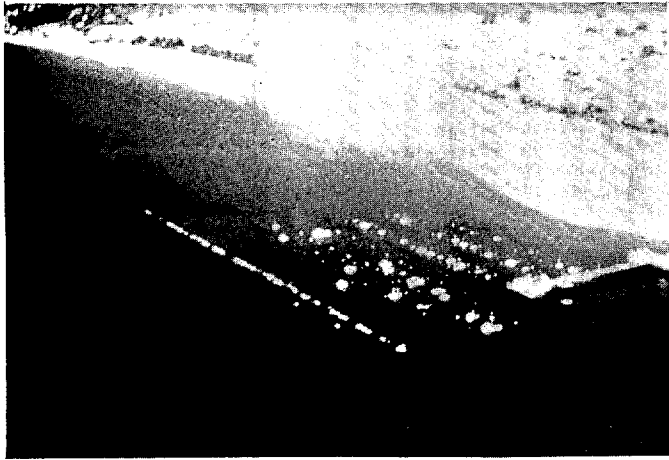


PHOTO 14

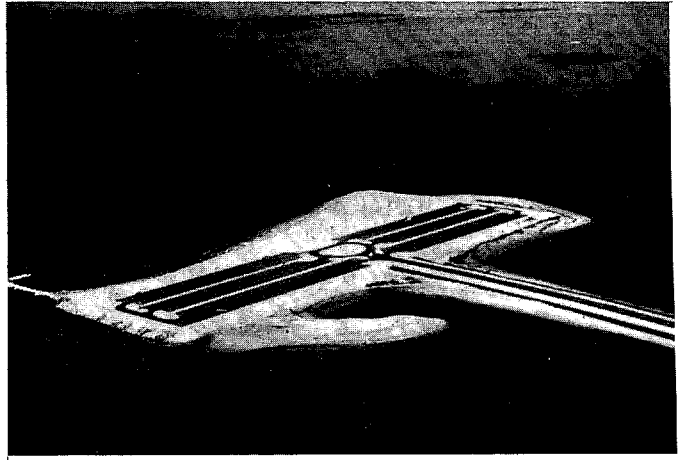


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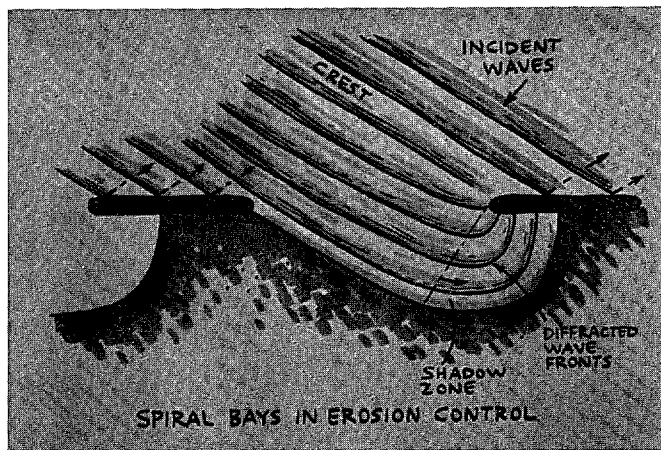


PHOTO 16

offshore breakwaters do tend to shelter the shoreline and tend to collect sand behind them. Again, it should be noted that these offshore breakwaters do not add any sand to the system, but they simply provide a sheltered area that causes sand to gather in the region of greatest sheltering, and they do form quite nice beaches. The sand collected behind the structure provides a very usable recreational area in the sense that away from the breakwater, the waves are the same height as they would be without the structure present. In the lee of that structure there is a wide range of wave heights. This type of structure is quite expensive, if built in water depths as shown here, and would cost on the order of \$5,000-\$7,000 per front foot of beach. They are quite expensive and probably most areas don't have the financial capability of installing these. Such structures can be justified economically only in densely populated resort areas which, through federal ownership, qualify for expenditure of federal funds.

14. This is an area in southern California where an offshore breakwater was constructed. It's not a breakwater which completely shelters the beach. It's quite permeable during periods when there is wave action. Some wave energy penetrates through the breakwater and impinges on the shoreline. The effect of modifications on the shoreline is much less severe than in the previous photograph.
15. This slide is included to show some of the types of structures that can be used, and how structures can be used to form shorelines. This is an offshore "island" built for recreational purposes. Incidentally, it is evident that this structure was slightly mis-oriented. Ideally the beach would be designed to be perpendicular to the incoming predominant waves. Structures such as these rock structures on the ends of the beach are used to retain sand. This principle should be effective for retaining beach nourishment sand.
16. One of the final methods that has not been used very much in this country, but has been used elsewhere and I think has a potential of being a very innovative, effective and relatively inexpensive means of erosion control, is the use of structures which are spaced on the order of several hundred feet apart to form "crenulate" or "spiral" bays. Basically these have many of the features discussed previously for offshore breakwaters. That is, they provide a sheltered area safe for children to play and then more exposed areas for those interested in surfing or other activities. These structures would be built in much shallower water than the offshore breakwaters, and hence would not be nearly as expensive. Although these structures have not been used widely, they do offer an attractive potential for beach erosion control. There is the problem mentioned earlier, that if during a storm the connection between the structure and beach is lost, or in effect the structure is flanked by waves, then, of course, the shoreline would recede very rapidly. Furthermore, it is important to note that, as discussed this morning, sea level is rising and the result will be continual deepening of the profile on the seaward side of the structures. Storm waves



will always tend to cause erosion in front of that structure and to cause it to fail. This kind of a combination of structures with the addition of sand could conceivably provide an attractive approach to a partial remedy of Delaware's beach erosion problem. Consider the case for this type of structure where the transport of sand under the natural wave system would be from right to left. Sand carried around these structures would be transported into the bay and then into the next bay and so on. If enough sand is provided initially then any interference with the natural supply to some downdrift area is minimized.

### BEACH NOURISHMENT

Beach nourishment is important because it is a procedure which will be the dominant approach in most future beach erosion control projects. As noted earlier, beach nourishment costs on the order of \$1 million a mile and probably is most effectively carried out in conjunction with structures to retain the sand. Sand for beach nourishment is usually obtained from offshore sources. In very early projects, sand was obtained from bays; however, present strong environmental concerns rule out this as a possibility. Moreover, sand from offshore areas is usually more compatible. The cost is about \$1-\$5 a cubic yard. It's important when considering a beach nourishment project to be sure that good quality sand is used, i.e. sand that is as coarse or coarser than the sand on the beach. Projects constructed with very fine sand usually have a very short life. Such material tends to be put into suspension by the waves and carried offshore. Generally, substantial beach nourishment projects require on the order of five years or so to be implemented. Perhaps some of the other speakers from the Corps of Engineers this afternoon can discuss this aspect in greater depth.

### SET-BACK LINES

One final approach, which I haven't mentioned but was briefly discussed this morning by Governor Du Pont, is that of a set-back line. The entire State of Florida at the present time has initiated a so-called set-back line, which simply represents the seaward limit where construction can occur without a variance being obtained from the State. The set-back line is established in proper recognition of shoreline processes and the storm tides that would occur with a certain return period (the State of Florida has elected to use a 20-year return period for the storm tide which they consider in their set-back line establishment).

### SUMMARY

I'd like to conclude by mentioning that at present we really do not adequately understand the degree of protection or effectiveness to expect from particular beach erosion remedial measures. More studies and monitoring are needed in this area. I think a particular example noted in some of the presentations has been

that a considerable number of beach nourishment projects have been conducted in Delaware Bay, but their effectiveness has not really been studied adequately. Moreover, most of these projects were relatively short, and there will be fairly high losses from the ends of such projects. These projects, unless carefully interpreted, are not really a fair test of the effectiveness of nourishment as a control measure. Unless terminal structures, the retaining features mentioned earlier, are installed, the duration of short projects will be extremely limited and the sand will be lost from the ends of the project.

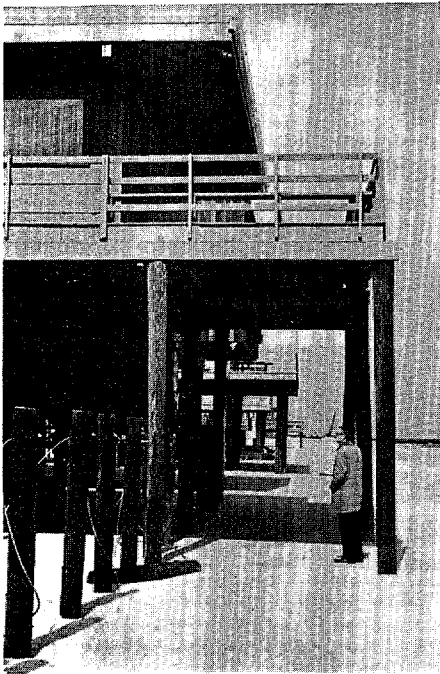


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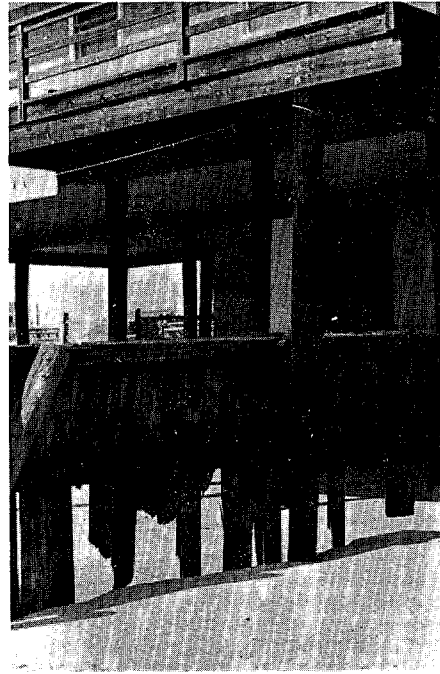


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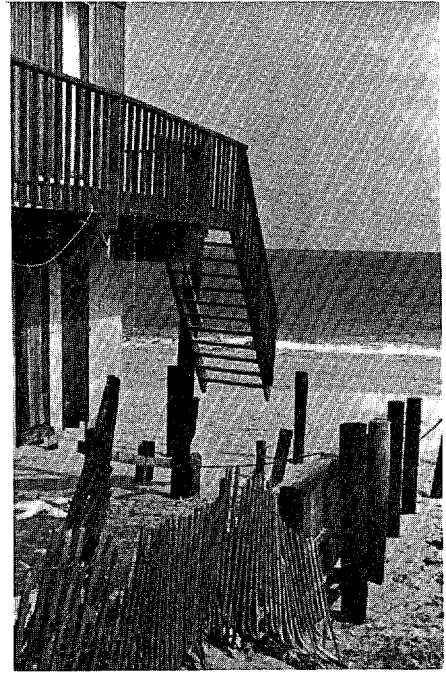


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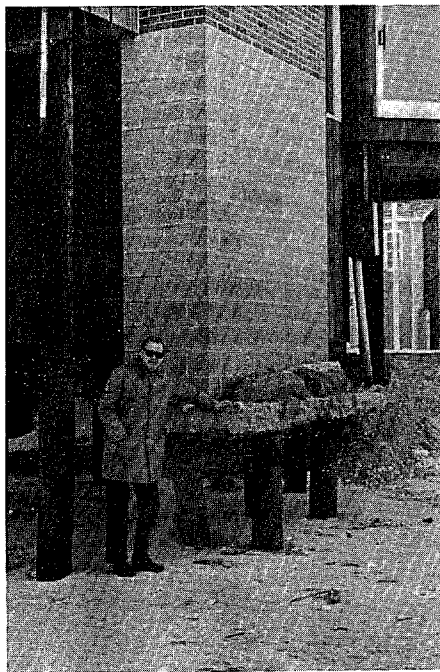


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PHOTO 5



PHOTO 6

## WALKING TOUR OF SOUTH BETHANY

During the lunch break, Dr. Kraft conducted a tour of South Bethany Beach so that the workshop participants could view first hand the effects of coastal processes on development.

The consequences of a "parade" of relatively mile "northeasters" were still quite evident; destroyed bulkheads, uprooted septic tanks, sheared support pilings, beach deflation and dune erosion. Remnants of damage from the March 1962, uncovered by the recent storms, were also visible. Dr. Kraft reiterated the geological processes responsible for barrier beach movement and described the futility of attempting to protect structures such as these from rising sea level, washover and flooding. He also illustrated how these houses actually contribute to their own destruction. It was his opinion that it was only a matter of time, and a short time at that, before the sea would claim these structures as it had in 1962.

Some participants expressed concern that, despite the unstable nature of this area and the obvious effects of recent storms, two new houses were under construction.

- 1-3 The storms of October and December, 1977, destroyed or damaged numerous bulkheads and removed fill material behind them.
- 4 Peter A. Larson, Executive Vice President of the Greater Wilmington Development Council and member of the Council on State Planning illustrates the degree of beach deflation following this past winter's storm.
- 5 Walter Pierson, Regional Director of the Federal Insurance Administration, flanked by Paul Jensen of the Marine Advisory Service and John Hill of WBOC TV.
6. Representative Gwynne Smith.

- 7 Senator Andrew Knox (L) and William Gaither, Dean of the College of Marine Studies.
- 8 Col. Harry Dutchyshyn, Philadelphia District Engineer, U.S. Army Corps of Engineers.
- 9 From left to right, Dr. John Kraft, Chairman of the Department of Geology at the University of Delaware; John Huges, Commissioner, Rehoboth Beach; Robert Henry, Beach Preservation Section, DNREC; and Austin Olney, Secretary, DNREC.
- 10 William Ratledge, Director of the Division of Soil and Water Conservation, DNREC flanked by Mrs. Lu Gonzalez (L) and Mrs. Alice Kaiser, both residents of Kitts Hummock.



PHOTO 7



PHOTO 8



PHOTO 9



PHOTO 10

OVERVIEW OF THE STATE PROGRAM-  
OPERATIONS AND REGULATIONS

Austin P. Olney, Secretary  
DNREC

One of the frustrating things about our beach program, after having listened to three hours of instructional material on how fast we are losing the battle, is that fighting erosion is a little bit like fighting a forest fire with a water pistol, I'm afraid. But, in any event, even though we have water pistols to work with I would like to describe what they can do. The Legislature, very wisely in 1972, passed the Beach Preservation Act. Recognizing the important aspects of beaches in Delaware, not only as an important part of the tourist industry and part of our recreation amenities, but also as an important part of the system of protecting our coastline from storms, the Beach Preservation Act provided, in part, the establishment of a beach preservation fund with an annual balance of \$1,000,000. That fund was established to enhance and preserve our beaches by means of preventing and repairing beach erosion. In addition, the Department of Natural Resources and Environmental Control was designated as the sole agency to carry out the provisions of that act. Moreover, the authority was given to the Department to promulgate regulations in order to further carry out the purposes of the Act. Basically, as our program has evolved, there are two principle parts: (1) a regulatory part; and (2) a beach maintenance part. As far as the beach maintenance part is concerned, I think most of you are quite familiar with our activities. In the past five years, the State has spent nearly \$2,000,000 to nourish beaches and perform mechanical work to restore beaches to a contour and dimension that will not only withstand storms better, but also to provide a recreation resource. In addition to that, under this beach program we have also carried out an extensive program to plant dune grass; about 600,000 dune grass plants were planted in the last fiscal year. I know that this does not sound like much, but it is absolutely a vital part of our beach program, aside from the nourishment work and the mechanical work that is performed by the State. Planting of dune grass helps stabilize the dunes and prevents accelerated erosion which would otherwise be caused not only by wind, but also by water. In the last fiscal year we have also erected nearly 40,000 linear feet of snow fence in an attempt to hold the dunes in place and prevent further erosion. I am also sure you have all seen our crews, under the direction of John Hughes, carrying out work to provide the proper dune shape wherever a dune has a face too steep that it would excelerate erosion. His crews are out reshaping the

beach so that it will have a contour that will be more able to absorb the energy of the waves and provide a better barrier to storm erosion. The Department also participates in Corps of Engineers projects to do beach nourishment and restoration work. Colonel Harry Dutchyshyn will talk to you in more detail about the federal program in which we participate. I will leave that part of it aside. I think one of the most important parts of our program, which I alluded to earlier, is the regulatory work. One of the most destructive forces to a beach and dune system is man himself; either by walking on dunes to create crossovers which in turn contributes to breaching of dunes during storms; construction of housing on the dune line, which accelerates the destruction of the dune; and by simply trampling on dunes in such a fashion that they lose their shape and are more susceptible to storm flooding. Under the authority granted to us by the Legislature, the Department enforces a beach crossover program where the number of places pedestrians can cross dunes is substantially reduced. We have thus eliminated all other areas for pedestrian traffic which in the past has accelerated dune erosion. This program has enabled the State to reduce the excessive number of breaches that were being caused by random pedestrian crossovers.

By far the most significant part of our regulatory program, aside from keeping vehicles and pedestrians off the dunes, is the regulation of construction of houses on the dunes. I think it was very apparent today in South Bethany that we have not been able to stop construction altogether, but what may be less apparent is that we have put construction standards into effect for the houses that are built. Those standards will better enable those houses to withstand storms and also provide better protection for the people who have residences behind those houses. In particular we have a policy which states that anyone, who has a lot which does not enable him to build on the landward side of the dune, must come to the Department of Natural Resources for a permit. This enables us to apply conditions to the construction of houses. We can require pilings to be driven to certain depths, and require certain types of construction methods to be used so that the structure will be able to withstand certain design storms, specifically a 100 year storm. This has been our principle method of regulating indiscriminate construction on the dune. In the past fiscal year seven permits were issued for construction of this sort. I think we do not have the records to know how much building was done before, but I think this would give an indication of how we have managed to at least put the lid on the type of building practices that took place in the past. The State does not have the authority, in the opinion of the Attorney General's Office, to prohibit construction altogether. There has been a lot of debate on this issue in other states and it is generally construed to be a



"taking" in the constitutional sense, if construction were absolutely prohibited. The primary thrust of our regulatory program, therefore, is not to stop construction, but to ensure that construction which does take place is done in the soundest manner possible and in a manner that will provide maximum protection for those residents who live behind those houses.

One thing I hope we do this afternoon is to discuss ways in which the regulatory program can be improved. I think it was apparent today, as Dr. Kraft pointed out in South Bethany, that building on the dune line continues to accelerate the erosion around the houses. That construction, in fact, can only help to contribute to flooding and breeching of the dune line on either side of the house and further jeopardize property owners behind that dune line. I think the State has an obligation, not only to protect the houses by insisting on high construction standards, but has an equal responsibility to see that the interests of property owners behind the dune line are also adequately protected. Our regulations now, frankly, are not detailed enough and they need to be amplified. Perhaps we could learn from other states. So I am hoping, as we get into the question and answer session later this afternoon, that we will be able to discuss some ideas about how to improve the regulatory program and to see that the interests of all property owners in the area are better protected.

## FISCAL ISSUES IN BEACH EROSION CONTROL

Nathan Hayward III, Director  
Office of Management, Budget and Planning

Well it always seems to fall to somebody to have to bring up the difficult, but nevertheless necessary subject of money. Since that seems to be part of my responsibility, I guess the job has to fall to me. What has been discussed so far this morning and this afternoon are really the problems of dealing with nature; nature in a very fluid and a very destructive mood. We must face the fact that there is absolutely no way we can control nature to the degree necessary to remove all risks. Work at the beach, whether public or private, is risky business. I do not think there is anyone in this room or anyone in the coastal communities that does not recognize that. The tradeoff, of course, is that there is both public and private pleasures to be derived from using beaches for recreational purposes, as well as pleasures for those home owners living there and the obvious financial advantage of an investment, which if properly constructed and located, can be a tremendous financial benefit to the individual owners. I think we all recognize the escalation in beach property value over the last 20 years, and I think that the statistics that were quoted earlier about the relative growth in the size of the beach area population vis-a-vis population growth in general are reflected in these values. Over the last decade, while the national population grew by 12%, coastal jurisdictions grew at three times that rate. There is clearly a financial benefit there and the question, of course, is what can or should the State, or what can or should the County, or other local governments do to protect this investment.

One way of looking at the problem is to begin by reviewing very quickly where the State is at the present time. The Beach Preservation Act established a revolving fund of \$1,000,000 for maintenance and preservation of the beaches, but it is bond money which has been borrowed over a 20 year period. I think you have all gained some appreciation today for the very short life of many of these beach erosion control and preservation projects. For example, last year we were faced with an emergency condition on part of Lewes Beach and the State invested, albeit a small sum of money (about \$15,000) relative to the total cost of what these projects can cost, to replace some of the lost sand on that beach. Today that sand is all gone. Likewise money has been invested in beach nourishment on a number of other beaches, both on the Bay and here along the oceanfront. In some cases the sand has lasted two years, in other cases three years and in others four, but nevertheless, you, the taxpayers, are

paying the interest on 20 year bonds to essentially maintain a short-term program. We have a very difficult financing choice to make, because it is a great deal easier in many respects to go out and borrow the money today and worry about paying it back tomorrow. It is a great deal more difficult when those in the General Assembly are asked to make the difficult tradeoff between paying the current costs of a maintenance project with current dollars, than it is to worry about borrowing it and paying it back over the long-term. Those costs are escalating all the time. You heard Dr. Kraft and Dr. Dean allude to that fact that the cost of a cubic yard of sand is anywhere from \$2-\$5, depending first of all where the sand has to come from and secondly where it has to go. The cost of dredging is very expensive, because it is expensive equipment and the overhead that is associated with that equipment is very high. Sources of suitable beach sand are very scarce in the state and we have very strict environmental requirements so that you cannot strictly look for any location for sand, since you have to consider both the navigation and the environmental aspects of it. The structural approaches which Dr. Dean mentioned are also very expensive. A linear foot of bulkheading, as he pointed out, could run \$200 to \$400. The groins which he mentioned are also very expensive. Well, within the last five years the State has spent more than \$3,000,000 of its own money towards a program of beach restoration. I think if you were to examine all of the beaches, you would realize that that is just a beginning. As the Governor pointed out in his opening remarks, the estimates of permanent placement of beach control projects reaches well over \$100,000,000 at today's prices. So the costs are substantial and they have to be weighed of course, not only against the relative means of financing - do we pay for current maintenance projects out of current tax revenues, or do we try to bond those?--but also weighed against other state priorities. Beach erosion control must compete with many other projects within the State; the construction of highways, the construction of hospitals, the maintenance of a correctional facility, provision of education. All of these are very complex and obviously very controversial subjects sometimes and one of the major concerns and issues that we want to discuss this afternoon is the degree to which government, whether it is the federal state, county or local, has responsibility for the maintenance of private property. When you think for a minute that the State of Delaware is financing this activity, and yet at the same time the benefit to private property owners accrues to those property owners and to the county or to the jurisdiction which is exercising a property tax on the value of that property, there seems to be a little inequity there. If a private property holder benefits from the investment of public dollars, then clearly, there ought to be some means for them to share in the cost of that protection.

Now one other issue that I hope we will get into later is the issue of flood insurance. As most of you know, the State participates with the federal government in a program of federally subsidized flood insurance. Well, we all pay federal taxes as well, and again the question which comes to mind is: To what extent is the cost of that program being borne by those people who actually benefit? One other point I would bring out deals with the question of what is the State's responsibility to property that is not clearly State owned. We have a system of State Parks throughout Delaware and clearly one of the major tourist attractions is the public beaches, which we maintain and in which we place great value. There are a very complicated set of problems dealing with the question of who owns beach rights. Some beaches are clearly State owned. Other beaches, by virtue of historical accident or deeds which have been passed down between families, are clearly private, and yet at the same time there is public access to that beach too. Beach rights and, therefore, responsibility for maintenance and protection is a very complicated issue.

Lastly, I would mention the inevitable, which is always on people's minds: what if, or what happens if, the 1962 storm was to recur. You have seen some minor evidence of the potential consequences today; the undermining of foundations and the destruction of not only private property, but public property also. The State has an enormous investment, for example, in coastal highways and the bridge over the Inlet at Indian River. Those are investments that must be protected. The analysis completed after the 1962 storm estimated erosion and flood damages at \$22,000,000 in 1962 prices. If you were to take that number and assume that there had been no development at all along the beach since that time, it is my suspicion that the damage figure would be almost twice that today. The major difference today, however, is that the area has grown and developed substantially since 1962. The best guess we can make is that, if a storm approximating the 1962 severity were to hit today, the damage would be well over \$100,000,000. This is only an estimate. Actual damages, of course, would be difficult to assess. Think for a moment what the costs would be to private and State property if a storm of that magnitude were to recur. Unfortunately, we know it will someday. In the discussion this afternoon, I hope everyone will concentrate on those questions of costs and try to balance the public and private benefits and costs, and the public and private notion of responsibility.

## FEDERAL SHORE PROTECTION PROGRAMS

Col. Harry Dutchyshyn  
Philadelphia District Engineer  
U.S. Army Corps of Engineers

The Corps gets involved in projects or appears to be involved in projects in three general categories: (1) The traditional ones, where we conduct studies and you see the Corps of Engineers through a contractor actually constructing some type of a facility; (2) Maintenance of projects that were built some time before, such as a periodic dredging of a navigation channel into a particular port or maintenance of a jetty or a flood control structure; and (3) Emergency work, such as the beach repair work that followed the storm of 1962. In this last category the Corps of Engineers gets involved in two types of emergency work. First is repair of Corps owned and maintained facilities. One such project being studied in Delaware at the present time is repair of the beach and dune system north of Indian River Inlet. The second type of emergency follows a Presidential declaration of a national emergency. In this case, the Federal Disaster Assistance Administration is the responsible federal agency for making some repairs and providing assistance and the Corps of Engineers is really working for the FDAA in carrying out the President's mandate of providing some emergency assistance.

I would now like to discuss the cost to become involved with a Corps of Engineers project. On almost all projects we have a requirement for local assurances for participation and financing. What are these local assurances? For most projects we require that the non-federal interest or the local authority, be it the State or a smaller subdivision thereof, will provide all land easements and rights-of-way for construction and maintenance and, if dredging is required, disposal areas; hold and save the U.S. free from damages due to the construction and maintenance work; accomplish alterations and relocations of buildings, transportation facilities, storm drains, utilities and other structures and improvements made necessary by construction; and in cases where a local cost sharing agreement is required, provide the cash contribution for the non-federal share. Other types of projects also require that the State maintain and guarantee no encroachment on the waterway or stream. In the case of water supply projects, where water supply is part of a federal project, the entire water supply cost is reimbursed by the water supply interest whether it is the State, the county or a particular water basin commission. In navigation projects, the State and/or local government provide a cash contribution equal to 50% of the construction costs allocated

to recreational navigation. The federal government pays 100% of the costs for those portions of a project benefiting commercial navigation. In the last 20 years or so, states have been required to provide the disposal area. In those cases this includes not only acquiring the use of the real estate, but also construction of the dikes to form the containment area for the spoils from the waterway.

Today we are talking about beach erosion and hurricane protection and the Corps has a list of assurances for these types of projects. The first is to provide a cash contribution for beach erosion control based on the ownership and type of use of the shoreline. If the land being protected is federal land, the federal government pays the entire cost of the beach erosion control. For protection of State owned beaches the State pays 1/3 of the cost and the federal government pays 2/3. For other public lands where costs are shared by local jurisdictions, such as a County or City, the federal government pays 50% and local governments 50%. If the project protects private lands, the federal government contributes nothing and the State or the municipality would have the task of paying the entire amount for that Section of the coast. For hurricane protection aspects of a project these same percentages also apply to the periodic nourishment required to maintain the dune line. In most beach erosion projects one must replenish the sand on a periodic basis and the cost sharing of the nourishment would be on the same order as the construction. For hurricane protection at least 30% of the maintenance cost would be shared by the local populace or the State. The State must also: 1) Provide access and facilities necessary to realize public benefits; 2) Control water pollution; 3) Ensure preservation of dune and beach areas; and 4) Prevent encroachment on protected areas. That provides a synopsis of the type of local assurances that are required. At the conclusion of a federal project it is inspected both for maintenance and for compliance and in those cases where a local authority has been found to be in non-compliance it receives letters and reminders about local assurances. A few years ago some questions were raised over this issue, so Congress passed a law requiring binding contracts with the State and ensuring that it was signed by a representative of the state who could be sued in the case that local assurances were not lived up to.

Secretary Olney asked for a couple of comments regarding existing beach erosion projects. We have a project at Indian River Inlet. With monies from the storm damage law (P.L. 94-99) plus some funds from the State of Delaware, we intend to make restitution of the dune line on the north beach. We are presently working on the design specifications and hope to bid the project shortly. In the past, the Corps in conjunction with the State has worked on Broadkill Beach and Lewes Beach; both of which are beach erosion projects.

Secretary Olney also mentioned the shoreline erosion control demonstration program. Presently we are planning to let a contract for the use of a floating scrap tier breakwater at Pickering Beach. We are working on plans for a perched beach at Kitts Hummock using three different types of materials as well as a fixed offshore breakwater at Slaughter Beach. The Pickering Beach proposal has been approved and is nearing the construction stage; construction is scheduled for completion some time in July or August of this year. The Kitts Hummock perched beach and the Slaughter Beach offshore breakwater have been proposed and approved and construction is expected in the very near future. Construction of these last two proposals is scheduled for completion in September 1978. Then all six sites, the three I named above, and three others-Broadkill, Lewes and Bowers Beach-are scheduled to be monitored over the next two to three years. The products of this particular effort would be a report evaluating the cost and effectiveness of different types of relatively inexpensive beach erosion control structures for use by various municipalities and counties.



## PANEL AND AUDIENCE DISCUSSION

### Panel Members

Senator Jacob Zimmerman  
Senator Andrew Knox  
Representative Karen Miller  
Representative William Vernon  
Colonel Harry Dutchyshyn  
Secretary Austin Olney  
William Ratledge  
Nathan Hayward  
Dr. John Kraft  
Dr. Robert Dean  
Robert Henry

### Audience Participants

Vernon Dibeler, Commissioner, Bethany Beach  
A. J. Cullen, Waples Mill Pond  
Philip Short, Bethany Beach  
Paul Jensen, Delaware Sea Grant Program  
Joseph Skelly, Millville  
Jay Wingate, Rehoboth Beach  
Adel Vignola, Rehoboth Beach Chamber of Commerce

Secretary Oleny-I think the best place to start might be some comments on what we've seen this morning. From DNREC's standpoint I think that the magnitude of the problem that we face is extremely serious. It appears that with the resources that we have in the State, we will have to be selective about how we approach this problem. Certainly one place we can start is what do we do about new activity in the beach zone. In effect, much of what you have already seen at South Bethany is past history; it is there; the damage caused by constructing on dune lines will continue. The question we have to consider now is; how far can the State go and how far should the State go in regulating any new activity? Moreover, if there is a repeat of 1962 storm and we lose a significant number of houses in areas like this, how much rebuilding should we allow? So the question I pose to the panel members and the audience is: Should the State allow new construction or rebuilding along beaches that are subject to storm waves and repeated damage? If you consider that, also consider what should be done to protect the property owners who may be subject to any adverse impact of building in front of the building line along the coast. So with that I would like to ask the panel to comment on whether the State should allow any new construction or rebuilding.

Senator Zimmerman-I don't know. I didn't come prepared to direct myself to a question such as that, because I think that is a policy decision that the State administration and local governments must get together and make. It is a serious question and, as Chairman of the Natural Resources Committee of the Senate, I am anxiously awaiting this decision. My primary thrust in the past several years in the General Assembly has been not in cutting out new paths for policy, but in attempting to protect those communities, particularly those communities in my own district. Protecting these communities and those areas that the public is utilizing is in the interest of the State. Insofar as your primary questions are concerned, I think it would be best responded to by someone else.

Secretary Olney-Thank you Senator. Again I reiterate that we already do have a policy on that. The policy is that we are going to allow construction with certain design standards and the question is; does that policy adequately protect public interests as well as interests of those people behind houses that are built on the dune line? Perhaps Senator Knox you could comment on that.

Senator Knox-Well I do agree with Senator Zimmerman that this is, in many cases, a local option. I was a member of the General Assembly and participated in the passage of the 1972 act. After the inspection over the lunch hour--and granted its dangerous to reach conclusions from one short visit to a beachfront situation--I really do not feel that the intent of the General Assembly is being met by what I saw happening on those dune lines. It was my recollection that our intent was to prohibit the further destruction of the dunes and beaches in the State of Delaware, particularly with residential construction. I understand the taking issues and

some of the problems in not being able to enforce the act as rigorously as we had intended, but I really was somewhat surprised with what I saw. I had heard about it, but that is nothing like seeing structures actually straddling the dunes and contributing to their own destruction. I know this is very difficult legislation to write because of private property rights, but I personally think the Legislative Branch, with the assistance of the Department and local government, should take another look at that legislation and see if there is anything that should be changed. Are we meeting the intent of the citizens? As one legislator, I will conclude by saying that I do not think that what is happening is meeting the intent of the General Assembly when it passed that law.

Representative Miller-I do not feel we are prepared to answer that question. In practical terms, as legislators, we have to address it and it would seem to me that all interested parties should work together on this issue. To work separately would be to lose a many elements that we need to talk about. If houses were built out of ignorance, and they probably were, we can't wish them away with a blink. On the other hand, I think future building should be very seriously considered and perhaps we should concentrate on what may be done and examine those areas where the difficulties lie. I don't think we can totally ignore these people, but eventually the sea may very well have its own way. Before that time, I think we have to set priorities. I think we have to ask ourselves: What is feasible for us to do? In terms of the human costs, I think we have to ask ourselves: What kinds of sacrifices are we willing to make to see that our beaches stay a place that people would like to visit or live on?

Representative Vernon-I would like to follow up on what Senator Knox and Representative Miller said. First of all I disagree that the houses were built out of ignorance, because even today there are a number of people applying for building permits on lots that lie totally on the dune line. They may have either recently bought the lot or they may have owned it for 10 or 15 years, but they are well aware of the consequences. I think that the problem lies with the fact that they have an oceanfront lot and they want to utilize it. From a practical standpoint, I agree with Senator Knox that there has been some damage to the dune because of construction. On the practical side, as far as the State is concerned, I do not know how we can attack the problem by either compensating someone, denying construction altogether or allowing them to build under certain design standards. I think most of the houses that are being built now, in fact all of them, are being built on pilings, and as one of the few people that experienced the 1962 storm, I can say that piling structures now being used probably will help eliminate some of the damage, because most of the properties that were heavily damaged in that 1962 storm were properties that were built on masonry foundations right on the beach and then were undermined. Of

course, utilities, driveways, and other appertenances underneath the houses all suffer damage in storms like this. The question is: If we prohibit building altogether, how does the State, from a practical standpoint, compensate someone. I'd like to direct that to Senator Knox to see if he has any thoughts.

Senator Knox-Taking without just compensation\* is a critical question that we must address in all of our environmental legislation. It really has not been resolved in the court. I can argue, philosophically, that any zoning law has some aspect of a taking without compensation. As our society becomes more complex and more and more people are affected by regulations, there is going to be some of that. To go so far as to absolutely prohibit somebody from building on a piece a land that they have had in their family for generations, may require monetary compensation or some type of development rights program.

Secretary Olney-In carrying this a little further, we should explore what the State might do other than what it is doing today. I think Bob Henry or Drs. Dean or Kraft may be familiar with what other states are doing. Do any of the three of you wish to comment on that.

Dr. Dean-Over the past seven years or so the State of Florida has administered the Coastal Construction Setback Line Law. Basically, the law requires that the entire sandy shoreline be surveyed and monumented and that a beach profile and offshore profiles be measured. Based on studies by coastal engineers the setback line is established and approved by the state. The essence of the setback line itself is that seaward of the setback line no permanent structures may be built. The state law also requires reexamination of the setback line, county-by-county, every five years to determine whether or not revisions are in order. If an individual loses some property due to a storm, and his structure is seaward of the setback line, or if he wishes to construct a new structure seaward of the setback line, he must apply for a variance from the State. Variances are examined on a case-by-case basis. Originally, I had expected that there would be many many law suits stemming from this act, but the public has come to

\*Editors Note. The issue of "taking without just compensation" is often raised in land regulation disputes. It has its genesis in the 14th Amendment to the U.S. Constitution which says, in part, that no State shall "...deprive any person of life, liberty, or property, without due process of law..." This clause has been interpreted to mean not only the expropriation of property without just compensation, but also the expropriation of property rights through strict regulation. If the police power of government is used in a fashion to deprive a person of all reasonable economic use of property, such regulation will be deemed a "taking", for which compensation must be paid. The Attorney General of Delaware has issued an opinion which says, in effect, that prohibition of construction on the beach, where no other reasonable alternative to such construction exists, would violate the 14th Amendment.

realize that the law seems to be in their own best interest. For example, when the setback line was being considered in Bay County, emotions ran high over the location of that line. At about that time Hurricane Eloise came through the area and actually destroyed houses back to the setback line. It was a rough educational process in which the public finally realized that indeed the setback line had some rationale to it. Many of the opponents of the setback line at that time were claiming the damage would never reach that far back. Hurricane Eloise, however, proved otherwise. There are two recommendations I'd like to make for Delaware: One, of course, is regulation and the other is education. It seems to me that people are basically rational individuals. If they know what kind of problem they will be encountering, I think they will act in a rational way. Part of the problem, which I have seen in Florida, is that people will buy a lot in the summer time when the beaches are wide and it is difficult for them to imagine waves that are a foot high at that time of the year can later develop into 20 foot breakers or that the storm tides can become 9 feet higher. I think that if people were made aware of the hazards which they may face, including the trend of beach erosion that was mentioned this morning, they would be more careful in making their decision to purchase property.

Dr. Kraft-It is very obvious to me that we need a setback line and it should be established. We have enough information to establish a firm setback line as opposed to a floating setback line. Such a setback line in this State, in my opinion, should be something like 300 feet. Now that may seem excessive to many people who have property in the coastal zone, but if you consider what is going to happen if we do not have such a setback ruling, along with the just compensation that Senator Knox has called for, something much worse is going to happen. Mr. Hayward brought forth the idea that the 1962 storm damage costs were about \$24,000,000 in 1962 dollars and today it might be about \$100,000,000. I would submit that in the future it is going to be much much greater than that. If we know this, it seems to me that it must be rational to make a decision now to do something. In a case where there is no question what is going to happen, it does seem to me that it would be most logical to take a stand, make a setback, and address ourselves more to the problem of proper compensation, zoning, State planning, development, and so on. Moreover, we must face the problem that there are some expenditures that must be made no matter what, forever, such as protection of the highway at Indian River Inlet or dune maintenance. I think a very long-term point of view needs to be taken and the quicker it's taken the better off we will all be. If we put it off for another five or ten years, that damage estimate of \$100,000,000 is going to be \$200,000,000. Eventually it will be \$500,000,000. Can you envision our coast line for 20 miles being developed as Ocean City? I cannot, but it frightens me - the concept of it. The concept of trying to hold the line because it is, therefore, more valuable frightens me.

Secretary Olney-Again, the question we are considering is: Should the State allow new construction or rebuilding along beaches subject to storm waves and repeated damages? Would anyone like to comment from the floor?

Mr. Dibeler-I am concerned about approaching the problem from this aspect, because it might give one the impression that we have already decided that there is no other means of improving our beaches. So I am a little disappointed, unless I misunderstand it. But, the other point I would like to make is that the Bethany Beach Commissioners are not primarily concerned with the protection of beach in front of somebodies home. Our primary concern is that of providing a beach for some 10,000 people to sit on in the summer time. No one wants to come down to the beach and sit underneath somebodies porch. Therefore, we have two problems. First, if you want to consider a setback line, well that's fine; I think the State must get into this kind of thing and not leave it to a local community. We have given a setback line serious consideration from time to time, but we have felt that we needed strong support from the State, for example, that would assist us in establishing such a line and getting our point across to property owners. We need help from the State. Since we may not have any beach space for the tourists, I do believe we not only want to think about the setback line, but we want to think about something positive, such as protection of the eastward side of the beach in order to reduce the damage of waves.

Secretary Olney-I certainly did not want to give the impression that we already abandoned the idea of holding the beaches. I think we can address that question next. One of the questions we want to address is: Should there be rebuilding in areas which have been wiped out by floods? I think that relates to your point that, if you do allow rebuilding in an area that has been flooded out, you may reduce the size of the recreational beach. So the issues are, I think, related.

Mr. Cullen-My question is directed primarily to Dr. Kraft. So far we have been speaking primarily of this ribbon of sand and human habitation of it. What about other areas such as the Bay? Are we not talking about possible devastation of a much larger area than just the beach?

Dr. Kraft-Flooding, of course, would intrude very far inland in Delaware. The problem is documented in a Coastal Management Program publication entitled "Coastal Storm Damage." I suspect that we have not really been addressing that problem, but storm flooding inland, of course, is something that can hardly be prevented. Barrier beaches, however, are your main defense. If the barriers are not breached, the flooding behind them will tend to be less, because the amount of water that can get through inlets or tidal rivers is limited. If the sea breaks over the barriers, the amount of area flooded expands by an order

of magnitude. This is what happened in the storm of 1962. During the more recent storms the barriers have not been breached to a significant degree and the flooding, as a result, was much less.

Mr. Short-I'm not an expert, but I question you people on some of your recommendations. The 300 foot setback can be appropriate in certain localities along the beach. In other areas such a setback may be excessive based on local experiences and in others it should be greater. In March 1962 the Corps of Engineers came up with a recommendation of 330' of free beach to the eastern toe of the barrier dune. This does not always work and in later publications they have used a 10' contour line. The thing that has not been used is the profile of the ocean's bottom in front of the area where the setback line should be.

I feel we need a discriminatory tax whereby the areas that reap the benefit from the beaches bear the expense of their maintenance. It was done years ago on the Gulf, but it has been discontinued. In the coastal zone area from Roosevelt Inlet to the Delaware line, there is approximately \$300,000,000-\$400,000,000 worth of fixed assets. There are a large number of us that derive direct revenue from the beach area. There are others that enjoy the beach area. There are people that use the beach area, but contribute very little directly or indirectly. My idea is the same as a ditch tax - the people who live in the area appoint Commissioners to run the project with the professional assistance from the State and other agencies. If you take the figure I just mentioned and multiply it by 10¢, per \$100 of assessed value you would be able to raise \$300,000 annually. We could float a bond issue to take care of our own.

Secretary Olney-There are two alternatives at opposite ends of the spectrum. One is to do nothing and simply let nature take its course. I do not think there is anyone who is prepared to accept that alternative. At the other end is the alternative of "holding the line" in its present position. We have an idea of how much it would cost to hold the line on the Atlantic beaches. The Corps of Engineers prepared a General Design Memorandum for the Atlantic Coast project. If I could I'd like to call on Bill Ratledge to briefly describe the extent of that project and what would be involved.

Mr. Ratledge-The Atlantic Coast project began, of course, after the 1962 storm and was handled primarily by the Highway Department. Our division became involved with it after the passage of the Beach Preservation Act. I happened to be involved in the final phases of the Atlantic Coast project, at the same time we were developing rules and regulations having to do with setback lines. I thought I should throw these few words in at this time because much of what we did related to the assumption that the Corps project was going to be constructed. Our original regulations had written in them a reference to a setback line designed by the Corps of Engineers and that setback line was based on a project of considerable magnitude. The project included among other things, millions of cubic yards of beach fill along the entire Atlantic



shoreline. Some areas were to be protected by bulkheads\* at a cost of about \$600 per foot. The Corps also required that the State of Delaware obtain easements and rights-of-way from owners of private land where these structures were to be built. I was almost laughed out of the meeting in Bethany Beach when I suggested that the private property owners should donate their land. I still think in situations, such as you saw today at South Bethany, property owners should donate their land in order to have the bulkheads constructed. These, however, are not simple bulkheads like those we saw at lunchtime. This project, if constructed, would cost between \$40-50 million dollars over a five year period. The State would have been responsible for about 39% of this cost.

Secretary Olney-That figure would have to be supplemented to include the annual maintenance costs which is in the neighborhood of \$3,000,000. Moreover, some very persuasive evidence was presented this morning by Drs. Kraft and Dean indicating that that solution is simply too expensive at this stage. So, I would like to ask the legislators to give us an idea of just how far the General Assembly might go in supporting these beach projects in order to give the Department an idea of how much money we may expect. We are authorized to have a balance in the Beach Preservation Fund at the beginning of each fiscal year of \$1,000,000 and I just wonder if the legislators here would comment on just how much more we can expect if we are going to be doing more of this work. Given the nature of the problem, do you think there is going to be continuing support in the Legislature for funding of beach nourishment projects. Would you see the need for any major changes or do you think funds are going to remain at the present level. I'm just asking for a guess, since you have a better feel than I do.

Representative Miller-I don't see how we can stay exactly where we are. We have been studying this problem for some time and we know its going to cost more money; there is no doubt about that. The State presently has two ways to fund beach projects and one is through the bond bill, although I do not know whether that's the best way to do it. The second way is through the general fund. I think we should figure out what we have been spending, both in bond and general funds and attempt to establish realistic budget guidelines. At present, I do not think we can say how much more money will be available, since the revenue estimates change every day in our State. I do not think that either the taxpayers or the legislature will be willing to spend money unwisely without a comprehensive program. Just throwing money at the problem on a placemeal basis would be foolish. We have

\*Editors Note. The bulkheads were to be constructed at Rehoboth, Bethany and South Bethany to an elevation of about 15 feet above mean sea level. The bulkheads were to be made of reinforced concrete.

a total beach line, we don't have pieces and snatches. Furthermore, if we approach this problem in a piecemeal fashion, I don't think we'll get very much, if any, more money. I do not think that is the approach to take, but that's probably what we've been doing too much of.

Secretary Olney-I think what I hear you saying is that if there is going to be more support from the Legislature, we would have to develop priorities so that the Legislature knew the money was going into the areas that needed it the most and that we have to have a comprehensive plan which does not just deal with the problem on an adhoc basis.

Senator Zimmerman-The question is; How much money would the General Assembly be willing to appropriate for beach preservation? Well, I just happened to come prepared for that today. Since 1972 there have been about \$3.2 million appropriated in the bond bill for beach preservation by the General Assembly. Our trouble is the Department, over the years, has refused to spend it. Today, there is authorized, but unspent, \$575,000 from previous bond bills even though there are projects yet needed to be done. With this money you could take care of many of the needed projects in Delaware Bay. These are the areas that the funds are directed towards, but you, Mr. Secretary and Mr. Hayward have been very reluctant to approve funds for use on these beaches. I feel that the General Assembly will meet the problem and their obligations, provided there is some input from the General Assembly as to where the funds are going to be spent.

Secretary Olney-I think you put your finger on a problem of priorities. We already know that you could do 56 million dollars worth of work on the Atlantic Coast, for example, but we're talking about a State fund that is \$500,000. As one who has to administer that beach fund, the biggest problem I have is that we don't yet have a good idea where that money should go first. We could probably spend all that money in just a couple of projects.

Senator Zimmerman-We can give you some advice if you need any help. (laughter)

Secretary Olney-The problem with the advice we get is it tends to be from a rather local source and if you were administering the program, I know where the funds would go. That is fine, you are doing your job, but I have the whole State to worry about and I think it would be very helpful if we could establish some priority on the use of these funds.

Representative Miller-I don't think, when it comes to appropriating the funds, that any legislator is going to be willing to set priorities which will negate past promises. If money has been appropriated and promised, and the people's expectations are there,

then I think that the problem has to be taken care of. I think in the future, however, one problem that we have had, is that too often we have been treating the symptoms rather than the overall problem. As legislators, we would all be glad to set priorities and then worry about raising the money later on. The questions which remain are: Who are we not making headway and what kind of headway can be made? I think there would be more cooperation among all parties concerned, if we would sit down and hammer some of these things out.

Secretary Olney-Again, I think we are talking about priorities. Do you think the funds should go first to the public beaches?

Representative Miller-Of course, but first we have to define public beaches, because I think all the shoreline is a part of the public beach area that will have to be protected. What I think we have to do there, is set up some way in which we have shared private/public ownership of at least that first 300 feet or so.

Secretary Olney-I think this is probably the most difficult question we have to face; where do the funds go first? The problem is getting bigger and the funds are simply not adequate. The biggest problem I have administering this program is knowing where to put the funds first.

Mr. Hayward-I think the point that the Secretary was trying to make and the point which should be addressed in any State policy, program, statute or regulations is that there has to be some consensus among the people where the priorities lie. Whether it is beach protection, education or any other State service, there is always a greater demand than there is a supply of both people to manage these programs and funds to pay for them. So what we are trying to do today, is get some feeling from people as to where priorities really lie. We have to look at every beach and we have to try and make some trade off, because just as soon as we begin investing on the basis of the "squeaky wheel gets the grease", we wind up in competition and we do not manage our resource in an intelligent fashion.

Representative Vernon-I want to address the question of whether, and how much, the General Assembly would appropriate money for beach erosion control. I think, however, that this is a backdoor approach. I too, think we must have a comprehensive engineering plan to address erosion to the best of our ability. Several experts have discussed beach nourishment, bulkheads, breakwaters and so forth, and so there appears to be a number of possible solutions to the problem. Before one starts talking about how much money should be appropriated, I think someone has to come forth with a plan that would provide at least a partial solution and then weigh that plan against the probability that it may work.

Mr. Jensen-I'd like to make a statement that will probably be viewed as unpopular and then ask a question. It seems to me that the presentations made by Drs. Kraft and Dean today showed that the beach is an integral part of the meshing of the land and water and that the beach existed several hundred feet further east a few centuries ago. The beach would be there even if the coastal properties along the beach were to be destroyed. It seems to me that the effort going into beach preservation is done primarily for those who own property behind the beach. The public will always have a place to swim. That's my unpopular statement. As you know, several plans to manage the beaches currently exist. It seems to me that these ideas, as well as the long-term financial implications of beach management and beach nourishment efforts, should be looked at in a comprehensive way. Mr. Hayward, could you give us your views on this.

Mr. Hayward-The first thing that we all need to remember is that the Corps prepared a General Design Memorandum which dealt with the Atlantic coast beaches. It was quite comprehensive, but everyone realized it was beyond the State's financial ability. Mr. Olney and I have met with the Corps several times and have reassured them that there is a commitment on the part of the State to participate in the beach preservation project. One of the problems, quite frankly, which is encountered when discussing a comprehensive investment, is that dollars get very big. Another question concerns the period of time over which the funds are to be spent. There is also a reluctance on the part of the Legislature to make long-term financial commitments. As you all know, one General Assembly simply cannot bind another to future commitments unless they appropriate the money today. So the point is this, we are looking at the State's coast as a total resource. There are many things that we should and could do, but the problem has to be looked at in terms of the State's ability to pay. Mr. Short has raised one point too, which is the question of who benefits and who pays and suggested a special beach tax district. Should those who come to use the beaches in the summer time, whether they are Delaware residents or not, and those who live on the beaches, be the ones who pay the largest percentage of the cost of maintenance and improvement. That is a very tough question to answer, but clearly there is a need for a look at the overall problem. We have done that and we have all determined that it is too expensive. Now what we have to do is to figure out what the State can afford, what the State is willing to afford and how that bill should be distributed.

Mr. Skelly-It is probably politically necessary to spend some money for beach preservation and it is humane too. The people with the oceanfront property are in a lot of trouble and it's no fun to see other people suffer. The sea, however, is moving west and no matter what we do, whether we use Mr. Short's subtle ideas about controlling erosion, or we build a Corps of Engineers bulkheads, the people are going to have to move west with it. Sooner or later the people will give way. That lighthouse fell in finally and the people who were living there don't live there any more. Therefore, after we finish deciding how much is politically necessary to spend on beach preservation, we should

give some thought to devising a program which will help ease the pain and suffering of property owners who have to pull up stakes and move westward.

Mr. Short-The suggestion was made to have another study. Well, studies have been conducted by recognized authorities, but have not been adopted. The beaches are very important for tourism and recreation, so indirectly the State has an obligation to this area. Therefore, I challenge you to do something for the best asset the State of Delaware has. Let's go forward and do something and not dilly dally with it.

Mr. Wingate-First, I would like to review what we've talked about today. We identified the problem this morning and that, of course, was one of erosion. We've discussed possible solutions. We've talked about replenishment of the sands on the beach and we've talked about construction of structures. Under structures we've talked about groins, seawalls, and breakwaters. Finally, we have come to the conclusion that there are two very strong controlling factors. The first is cost, and most here agree it is prohibitive, but not too much has been said about time. I think we should all recognize that time is a controlling factor. These comprehensive plans take time. We should have an overall plan, but the idea I would like to discuss what could be accomplished quickly and cheaply and falls under the concept of a breakwater. What I refer to is the sinking of old vessels along our coastline to form an underwater breakwater. I believe it was after the 1962 storm that this idea was discussed at great length and I think Senator John Williams actually had arranged to have six to eight concrete vessels made available to do just that. The plan was dropped and I don't know if anybody can answer the question as to why. It seems to me that there are such vessels available. This is something that could be done with simple towing charges. The vessels could be sunk and provide an underwater breakwater at little cost. If it didn't work as far as protecting our beach we would at least improve the local fishing industry, because it would be an ideal place for fish. I would just like to ask if anybody has given any thought to this in recent years and why the plan was dropped eight or ten years ago?

Dr. Kraft-I think there is some merit to the idea of sinking a ship in the area to control erosion, but what has to be considered is that erosion around the ends of this breakwater will increase. So, there may be some merit in a place like Indian River Inlet where the erosion zone could be spread over a broader area, but you must have a continuing plan on down the beach, because breakwaters are deleterious to it. I've seen two of them sunk offshore. They are still sticking up and is an embarrassment to the community. So, it would have to be done very carefully so that it was completely under water.

Dr. Dean-I think it has considerable merit and probably should deserve consideration or reconsideration. I do not know why it was dropped from consideration in the past.

Mr. Olney-There is one other issue I would like to raise. If the State does undertake, with or without the assistance of the federal government, protective measures that benefit flood prone property owners, should the State recoup some of that investment. We've heard some suggestions and I would like to open it up to the panel to talk about that proposition.

Representative Miller-I'm sure that we could make arrangements with the local governments to share costs. There is no way the State could come up with \$17 million for the Corps project. The money is not there, but we can make plans in the future to share costs and that's more realistic. I'm not prepared to say exactly how we can do it, but we can certainly sit down together and begin to work something out. I believe the citizens would accept that.

Senator Knox-I would agree with that. We always have to keep in mind that there are public and private beaches. Certainly some installation that would clearly benefit just a small group of people, should be paid for, in large part, by them.

Senator Zimmerman-The various levels of government own considerable beach front and many other areas have donated access easements. I know of very few places where there is an exclusively private beach. I think they are all being used by taxpayers. The access to some may not be as great as access to others, but I think that the State and the federal government can certainly justify expenditure funds for many projects without necessarily having to pinpoint which beaches are public and which are private. I think that the beaches are a resource of value to the entire State and are in the interest of all the taxpayers of the State to support.

Representative Vernon-I was somewhat interested in Mr. Short's idea. The only practical problem with that is, that most of the coastal area has been hard hit by taxes since the last county reassessment and the new tax bills, especially in the beach area, where heavy. Moreover, we have several sewer districts under construction and one completed, and that is adding a considerable financial burden to the local people. So, I'm not so sure that at this time the people could stand any more local or discretionary taxes.

Ms. Vignola-I might help you to make up your minds. The State of Delaware gets about \$200,000,000 from these resort areas and about \$21.5 million dollars in taxes, so we're no little part of the State. You are getting quite a bit from us and if we don't have a beach any more, how are you going to do without this much money? I'm concerned about the entire coastal area. I understand they have problems up there, (Kent County) but right now I'm right here and I'm concerned with my area. I think today we are putting the cart before the horse when we say to

our legislators: Will you give us the money? First of all, what are we going to do with that money? I think we have to find a way to solve the erosion problem and then go to the legislature and ask for the required amount to stop the erosion.

Secretary Olney-I think one thing that was said down at the beach by Dr. Kraft, is that the migration of the land westward and the advancement of the water is an inevitable process. The only variable is time and we wouldn't be here if we had the answers. If it were simply a question of throwing money at the problem, we wouldn't be here, because we would have done it. The problem is the magnitude of the forces that we are trying to deal with and as Mr. Skelly says, perhaps we should be thinking about how to move people westward. If we could control the erosion I think I'd feel more confident about saving the tourist industry and keeping everything where it is. I think there is a real question, after what I saw this morning, as to whether we can actually do that.

Mr. Hayward-Let me just reemphasize that you people, who are participating in this Workshop, are really the essence of decision making in the State. It is from people like you from whom Legislature receives ideas and input and ultimately takes the necessary action to give the Executive Department of the State the necessary authorities to carry out programs. Let me emphasize that your thoughts and comments are extremely important to all of us in State Government. We would like your ideas and we would like to hear more from you. Please direct your thoughts and ideas either to Secretary Olney at the Department of Natural Resources and Environmental Control or to myself at the Office of Management, Budget and Planning. We are vitally concerned.

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from the Bureau of Archives and Records, Hall  
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Printed in U.S.A.