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Coastal Management Solutions to Natural Hazards

Texas Coastal Management Program

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National Ocean Service
Office of Ocean & Coastal Resource Management
Coastal Programs Division

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The problem of coastal hazards is more pressing now than ever before. Americans continue to demand more opportunities for coastal recreation, leading to intense pressures to develop resort areas and single family vacation houses along the beach. The consequences of this development is increased exposure to storms and the potential for loss of life and property, a potential realized in South Carolina when Hurricane Hugo made landfall last year. Less dramatic, but of equally great concern, is the interference intensive development causes in natural shoreline processes. A seawall on a beach not only accelerates beach erosion, but also inhibits the beach's ability to absorb storm energy, thus exposing structures to the full force of wind and waves. In many parts of the country, beaches also act as buffer zones to protect wetlands; as the beach/dune system is damaged or destroyed by unwise development, unprotected wetlands resources will suffer as well.

State coastal zone management agencies are at the forefront of efforts to mitigate coastal hazards through restrictions on development, mapping and monitoring erosion rates, participating in beach renourishment projects, educating the public and other efforts.

The Office of Ocean and Coastal Resource Management (OCRM) of the National Oceanic and Atmospheric Administration (NOAA) has produced this technical assistance document to provide examples of innovative, successful state coastal management program efforts to address coastal hazards. OCRM believes these examples will be of interest to other states faced with similar problems, as well as to individuals interested in the welfare of the nation's coasts. This report reviews only selected projects conducted by state coastal agencies under §306 and §309 of the Coastal Zone Management Act (CZMA) and does not include programs under other CZMA sections.

For further information on activities highlighted in this report, contact either the state program manager listed at the end of this document directly or:

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OCRM thanks the many state program managers who contributed to this document.

Sincerely,

Timothy R.E. Keeney
Director

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Coastal Management Solutions to Natural Hazards Mitigation
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Part A

An Overview of Hazards and Hazards Mitigation

Source: Miami Beach Tourist Development Authority

CHAPTER I
THE PROBLEM OF COASTAL HAZARDS

Introduction.

Coastal hazards, be they cataclysmic natural disasters, gradual erosion, or steadily rising sea and lake levels, are an ever-present threat to public health and safety, natural resources, and property. Options for dealing with these hazards are many. But because each option has its own environmental, economic, and political costs, there is little consensus on how governments should respond to coastal hazards.

Meanwhile, threats to public safety and the public cost of failing to address coastal hazards continues to increase:

* NOAA's National Hurricane Center in Miami has refined its prediction techniques to give a 12-hour warning of a hurricane's landfall. Because hurricanes can change intensity and direction suddenly and unpredictably, this warning time is unlikely to lengthen. However, emergency planners estimate an evacuation of Galveston, Texas, would take 26 hours; officials would need over 30 hours to evacuate the Florida Keys. These evacuation times will increase in the face of continued development and population growth. The Tampa Bay Regional Planning Council, for example, estimates that a "worst case" hurricane would cause $9.6 billion in structural damage in the region.

* According to 1985 figures, about 75% of the Atlantic and Gulf coastal populations most vulnerable to hurricanes moved to those areas since the last direct hit by a major hurricane and are thus less likely to be familiar with appropriate responses.

  The evacuation problem will intensify as Americans continue to be drawn to coastal areas for recreational opportunities, climate, and the other benefits coastal communities offer. Some 53% of the U.S. population lives within 50 miles of the coast, a percentage expected to increase significantly in the future. As coastal populations continue to swell, the consequences of both severe storms and the longer term processes of erosion and sea and lake level rise become more severe.

* The insurance industry's All-Industry Research Advisory Council (AIRAC) estimates that a major hurricane making landfall in a heavily populated area of the South Atlantic or Gulf coasts would trigger $7 billion in claims. (AIRAC estimates insured wind losses alone from Hurricane Hugo will approach $4 billion; Hugo ranked 3 to 4 on a 1 [moderate] to 5 [catastrophic] scale of hurricane severity.)

* Through federal programs such as the National Flood Insurance Program (NFIP), the nation's taxpayers help underwrite billions of dollars of insurance coverage on structures built in hazard areas.

* After major storms, as many as 50 federal agencies provide funding and support for coastal redevelopment. Because of this assistance, development after hurricanes and severe storms may in fact be more dense and property values higher than before, exposing taxpayers to even greater expenditures for future storm recovery efforts.

* Less easily quantified, but perhaps more important in the long term, is the loss of beaches, bluffs, and barrier islands as first line defenses against storms and sea and lake level rise.

Long-term Beach Erosion.
While major events such as Hurricane Hugo provide dramatic confirmation of the perils of living too close to the water's edge, the more subtle process of shoreline erosion also threatens property along the nation's coasts. Beaches are by nature dynamic; beach profiles and widths depend on natural movements of sand, wind, storms, currents, and seasonal changes. Furthermore, many areas of U.S. shorelines are receding due to sea level rise caused by geologic and global hydrologic processes and subsidence from human activities such as hydrocarbon or water extraction. Once development takes place on inherently unstable beaches and barrier islands, property owners naturally want to protect their investments from erosion. But efforts to supplement the natural storm protection dunes and beaches provide with "hard" erosion control structures interfere with natural beach systems, exacerbating erosion. Beaches disappear, exposing property perched on the edge of bulkheads to the full force of the next major storm.

Threats to Natural Resources.
In a broader context, the loss of beaches and barrier islands exposes wetlands and upland areas to the full brunt of storms. The dynamic nature of beach/dune systems allows them to absorb storms' energy; during a storm, waves flatten the beach profile and move sand offshore to create sand bars that help dissipate wave energy. Calm weather returns the sand to the beach. As protective systems for wetlands, barrier islands prevent normal and storm-wave energy from reaching wetlands, and prevent sand and salt water intrusion. Barrier islands migrate with storms and sea level rise; if "stabilized," eventually they, and any development on them, will face increased risk from heightened vulnerability to normal and storm wave action.

CHAPTER II
THE FEDERAL ROLE IN COASTAL HAZARD MANAGEMENT

The Coastal Zone Management Act of 1972.

In 1972, Congress passed the Coastal Zone Management Act (CZMA) to encourage states to better manage the nation's coastal resources, resources increasingly threatened by poorly planned development and consequent environmental degradation. The CZMA was designed as a state-federal partnership to encourage states to develop and implement comprehensive coastal zone management plans to address these and other concerns.

The CZMA uses an innovative approach that funded state coastal plan development and implementation, but also provides that once NOAA approves a state's coastal management plan, other federal agencies carrying out activities affecting a state's coastal zone must make their actions consistent with that plan. The program development phase of the CZMA has expired, but NOAA continues to fund implementation in the participating states. Since the CZMA became law, 29 states and territories of the 35 eligible have joined the program.

At the state level, a lead agency oversees program implementation and administers federal implementation funds. The agency may be solely responsible for planning, regulation, and management in the coastal zone, or share that authority with other state agencies. Local governments play formal or informal roles in implementing state programs and policies. Some state programs delegate planning authority to local governments, which make decisions according to state coastal program requirements. Federal agencies participate in state programs through consultation and consistency reviews to determine whether federal activities and actions are consistent with state coastal programs.

While the Office of Ocean and Coastal Resource Management (OCRM) in NOAA's National Ocean Service (NOS) is the only federal agency directly involved in administering the CZMA, other federal agencies play important roles in regulation, emergency response, and prediction.

Prediction.

The National Weather Service (NWS), another NOAA line office, is responsible for the nation's weather forecasting system. Using weather stations, satellites, specially equipped aircraft, and other instrument platforms, NWS's National Hurricane Center in Miami monitors and tracks hurricane activity from the west coast of Africa, where most are spawned. It is the Hurricane Center that issues warning times and probabilities for storms striking a particular coastal area.

In addition to its weather forecasting responsibilities, NWS also has developed the Sea and Lake Overland Surge from Hurricanes (SLOSH) computer model, which is widely used by state and local emergency preparedness officials to predict flooding from storm surge, the dramatic increase in sea level caused by the low barometric pressure associated with hurricanes.

Other NOAA offices supply information on tides, currents, ocean temperature, and other ocean and coastal measurements.

Emergency Response.
The Federal Emergency Management Agency (FEMA) is charged with responding to natural disasters with immediate relief, in the form of emergency personnel, communications equipment, medical services, food and water, housing, and other needed supplies and services. FEMA also supplies intermediate and long-term assistance through loan and grant programs for homeowners, businesses, and communities, and encourages emergency preparedness through a variety of assistance programs for planning and evaluation.

The U.S. Army Corps of Engineers (Corps) provides construction-related services after disasters. For example, NOAA predicted unusually high spring tides in the weeks following Hurricane Hugo. Hugo had eroded the beach and dune system from much of the South Carolina coast; without their buffering capacity, South Carolina's already devastated coastline faced further flooding. Using heavy equipment, the Corps scraped the beaches all along the coast to build temporary artificial dunes to protect beachfront property.

The Corps also removes debris (it removed thousands of tons of material from South Carolina beaches and wetlands after Hugo), provides a variety of other intermediate-relief services, and in some regions, takes an active role in evacuation planning.

Erosion Control and Renourishment.
The Corps of Engineers is charged with responsibility for navigation projects, such as dredging, and jetty and breakwater construction, and plays a major role in many beach renourishment and sand bypass projects. Through cost share agreements with states and localities, the Corps provides design expertise and other technical assistance for such projects.

Flood Insurance.
In addition to its emergency response role, FEMA also administers the National Flood Insurance Program (NFIP). The NFIP underwrites insurance for flood-prone areas in communities participating in the program. In exchange, communities must manage floodplain development, homeowners must meet the elevation requirements FEMA sets for each community, and banks must require floodplain insurance as a condition for writing a mortgage for new construction. Congress intended that these requirements act

as a disincentive to development in flood-prone areas. Enforcement of the NFIP's provisions, however, has proven to be difficult, and the program's record has been criticized by those who feel the NFIP can actually encourage development in high hazards by insuring property owners who unwisely build in such areas.

In 1987, FEMA requested the National Research Council (NRC) to review erosion management strategies and to advise FEMA on how best to implement these strategies through the NFIP. Currently, FEMA delineates flood depth, frequency and velocities in determining coastal hazard risks. In a report entitled "Managing Coastal Erosion," the NRC found that an actuarially sound NFIP depends on FEMA developing accurate erosion rate information and including erosion as a risk factor in writing coastal flood insurance policies. The NRC further recommended that FEMA delineate coastlines subject to erosion to include:

* Imminent erosion hazard, or areas likely to be directly affected by erosion within 10 years;

* Intermediate erosion hazard, areas likely to be affected within 30 years; and

* Long-term hazard, areas likely to be affected within 60 years.

The NRC suggested that these zones (referred to as E-10, E-30, and E-60, respectively), be determined initially using historical shoreline change maps and that FEMA help develop more sophisticated methodologies to more accurately predict shoreline change.

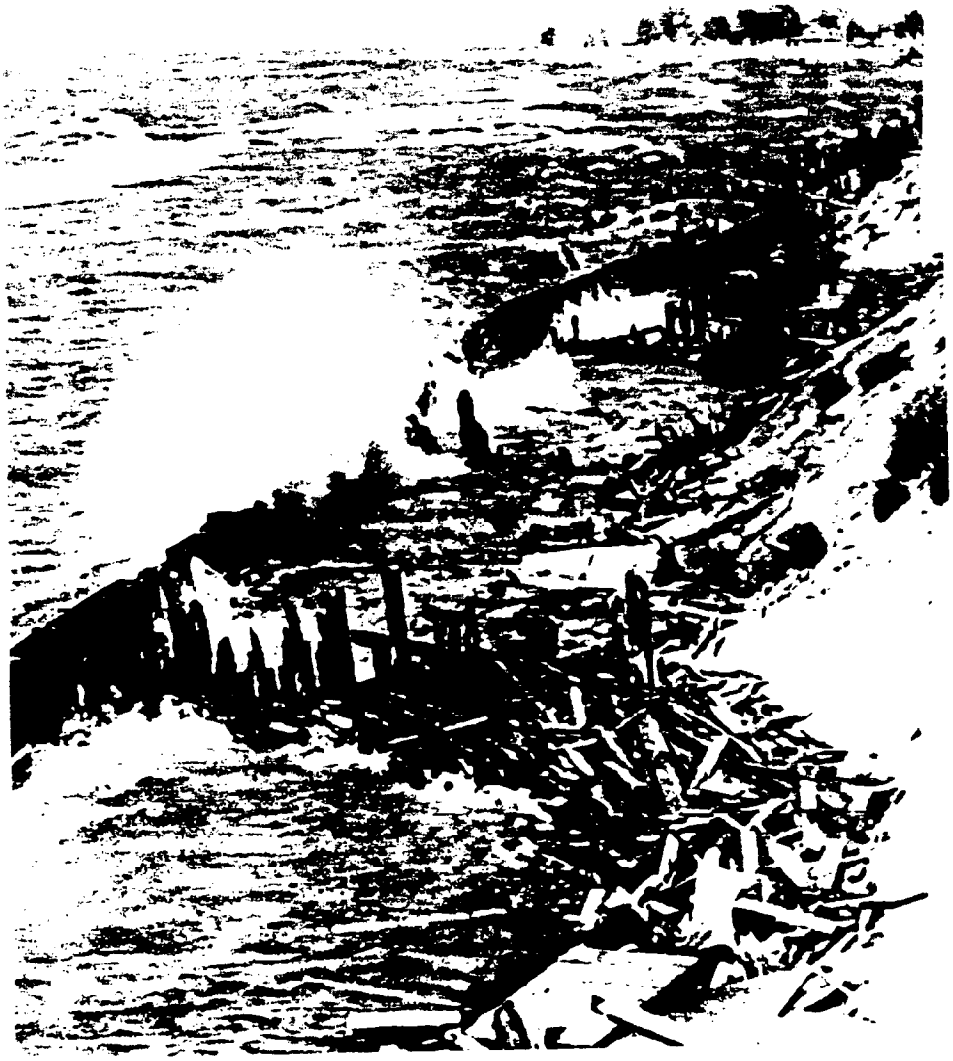
The NRC recommended that only readily moveable structures be permitted seaward of the E-60 line; most development should be confined landward of the E-30 line. No structures over 5,000 square feet should be allowed seaward of the E-60 line. No new NFIP policies should be issued for the E-10 zone; all other policies issued in the E-30 and E-60 zones should be based on actuarial standards.

According to the report, FEMA should use existing state setbacks whenever possible, even if they are more stringent than FEMA standards, and establish minimum standards for local erosion management as a prerequisite for eligibility for disaster relief and other federal programs, including highway and water and sewer funds. FEMA currently is reviewing the NRC's report internally.

In addition to FEMA's review and evaluation of the NFIP, Congress is considering a number of reforms that would both ease the difficulties of administering the NFIP and address concerns that the NFIP as currently structured unnecessarily subsidizes development in high-hazard areas.

Part B

State Coastal Program Responses to Hazards Mitigation



Source: National Research Council, Managing Coastal Erosion

CHAPTER III
MANAGING DEVELOPMENT, EROSION CONTROL STRUCTURES AND BEACHES IN HAZARDOUS AREAS

Mitigation Policy Responses.
Evacuation planning and other emergency measures are the traditional--and until recently, the only--approaches to mitigating the effects of hurricanes and severe storms. But an improved understanding of beach/dune systems, the extremely high cost to the public and private citizens to replace or repair storm-damaged structures, and the limited ability of public agencies to evacuate densely developed high hazard areas indicate the need for a much broader approach to coastal hazards management. Mitigating the effects of severe storms and chronic erosion presents different political and policy problems, but to address either effectively requires unified and comprehensive approaches. Sound hazards mitigation does indeed include better evacuation plans and emergency preparedness, but also requires policies to minimize risks and exposure, and therefore public costs, through managing the siting and construction of shorefront development, and preserving the natural protective functions of beaches and dunes by imposing restrictions on erosion control structures.

States have at their disposal a number of management options. The most widely used include:

* Managing Development;
* Comprehensive Policies for Erosion Control Structures; and
* Beach Renourishment.

Managing Development.
Perhaps the most difficult approach politically, restricting beachfront development is also the most effective. Risk from coastal hazards is greatly diminished when development densities are reduced, beach front structures are set back behind primary dunes and bluffs, and areas most vulnerable to erosion such as highly mobile spits are left undeveloped. For example:

* Development densities on barrier islands should be matched to the evacuation capacity of roads and bridges to the island.
* Public expenditures for bridges, roads, and other infrastructure on and to barrier islands and hazardous areas should be limited to discourage unwise development.
* Beach and bluff setbacks based on local erosion rates should be established; structures built near these setbacks should be designed so as to be movable to

locations further inland when threatened by erosion.

Purchasing property in high hazard areas and holding it as open space is the most direct way to control development; however, it is also expensive, making it less popular than other options for most states. Although property acquisition can alleviate concerns that restricting development constitutes an unlawful taking of private property, it raises other issues such as whether public purchases of highly eroding land are sound investments.

Comprehensive Policies for Erosion Control Structures.
Erosion control structures have the ironic effect of accelerating erosion, either in front of the development the structure is designed to protect, or downdrift. Groin fields, for example, interrupt the longshore transport of sand that replenishes beaches naturally, building up the beach on the updrift side of the groins and leaving steadily eroding beaches downdrift. Jetties designed to stabilize harbor mouths and inlets can affect entire regions: the Charleston Harbor jetties built by the Army Corps of Engineers have caused Sullivan's Island to accrete while starving Folly Beach to the south. And although seawalls and bulkheads may stabilize an eroding shoreline for a time, normal and storm wave action eventually strip away the beach in front of the structure and scour out its base, causing the wall or bulkhead to fail.

Sound beach management requires that state and local governments limit or prohibit erosion control structures, particularly vertical structures such as seawalls and bulkheads. Policy options range from requiring that erosion control structures be removed entirely to restrictions on control structures' repair and replacement.

Beach Renourishment.
In areas where development is particularly dense, or to protect an important natural or man-made feature, beach renourishment may be viable. Ocean City, Maryland, and Miami, Florida, for example, have undertaken large-scale renourishment projects both to protect buildings that were literally at the ocean's edge and to restore the beach as a recreational amenity. In a typical project, dredges or pumps move sand of a suitable type and size from a sand bar, an accreted area, or an upland source to the beach where it is graded to approximate a natural slope. Unfortunately, renourishment is expensive--the Miami project cost $64 million, Ocean City's new beach about $45 million. Further, there are no guarantees the new sand will stay in place; it may erode gradually (although usually faster than the original beach eroded) or be carried away in hours by a storm.

Although largely funded by Congress in the past, the increased cost of such projects, greater need for renourishment, and changes in federal cost sharing requirements have placed more of the funding burden on states and localities.

The State Response.
Examples of state efforts to implement the policies outlined above follow.

ALABAMA

Zoning for Hazards.
In 1989, the Dauphin Island Town Council adopted a zoning ordinance in large part developed by the South Alabama Regional Planning Commission with funds provided by the Alabama Coastal program. The ordinance improved monitoring and enforcement of the Coastal Control Line (CCL) for Dauphin Island and prohibited development in several hazardous areas on the island.

ALASKA

Local Hazards Planning.
The Alaska Coastal Management Program (ACMP) delegates authority to local districts to formulate specific coastal management programs based on ACMP standards. One such standard requires that district programs identify and address geophysical hazard areas. For example:

* The Bering Straits Coastal Resource Service Area Management Program directs development away from hazardous areas. Where this is not feasible, the development must incorporate siting, design, construction, and operation measures to protect against losses of life and minimize property damage and environmental impacts.

* The Sitka Coastal Management program prohibits the issuance of any building permits for developments in geophysical hazard areas until mitigation for such hazards has been incorporated into the project design.

* In Juneau, the coastal program prohibits industrial and resource extraction activities in high landslide or avalanche areas, unless the project can be shown to reduce the threat of landslides and avalanches to existing and potential development.

CALIFORNIA

Coastal Geologic Evaluations.
The California coast presents numerous natural hazards to coastal users, including cliff erosion and shoreline retreat, storm wave run-up, tsunamis, landslides, earthquakes and soil liquefaction. In implementing the California Coastal Act, the California Coastal Commission requires that natural hazards be considered in new development planning.

The Coastal Commission requires geotechnical hazards reports for any project located in an "area of demonstration." An area of demonstration includes the base, face, and top of

all bluffs and cliffs. The Commission defines "bluff top" as the area between the face of the bluff or cliff and a line described by a 20 degree angle from the toe, or 50' inland of the edge of a cliff or bluff, whichever is greater. In areas of known geologic stability or instability (as determined by adequate geologic evaluation or historical evidence), the Commission may designate a greater or lesser area of demonstration.

Among other factors, geotechnical hazard reports must consider, describe, and analyze historic, current and foreseeable cliff erosion, evidence of past or potential landslide conditions, ground/surface water conditions, marine erosion effects, and the potential effects of the most severe probable earthquake. These reports must also address off-site development impacts and mitigation.

Finally, most projects located on the coast must consider and plan for the effects of potential storm surge and tsunami run-up.

San Francisco Bay Seismic Engineering Requirements.
The San Francisco Bay Conservation and Development Commission (BCDC) manages the coastal resources of the San Francisco Bay Area under the McAteer-Petris Act. To ensure all developments on new fill in the Bay Area are constructed safely, BCDC relies upon its Engineering Criteria Review Board (ECRB). The ECRB consists of experts in the fields of soils engineering, geology, structural engineering, engineering geology, and architecture, who volunteer their time and services. The ECRB reviews all projects that involve fill and problems relating to the safety of fills and/or structures on fills.

The roots of the ECRB can be traced to 1965, when the California Legislature established BCDC and charged the Commission with preparing a plan for San Francisco Bay to protect and develop its shoreline in the long-term interest of the general public. The BCDC and its staff began this comprehensive planning effort by reviewing the major development issues confronting the Bay and its physical characteristics. Four of these studies dealt directly with the issue of the safety of fills during an earthquake.

Based on these reviews, the Commission appointed a Board of Consultants to Review Safety of Proposed Fills in 1968. As a first step, the Board began the study of criteria necessary to establish a satisfactory level of safety in a field where no generally accepted standards existed. The Board believed that these safety criteria should be developed and made enforceable by requiring their inclusion in any plan for the conservation and development of San Francisco Bay. The Board adopted a report entitled "Carrying out the Bay Plan: The Safety of Fills," which recommended a set of qualitative criteria involving geological and seismological considerations, soil and foundation engineering considerations, and engineering safety requirements. The report also recommended the Commission include in the Bay Plan a Board of Consultants to continue working on seismic safety considerations and to:

- establish and revise safety criteria for Bay fills and structures thereon with respect to risk zones;
- review all except minor projects for the adequacy of their specific safety criteria;
- gather and make available data developed from projects in the Bay;
- complement the efforts of local building and planning departments.

Based on the technical background reports and the recommendations of the Board of Consultants, BCDC included findings and policies on the safety of fills in the San Francisco Bay Plan. To implement "Safety of Fills" policies of the Bay Plan, the Commission also created the permanent Engineering Criteria Review Board.

The ECRB reviews all major applications for Bay fills to ensure developers use appropriate safety criteria and state-of-the-art techniques to build structures. A number of subjective and quantitative factors are balanced to establish these safety criteria, such as the professional judgment and technical skill of the designer, the degree of geologic hazard, the importance, use and configuration of the structure, the sophistication of the analysis, and the choice of construction materials and techniques.

Overall, the ECRB's review has resulted in a significant improvement in the seismic engineering of fills and structures built on them. In many cases, the ECRB has advised applicants that additional soils and geologic information was needed to properly define the hazards inherent in a development, which in turn led to design changes to reduce risks. Moreover, the mere existence of the ECRB, with its reputation or thorough review, encourages developers, public agencies, and their consultants to consider seismic safety carefully in the design of projects and to use more sophisticated analytical methods than those required by existing code standards.

The Loma Prieta Earthquake in 1989 confirmed ECRB's value. Following the earthquake, BCDC evaluated a number of Bay fill projects reviewed by the ECRB as conditions of their Commission permits. This analysis found that the projects scrutinized by the ECRB suffered very little damage during the earthquake. The ECRB, for example, required significant changes in the design of the Dumbarton Bridge, which survived the earthquake with little damage.

San Francisco Bay Sea Level Rise Policies.
The BCDC has taken a leadership role in planning for the effects of future rises in sea level. Extensive studies indicate that as a result of global warming, Bay water levels could rise approximately one-half foot in the next 50 years, and possibly up to five feet by the year 2100. Such a rise in sea level could have catastrophic effects for the Bay

Area. In response to this problem, BCDC developed new policies and amended its program in 1989 to require that new shoreline development take sea level rise into consideration. The new policies generally require that any new project requiring fill should be above the highest estimated tide level for the design life of the development. BCDC has also been working with Bay Area local governments to assist them in addressing future sea level rise.

CONNECTICUT

Hazards and Permits.
The Connecticut coastal program requires all coastal towns to consider coastal flooding and erosion risks in conducting permit reviews for proposed waterfront development activities. In addition, the Connecticut program has encouraged and provided funds for many coastal towns to incorporate fixed waterfront and wetland setbacks in local zoning regulations as a component of municipal coastal plans.

Land Acquisition.
The Connecticut DEP oversaw acquisitions of coastal hazard areas in several significant instances. Milford Point in Milford and Cedar Island in Clinton are barrier beaches located in FEMA's V-zones.[*] In both cases, coastal management standards and direct involvement during coastal site plan review prevented housing construction in valuable resource areas subject to severe coastal flooding. With substantial coastal program technical assistance and coordination, Milford Point was purchased and incorporated into the Connecticut Coastal National Wildlife Refuge; Cedar Island was purchased jointly by the state and the Nature Conservancy and added to the Hammonasset Natural Area Preserve.

FLORIDA

Sanibel Hurricane Code.
Using federal coastal zone management funds the Florida coastal program provided, the City of Sanibel developed a Hurricane Resistance Construction Code to protect lives and property on the barrier island in the event of a major storm. The code, adopted in 1984,

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[*] FEMA delineates and maps flood hazard zones. "V-zones" designates the 100-year floodplain subject to high-velocity wave action from coastal storms or seismic sources. "A-zones" refer to the flood hazard zone corresponding to the 100-year floodplain, but not subject to such wave action. "B-zones" are the areas between A-zones and the 500-year flood plain; B-zones also include areas subject to 100-year shallow flooding (less than one foot). See appendix for diagram.

adds National Standard Minimum Design Loads for buildings and other structures to the city's building code. It includes requirements that new construction meet wind and wave design standards based on plans certified by engineers and that structures be inspected after hurricanes.

Building Setbacks.
The Florida Coastal Program, through the state Department of Natural Resources (DNR), has set a 30-year erosion line and a coastal construction control line (CCCL) along the sand beaches in each coastal county in Florida. The lines delineate the portion of the beach/dune system most vulnerable to storm surges, storm waves, erosion, or other unpredictable weather conditions. No construction is permitted seaward of the 30-year erosion line. Between the CCCL and the 30-year erosion line, special siting and design considerations are required to ensure that the beach/dune system, proposed and existing structures, and adjacent properties are protected.

The DNR sets the CCCL using field data collected from reference monuments linked to the state plane coordinate survey system installed at 1000' intervals upland of Florida's ocean-fronting beaches. At each monument, DNR field survey teams measure beach profiles, which extend from behind dunes into the surf. Special features such as vegetation lines and existing structures are recorded for future comparisons. Offshore profiles are surveyed at every third monument. Finally, photomaps generated from aerial photography runs provide further confirmation and documentation for each CCCL.

MASSACHUSETTS

Development Restrictions on Barrier Islands.
The Massachusetts Coastal Zone Management Program (MCZMP) implements Executive Order #181, which prohibits state expenditures on undeveloped barrier islands and designates barrier islands a state priority for acquisition.

Mapping and Sea Level Rise.
The MCZMP funded Shoreline Change Summary Maps to consolidate data from NOAA's National Ocean Service (NOS) Shoreline Change Maps.[v] Some 230 local shoreline change maps are available. Based on the Shoreline Change Summary Maps, the MCZMP makes siting or mitigation recommendations during project review and development permitting stages.

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[v] NOS Shoreline Change Maps are generated from surveys of the U.S. coasts undertaken by the U.S. Coast Survey beginning in the 1840's. That agency--now known as the Office of Charting and Geodetic Services--is part of NOAA's National Ocean Service.

The recent Massachusetts Coastal Submergence study yielded a report titled "Passive Retreat of Massachusetts Coastal Upland Due to Relative Sea Level Rise." The report consolidated information coastal communities use to estimate the degree to which upland areas will be affected under different sea level rise scenarios. Based on the study, MCZMP developed policies that require a review of projects proposed in the 100-year floodplain to determine the effects of relative sea level rise as well as the project's potential to exacerbate those effects.

Land Acquisition.
The MCZMP worked closely with FEMA in acquiring coastal storm-damaged property after the Blizzard of 1978. The state, FEMA, and the town of Scituate cooperated to acquire 13 parcels of storm-damaged property in areas highly vulnerable to storm surge and coastal flooding.

MAINE

Beach/Dune Management.
In 1980, Maine adopted legislation to manage the state's beach/dune system. Although beaches comprise only 60 miles of the state's 2,500-mile coastline, they represent an important part of the state's tourist economy. The law requires applicants proposing activities in the beach/dune system--defined as "sand deposits within a marine beach system above high tide, including beach berms, frontal dune ridges, back dune areas, and other sand areas deposited by wave or wind action"--to demonstrate that those activities would not:

* Unreasonably interfere with navigation or recreational uses;
* Cause excessive soil erosion;
* Unreasonably harm wildlife or fisheries; or
* Interfere with natural sand supply and movement.

In 1987, the state coastal program sponsored a set of amendments to the dune regulations to:

* Prohibit construction in the V-zone or on or seaward of a frontal dune;
* Prohibit construction elsewhere in the beach/dune system if, within 100 years, the project may reasonably be expected to be damaged as a result of changes in the shoreline;
* Prohibit seawalls;

* Require that if the shoreline recedes so that a structure is located in a coastal wetland for six months or more, the structure must be removed and the site restored to natural conditions;

* Require that new coastal structures be constructed to withstand winds from a 50-year storm;

* Require that the first floor of new single-family houses or additions to existing structures built in the FEMA A- and B-zones be at least 1' above the 100-year flood zone and built to withstand winds from a 100-year storm; and

* Prohibit the construction of buildings covering more than 2,500 square feet in ground area or more than 35' in height in A- or B-zones unless the builder demonstrates that the site will remain stable after allowing for a 3' rise in sea level over 100 years. The first floor of multi-unit structures must be at least 4' above the 100-year flood zone. The Sand Dune Rules assume that smaller structures can and will be moved if necessary.

The coastal program helped develop a model local floodplain ordinance incorporating these amendments, which a number of local governments have adopted. Other Maine regulations restrict development in flood risk areas and direct coastal managers to consider sea level rise and its implications in making management decisions. A governor's directive requires state agencies to align their activities and prepare plans to implement this policy.

The Maine coastal program developed the state Coastal Barriers Resource System, which uses the federal Coastal Barriers Resources Act of 1982 as a model. State expenditures for development activities within the coastal barrier resource system are prohibited.

MARYLAND

Reducing Development Densities.
The state's Chesapeake Bay Critical Area Program will reduce potential damages from natural hazards by reducing development density along the coast. Resource Conservation Areas designated under the program may be developed at no greater density than 1 unit per 20 acres. Developments must include a 100-foot natural buffer adjacent to tidal waters and wetlands to help mitigate the effects of tidal flooding and sea level rise.

Historic Shorelines.
The Maryland coastal program has begun a major effort to update and computerize mapped information on historic shorelines and annual erosion rates. The program will use a Map and Image Processing System (MIPS) to computerize information from

orthophoto quads and NOS Shoreline Change Maps to produce digitized maps showing historic shorelines and erosion rates from the 1840's to the 1980's. The information and MIPS software will be used by various DNR divisions to implement more effectively the Tidal Wetlands Permit/License Program, Non-Structural Shore Erosion Control Program, and the Waterways Improvement Program.

MICHIGAN

Evaluating Erosion.
The Michigan coastal program is funding a three-year project with the University of Michigan on coastal monitoring and shoreline evolution to better understand the causes and effects of coastal processes, including erosion.

Mapping and Geographical Information Systems.
Michigan Coastal Management staff has been instrumental in developing the Great Lakes Information System (GLIS), the only centralized integrated information system for Great Lakes data storage, retrieval, and computer modeling in the region. The GLIS is part of a broader geographic information system, the Michigan Resource Inventory System (MIRIS), which contains almost all land use/land cover data for the Michigan Great Lakes shoreline. Used together, GLIS and MIRIS databases can provide detailed maps at any scale that display a wide variety of information useful to resource managers, community planners, and others. These maps, for example, provide finer imaging than the National Flood Insurance Program's Flood Insurance Rate Maps (FIRM), allowing a more accurate interpretation of the 100-year floodplain. In addition, the system generates map overlays showing high risk erosion areas, wetland areas, and other areas of special interest to provide local decisionmakers with a more thorough understanding of the environmental hazards and conditions of a given region.

In addition, Coastal Management staff has completed a high-risk erosion area photogrammetric analysis of the majority of Michigan's 3,200 miles of Great Lakes shoreline. Current efforts are directed toward updating these recession rate studies; expanding the database by a minimum of 10 years to include the impacts of changing water levels, storms, mass wasting, installation or deterioration of shore protection structures, and other processes that affect shorelines. This research is the basis for Michigan's high-risk erosion area construction setbacks.

Land Acquisition.
Nearly $2 million recently has been made available for acquisition of high-quality coastal sand dune or wetland habitats. In addition, tax-reverted properties in hazardous areas are often retained in state ownership to prevent development.

Restricting Development.
The Michigan Coastal Management Program administers the Shorelands Protection and Management Act of 1970, which directs the Department of Natural Resources (DNR) to identify coastal hazard areas and implement regulations to minimize risk to development in those areas. The Coastal Program identifies and designates the following hazard areas: High-Risk Erosion Areas, Environmental Areas, and Flood Risk Areas.

* In High-Risk Erosion areas, new construction, including additions and substantial improvements to existing structures, must meet requirements for setbacks from the bluff line, which are based on local shoreline erosion rates.

* In Environmental Areas, the DNR regulates all dredging, filling, grading, or other alteration of the soil, natural drainage, or vegetation, or placement of permanent structures, reviewing permits for such activities for consistency with hazards mitigation goals.

* Construction in the floodplains of Flood Risk Area communities must meet state elevation standards to mitigate for 100-year floods.

The DNR has permitting authority under these programs; localities may opt to assume permitting authority following adoption of a DNR-approved zoning ordinance. An approved ordinance may be revoked and state permitting authority reinstated in the event of local noncompliance.

In July 1989, the State Legislature passed amendments to the Sand Dunes Protection and Management Act. Key provisions of the Act include the designation of 70,000 acres of Critical Dune Areas, the establishment of a model zoning plan for sand dunes protection, and an option for local governments to administer the act if the implementing local ordinance is approved by the Department of Natural Resources and provides protection equal to or greater than the Act's model sand dunes zoning plan. The amendments prohibit certain uses in Critical Dune Areas unless the administering authority grants a variance. Examples of proscribed activities include:

* structures on a slope of 18%-25% unless plans are prepared by a registered professional architect or engineer;

* all uses on slopes greater than 25%;

* silvicultural practices, vegetative removal and uses involving contour changes likely to increase erosion or decrease stability; and

* uses not in the public interest.

Placement of shore protection structures on Great Lakes bottomland is regulated under the Great Lakes Submerged Lands Act of 1955. DNR staff review permit applications under guidelines developed to minimize the negative effects of such structures on adjacent shoreline property owners and the state's natural resources.

MISSISSIPPI

Beach Management.
Using federal CZM funds, the state developed a Sand Beach Master Plan to manage publicly owned man-made beaches for recreation, habitat, and hazard mitigation. As part of that management plan, the state recently launched a dune construction project in an effort to further restore beach values.

NEW HAMPSHIRE

Shoreline Change.
The New Hampshire Coastal Program sponsors periodic updates of "Assessment, Impact and Control of Shoreline Change Along New Hampshire's Tidal Shoreline," a survey identifying eroding or accreting shorelines.

In addition, the program funds bathymetric mapping projects for Great Bay and Little Bay. Mapping the estuarine system enables staff to track sediment movements, and provides a baseline for sea level change measurements.

NEW JERSEY

Erosion and Inlet Mapping.
The New Jersey Coastal Management Program (NJCMP) generated computer-based shoreline maps which depict historical positions of mean high water for the state's coastline based on NOS Shoreline Change Maps. The NJCMP uses these maps to establish the 30-year setback line required for hazardous and high erosion areas and in permit reviews.

Efforts are underway to transfer the cartographic data to a Geographic Information System (GIS) to combine erosion maps, political boundaries, reference points, and roadways. The NJCMP plans to make the GIS information available to coastal counties in a format readily useable by local planners.

The coastal program also funded the Inlet Data Program, which collected historical data to help evaluate dredge and beach renourishment projects.

Restricting Development in Hazardous Areas.
The New Jersey coastal program has proposed revisions to several coastal erosion and flooding management policies. Currently, the NJCMP is reviewing public comment on the proposed changes, as outlined below. The coastal program expects to adopt the revisions by the end of 1990. The Erosion Hazard Areas policy prohibits all development between the mean high water line and the 30-year erosion line, and allows only one- to four-unit dwellings between the 30-year and 60-year erosion lines. Exceptions are made for existing commercial beach and tourism-related facilities or if an area is already zoned for such uses, and for single-family and duplex infill development. The revisions also place further limits on extending or fortifying existing seawalls and bulkheads.

The revised policies will be consistent with the National Flood Insurance Program's newly adopted Guidelines for Erosion Hazard Areas and will allow New Jersey residents to participate in the Upton-Jones* program. The Coastal High Hazard Areas policy prohibits residential development, including hotels and motels, within FEMA V-zones, although the beach-related commercial and infill development noted above is excluded.

The Flood Hazard Areas Policy limits development in FEMA and state-designated floodplains. In undelineated areas, the state will determine the 100-year floodplain case-by-case. What development is allowed must comply with applicable federal and state construction standards for flood risk areas.

NEW YORK

Defining High Hazard Areas.
The New York Coastal Management Program (NYCMP) provides funding to the Department of Environmental Conservation (DEC) to implement the Coastal Erosion Hazard Areas Act (CEHA) within the state's coastal erosion hazard areas. CEHA's thrust is twofold:

* In areas defined as structural hazard areas, a 30-year setback is required for all major buildings. Although the NYDEC generally discourages the use of "hard" erosion control structures, it has established criteria for the construction of erosion control structures, which, where properly designed and constructed, would be

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* The Upton-Jones Amendment to the National Flood Insurance Act provides funds for the relocation or demolition of structures in imminent danger of collapse from erosion or subsidence. Under Upton-Jones, property owners may receive 40% of the value of their structure to relocate it to a more stable site, or 100% of the structure's value (exclusive of site value) plus 10% for demolition if more stable sites are unavailable.

likely to minimize or prevent damage or destruction to property, natural protective features, and other natural resources. The protective measures must have a reasonable probability of controlling erosion on the immediate site for at least 30 years; each structural permit application must be accompanied by a long-term maintenance program to ensure this goal will be met.

* In areas with natural protective features, such as dunes, bluffs, and beaches, development activities must not harm these features.

NYDEC has issued maps defining these areas along the New York coast. A number of communities already have exercised the option to implement the program at the local level through the adoption of a local ordinance. Otherwise, DEC will administer the program.

Because of long-term natural processes and extensive seawall, jetty and groin construction along Long Island's South Shore, erosion and flooding threaten natural resources, infrastructure, and existing development. Rather than continue to approach these problems on a short-term crisis basis, NYCMP recognized the need for comprehensive and coordinated land use management and erosion control and commissioned a study to devise a management strategy. The results of this study are incorporated into a Hazards Management Program for the South Shore, developed in cooperation with the Long Island Regional Planning Board. The Hazards Management Program provides general recommendations for the region, and specific recommendations for local shoreline segments when appropriate.

For erosion control, the Hazards Management Program makes the preliminary recommendation that a state wide sand-bypassing implementation plan be developed to address conditions in the 5 inlets along the South Shore, and for long jetties. The program also recommends that all new inlets be allowed to close naturally, or by intervention after a reasonable period of time. For flood control, the program recommends the creation of a primary dune system, shoreline maintenance, and the preservation of the continuity of the barrier island system.

The NYCMP also participated with the New England/New York Coastal Zone Task Force in a study entitled "Developing Policies to Improve the Effectiveness of Coastal Floodplain Management." The Task Force's efforts helped develop policies for coastal hazard areas by evaluating the costs and revenues to government entities from coastal development; considering the costs and revenues associated with various responses to the continuing problem of erosion and storm damages in these area; and projecting these costs and revenues under various scenarios of future sea level rise.

NORTH CAROLINA

A Soft Stand on Erosion Control.
As long-term barrier island migration and short-term storm erosion shaped North Carolina's coast, shorefront property owners sought to protect their property and structures with bulkheads, riprap, groins, and jetties. In the early 1970s, North Carolinians became concerned that their coast would become long stretches of hardened shoreline with narrow or non-existent beaches. To prevent such a scenario, North Carolina became one of the first states to take a "soft," or non-structural, stand on coastal hazard mitigation.

In 1979 the North Carolina Coastal Resources Commission (CRC) adopted rules establishing an ocean hazard setback area based upon the average long-term annual erosion rate. In 1983, the CRC revised these rules to require a greater setback for multi-unit structures. The CRC also found that risks near inlet areas were greater than in beach areas and strengthened inlet hazard area development regulations.

The CRC's amendments to the North Carolina Coastal Area Management Act (CAMA) regulations are designed to minimize the loss of life and property, prevent structures from being built on public beaches and other encroachments, and reduce public costs due to improperly designed development. The amendments designate three types of coastal hazard Areas of Environmental Concern (AEC):

* Ocean Erodible. Ocean erodible AECs extend from mean low water landward to a distance 60 times the long-term average annual erosion rate for a particular stretch of shoreline, plus an additional distance where significant erosion can be expected during a major storm. AEC widths vary from 145 feet to over 700 feet;

* Inlet Hazard. Inlet hazard AECs extend from mean low water landward to where the inlet can be expected to migrate and range in width from 250 feet to 4,000 feet; and

* High Hazard Flood. High hazard flood AECs are defined by FEMA V-zones.

General CAMA development standards for all coastal hazard AECs include requirements that:

* No development shall significantly alter the sands or vegetation of primary or frontal dunes;

* At a minimum, development must be 60 feet landward from the first line of stable natural vegetation. Where the erosion rate is greater than two feet per year, the erosion setback line extends landward from the first line of stable natural

vegetation to 30 times the average annual erosion rate at the site. For structures of 5,000 square feet or more, or containing more than four dwelling units, the erosion setback line is 60 times the average annual erosion rate at the site, not to exceed 30 times the average annual erosion rate plus 105 feet.

* A permit applicant must sign an AEC Hazard Notice acknowledging an awareness of the risks associated with development in coastal hazards AECs and that the state assumes no liability for damage or injury. In signing the notice, the applicant also indicates an understanding that no permanent erosion protection structures may be used to protect the applicants' property or dwelling;

* Development in coastal hazard AECs also must comply with all local government minimum lot size and setback requirements and land use plans, not unduly interfere with public access, and not cause irreversible damage to historic resources. Mobile homes may not be placed in the coastal hazard AECs unless they are within mobile home parks that existed prior to June 1, 1979;

* Publicly funded facilities are permitted only if there is an overriding public benefit, and if the infrastructure will not promote additional development in the AEC, will not damage natural buffers, and is designed to withstand erosion and storm damage.

* All newly constructed structures must comply with the "Windstorm Resistive Construction" standards of the N.C. Residential Building Code. The Code further specifies that structures must be elevated above the 100-year flood level, and that numerous "piling" requirements be met. Private dune walkovers are allowed only if they cause negligible alteration of the dune.

In addition to the coastal hazard AEC general use standards, development in inlet hazard AECs is limited to residential structures of four units or less, and non-residential structures of 5,000 square feet or less. All development must be set back from the first line of stable vegetation at a distance equal to the adjacent ocean erodible area setback.

Erosion rate maps, produced by the North Carolina Coastal Management Program, show the average rate of erosion in a given part of the coast for the past 50 years. The maps are updated every five years. The erosion rate and setback derived from this rate are used by prospective coastal property buyers to make investment and construction decisions.

In 1985, the CRC amended the CAMA regulations such that no permanent shoreline stabilization structures, i.e., bulkheads and groins, are allowed in coastal hazard AECs. Limited bulldozing of sand, beach nourishment, and emergency sand bagging is permitted. Any erosion control activity must be timed to cause minimal damage to wildlife.

As a result of these measures, North Carolina has been able to maintain the natural dune and sand transport system and wide beaches, resulting in greater protection for structures, businesses, and public infrastructure.

The Nags Head Storm Mitigation and Reconstruction Plan.
The Town of Nags Head has developed an innovative program to deal with hurricane preparedness and town reconstruction after a severe storm. The Hurricane and Storm Mitigation and Reconstruction Plan (or Plan), which was prepared and adopted by the town prior to a severe storm, allows for objective decision-making and lessens post-storm social, political and economic pressures. The Plan will ensure the town is rebuilt in a planned, safe and economical manner. The Plan also will assure that all rebuilding will be in accordance with state and local laws and regulations.

In the early 1980s, Nags Head officials realized that no preparations were made to manage reconstruction after severe storms, the unique physical, historical and cultural features of the town could be permanently altered. In 1984, Nags Head received $10,000 in Federal CZMA funds from the North Carolina Division of Coastal Management to address a new North Carolina Coastal Management Program (NCCMP) requirement on planning for storm hazard mitigation and reconstruction. The town found that 62% of its assessed property value was within the 100-year flood zone. As a result, policies were adopted in its 1985 Land Use Plan Update to help the own reduce new construction in the 100-year flood zone and to lessen damage from storms or existing development.

The primary hazard mitigation goal included in the 1985 Land Use Plan was, " . . .to reduce, to the extent possible, future damage from hurricanes and severe coastal storms. It is the town's intent to reduce these hazards both in advance of such events and to require mitigation measures during reconstruction which reduce damages from future storms."

In 1986, the North Carolina Division of Coastal Management awarded $12,000 in Federal CZMA funds to Nags Head to further develop the goals and policies adopted in the town's 1985 Land Use Plan. Following two years of meetings, workshops and widespread public involvement, the plan was adopted by the town on October 10, 1988.

The town's Planning and Development Staff kept the various town boards, elected officials, development and realty community, and general public informed every step of the way. This greatly reduced opposition to the various mitigation and reconstruction proposals.

The town combined growth management techniques with an understanding of the natural coastal processes. The effects of wave and wind action, barrier island migration, dune and beach dynamics, and storm processes on coastal development were factored into the town's zoning and subdivision ordinances, and policies.

The Nags Head Hurricane and Storm Mitigation and Reconstruction Plan establishes:

* Various building moratoriums based upon the severity of damage. These range from an initial building moratorium of 48 hours for all construction and permits to 30 days for the replacement of destroyed structures. All replacement construction must comply with new ordinances and building codes. Where new inlets have formed, construction will be allowed only when the Board of Commissioners deems it appropriate. Building permits issued by the town prior to the storm are revoked for a minimum of 30 days.

* A Reconstruction Task Force consisting of 13 local officials and representatives from the construction or realty community who will advise the Board of Commissioners on a wide range of reconstruction issues.

* Requirements for the issuance of building permits to repair storm-damaged structures. These requirements vary for destroyed structures (repairs of 50% or more of the replacement cost at the time of damage), and structures with major (repairs of 10%-50% of the cost of the structure) or minor (less than 10% of the cost of the structure) damage.

* Use standards and setback requirements for construction in coastal hazard areas. This provides strict conditions for the replacement of structures on lots existing prior to June 1, 1979, seaward of the applicable setback line in ocean erodible areas. For the most part, the town's setback lines follow the state's; 30 times the annual erosion rate for residential structures, and 60 times the annual erosion rate for structures of 5,000 square feet or more or with four or more dwelling units.

* Requirements for the recombination of land under certain circumstances to allow buildings to move back from eroding areas.

* Conditions for declaring damaged structures and structures in public trust areas as public nuisances to facilitate clean-up activities.

* Policies that give the town time to consider its options for the reconstruction of public roads. These policies also prohibit the use of public funds to repair private roads, except where the town's water system is in need of repair.

* A program for rapid acquisition of land for open space, parks, recreation areas, and historic or scenic areas.

* An Assistance Facilitator-Consultant to advise the town of the types of assistance and post-storm aid available, and to assist in securing such aid.

* A Mutual Building Inspector Assistance Program through which the town can arrange ahead of time to have other communities assist Nags Head in the event of a major storm.

In recognition of the first plan of its kind signed into law in North Carolina, the Town of Nags Head received the 1989 Small Community Outstanding Planning Award presented by the North Carolina Chapter of the American Planning Association. In April 1990 the town received further recognition for its leadership in developing the Plan when it was awarded the 1990 National Hurricane Conference's "Legislative Award," normally awarded to a state legislator or member of Congress. The Nags Head Hurricane and Storm Mitigation and Reconstruction Plan, however, was singled out as the year's most significant legislation addressing hurricane and storm hazards. The Conference also believes that the plan should be a model for other coastal communities.

NORTHERN MARIANA ISLANDS

Permitting and Setbacks.
Coastal Resources Management permits are required for all projects proposed for Areas of Particular Concern (APCs) designated by the coastal program, and for major projects outside APCs. The Coastal Resources Management Office established setbacks for development along the shoreline. Among other restrictions, no structural development is allowed within 75 feet of mean high water. The only exceptions to the setback requirements are for projects within the Port and Industrial APC.

OREGON

Land Use Planning in the Coastal Zone.
The statewide land use planning program in Oregon requires cities and counties to adopt comprehensive land use plans and zoning ordinances to implement the statewide goals. Three of these goals set specific standards for natural hazards.

Statewide Planning Goal 7, Areas Subject to Natural Disasters and Hazards, mandates that development subject to damage shall not be located in known areas of natural disasters and hazards without appropriate safeguards. The goal defines hazardous areas as areas subject to natural events such as stream flooding, ocean flooding, erosion and deposition, landslides, earthquakes, and other hazards. Local plans are based on an inventory of natural disaster and hazards areas. Goal 7 also delineates specific factors to consider in locating development in hazardous areas.

Statewide Goal 17, Coastal Shorelands, requires coastal cities and counties to identify coastal shoreland areas, which include those areas adjacent to estuaries, the ocean,

coastal lakes, areas subject to flooding, coastal headlands, land within 1,000 feet of the shoreline, and areas of geologic instability. Local governments must establish management policies for these areas according to state standards. Goal 17 states explicitly that policies should favor nonstructural over structural solutions to problems of coastal erosion and flooding.

Goal 18, Beaches and Dunes, sets standards for regulating new development in beach and dune areas. The goal prohibits building on undeveloped foredunes subject to ocean flooding or erosion. Goal 18 includes other standards to protect development from flooding and erosion, and to avoid interference with the natural beach/dune system:

* Findings are required for any new development in beach or dune areas. These findings must assess the effects of the proposed development on the beach and dunes and on surrounding development, and demonstrate how the development will avoid or minimize impacts on the dune and adjacent areas;

* Breaching of foredunes is prohibited, except for temporary breaching in emergencies, such as to drain floodwater from upland areas;

* Riprap and other structural means of erosion control are allowed only on shorelines that were developed before January 1, 1977.

Coastal cities and counties have responded to the goals' mandates with appropriate comprehensive plan provisions and by implementing ordinances regulating development in hazardous areas. Local governments have used a variety of planning tools, such as hazard overlay zoning, beach and dune overlay zoning, site-specific geologic report requirements, and density bonus awards to developers who avoid hazardous areas. Comprehensive plan elements addressing Goal 18 typically are implemented through special zoning districts or overlay zones which require that any proposed development or dune alteration be reviewed and approved by the local government. Usually, ordinances require minimum setbacks from the beach zone line.

Local zoning ordinances also incorporate the federal floodplain management requirements. Regulations adopted to implement these requirements prohibit development in high-velocity flooding areas.

Finally, state coastal program field representatives provide assistance to local governments as local officials develop and adopt comprehensive plan policies and zoning ordinances and as they make land use decisions.

PENNSYLVANIA

Monitoring Bluff Erosion.
In 1987, the Pennsylvania Coastal Zone Management Program (PCZMP) funded "Great Lakes Shoreline Existing and Potential Damage Survey, Lake Erie/Pennsylvania Coastal Zone." The coastal program also completed a project to remeasure the bluff recession monitoring control points on a 1/2 km grid along the Lake Erie shoreline. Local governments with ordinances restricting development in bluff recession hazard areas will receive the remeasuring project results.

Limiting Development Along Bluffs.
The PCZMP also administers the Bluff Recession and Setback Act of 1980 (BRSA) which mandates that coastal communities in recession hazard areas adopt setback ordinances for stationary structures. Communities maintain and enforce the setbacks as part of the local building permit review process to:

* regulate new buildings within the bluff recession hazard zones;

* monitor improvements to existing buildings in such hazard zones to ensure that no improvement exceeds 50% of the structure's market value for a five consecutive year period; and

* maintain variance procedures enabling property owners to build or add to structures provided they meet the Act's requirements.

The PCZMP program has increased its monitoring of local BRSA implementation by stepping up surveillance. Each year, in conjunction with annual overflights, coastal program and other agency staff tour each municipality's bluff recession hazard areas to detect new construction and substantial improvements.

The coastal program also has received FEMA approval to certify structures in danger of imminent collapse because of erosion caused by high lake levels for Upton-Jones purposes.

RHODE ISLAND

Erosion Mapping.
The Coastal Resources Management Council (CRMC) has mapped all critical erosion areas and calculated average annual erosion rates for these areas. The state uses the information to establish building setback lines in highly eroding areas.

The CRMC also has prepared maps to describe various sea level rise scenarios for the southwestern Atlantic beaches. Included in the project was an analysis of the economic effects of sea level rise.

Controlling Development on Barrier Islands.
The Coastal Resources Management Council (CRMC) formulated a set of general coastal hazard mitigation policies as well as comprehensive controls on construction and development on the state's barrier islands. General policies include:

* A minimum 50 foot building setback along the shoreline. In state-designated "critical erosion areas," the setback is a minimum of 30 times the annual erosion rate for housing with 4 or fewer units, and 60 times the annual erosion rate for structures containing 4 or more units.

* Repair or reconstruction of all structures destroyed 50% or more by natural processes such as wind, storm surge, and erosion requires that a new CRMC Assent Order be issued. In a number of cases, the CRMC has required that the remains of the structure be removed completely.

* In "Type I" conservation areas and waters--the majority of the state's waters--any type of erosion control device is prohibited.

To regulate construction and development on Rhode Island's barrier beaches, the CRMC forbids construction on frontal dunes; and requires that all development be set back at least 75' landward of the primary dune, except in developed areas. The CRMC has characterized the state's barrier islands and divided them into three categories:

* Developed Barrier Beaches. Rhode Island faces little high-density development; developed areas generally are characterized by single-family detached dwellings. Property owners on developed barrier beaches may not build seaward of a line drawn across the face of existing buildings, or closer than 75 feet landward of the primary dune crest.

* Moderately Developed Barrier Beaches. There is some infrastructure on these islands, but little other development. No new development is permitted, other than public recreational facilities such as changing and shower rooms. Existing private recreational structures may be repaired, but not expanded.

* Undeveloped Barrier Beaches. No new construction may take place on these barrier beaches.

In addition, no public funds may be expended for infrastructure on barrier islands in Rhode Island, whether or not they are developed. Some 82% of Rhode Island's barrier

islands are either moderately developed or undeveloped.

The CRMC has adopted a post-hurricane and storm policy which authorizes a moratorium of up to 30 days on reconstruction of structures in V- or A-zones at least 50% destroyed by storm, flood, wave, and wind damage. During the moratorium, the state may consider purchasing damaged properties or pursue other mitigation responses.

SOUTH CAROLINA

Regulating Beachfront Development.
The 1977 law establishing the South Carolina Coastal Management Program (SCCMP) provided the South Carolina Coastal Council (SCCC) with permitting jurisdiction in the "critical area"--coastal waters, tidelands, and beaches and primary dunes. The SCCMP definition of beaches and primary dunes limited the SCCC's permitting authority to the landward trough of the primary dune if the crest of the dune was located within 200' of mean high water. This and other statutory limitations on its beach and dune critical area jurisdiction prevented the SCCC from effectively managing South Carolina's beaches in that construction just outside the critical area often interfered with the natural movement of the beach/dune system.

Recognizing this jurisdictional problem, and the threat to the long-term health of its beaches construction encroaching on the beach/dune system posed, South Carolina in 1986 appointed a Blue Ribbon Committee on Beachfront Management. The Committee was charged to investigate the problems of beach erosion along the coast and to determine how the state could best manage the beach/dune system for the public good.

The Blue Ribbon Committee on Beachfront Management.
The Committee's efforts were lent new urgency when in December 1986 and January 1987, two severe winter storms caused considerable beach erosion and property damage. The Council received numerous permit applications to rebuild houses, pools, seawalls, and revetments. Although the Council made every effort to require applicants to relocate the new structure as far landward as possible, its limited jurisdiction meant that many of these structures were rebuilt where they would likely be damaged again and would continue to contribute to the destruction of dunes and beaches by interfering with natural sand movements.

In its 1987 report, the Blue Ribbon Committee found that the coastline is a vital component of the state's economy, that many miles of South Carolina beaches are eroding and that this erosion threatens the beach/dune system. In the absence of a health beach/dune system, the Committee reported, life, property, the tourism industry, vital state and local revenue, and marine habitat were at risk from continued erosion and exposure to storm hazards. The Committee also found that the primary causes of this erosion were: a persistent rise in sea level, poorly planned development which

encroached on the beach/dune system, and a lack of comprehensive beach management planning. The Committee recommended prompt legislative action by the General Assembly to include an expansion of the SCCC's jurisdiction, a policy of a retreat from the beach over a number of years, the establishment of setback lines based on local annual erosion rates, size and other restrictions on structures built seaward of these setbacks, and the development of local and state comprehensive beach management plans.

The Beachfront Management Act of 1988.
In 1988, the South Carolina General Assembly passed the Beachfront Management Act, which declared that the policy of South Carolina is to:

* "Protect, preserve, restore, and enhance the beach/dune system, the highest and best uses of which are declared to provide: a barrier and buffer from high tides, storm surge, hurricanes and normal erosion; a public area which serves as a major source of state and local revenue; habitat for indigenous flora and fauna; [and] a place which harbors natural beauty;"

* Develop long range comprehensive beach management plan, which must include a gradual retreat from the beach/dune system over 40 years;

* "Severely restrict the use of hard erosion control devices to armor the beach/dune system and to encourage the replacement of hard erosion control devices with soft technologies;"

* Encourage the use of erosion control techniques which do not adversely affect the beach/dune system;

* Promote carefully planned beach renourishment projects where economically feasible; and

* Develop guidelines for the emergency management of the beach/dune system following significant storm events.

To accomplish these objectives, the BMA required the SCCC to determine local erosion rates for all portions of the coast, except areas already protected from development, and to establish development setback derived from expected beach erosion over 40 years. To help preserve the beach and ensure the Act's 40-year retreat goal was realized, all new erosion control structures were prohibited and such structures damaged more than 50% required to be removed. The Act also expanded the beach/dune critical area to include the area between mean high water and the setback line, required the SCCC to develop a comprehensive permitting scheme for the newly expanded beach/dune critical area, directed the SCCC to develop a statewide beach management plan, provided for local governments to develop beach management plans consistent with the state management

plan, and required the disclosure of specific hazards conditions during property transfers.

Baselines and Setbacks.
To determine the setback line, the SCCC established monumented and controlled survey points along the coast to help develop the topographic and beach profile information necessary to establish baselines and setbacks. From these monuments, the Council set a "baseline" at the crest of an ideal primary oceanfront dune for each standard erosion zone. A standard erosion zone is a section of shoreline subject to similar coastal processes, having a fairly constant range of beach profiles, and not directly influenced by tidal inlets or associated inlet shoals. In areas where the shoreline has been altered by the construction of erosion control devices, groins, or any other man made alteration, the baseline is set where the crest of the primary dune would have been had the shoreline not been altered. Baselines within unstabilized inlet erosion zones are set at the most landward point of erosion at any time in the past 40 years, unless scientific and/or technical information indicate the shoreline is unlikely to return to their former position. For stabilized inlets, the baseline is set in the same manner as for standard erosion zones.

The BMA also required the SCCC to establish a 20' buffer, or "dead zone" delineated by the "minimum setback line" immediately landward of the baseline. The SCCC then established a "setback line" for all locations at a distance from the baseline 40 times the local annual erosion rate. However, the setback is a minimum of 20'. The BMA provides for periodic line reviews and an appeals process for property owners who believe lines have been set improperly.

Limits on Construction.
The BMA prohibited construction seaward of the baseline and within the dead zone. Seaward of the setback, habitable structures were to be located as far landward on the lot as practicable and limited in size to 5000 square feet, inclusive of porches, decks, and garages. No part of habitable structures were to be constructed seaward of the landward edge of the dead zone.

The BMA also provided that all vertical erosion control devices seaward of the setback line be removed entirely or be replaced by sloped erosion control structures within 30 years, and forbade the construction of new erosion control devices anywhere seaward of the setback line.

Damage to Existing Structures.
To implement the 40-year retreat policy, the BMA required that if a structure located between the baseline and the setback line was two-thirds destroyed (or "destroyed beyond repair"), that structure must be torn down and if rebuilt, be constructed as far landward on the lot as practicable. In cases where the structure was located seaward of the minimum setback line, and the lot was not large enough to allow reconstruction landward of the dead zone, the structure could not be rebuilt.

Vertical erosion control devices more than 50% destroyed were required to be removed. If replaced with a sloping erosion control structure, the BMA required that it be moved as far landward as possible.

Implementation and Hurricane Hugo.
In some areas, particularly where the beach/dune system had been altered with erosion control structures, the methodology used to establish baselines meant the baseline could be located well landward of the existing primary dune, leaving a number of lots unbuildable, and would have prevented rebuilding of about 1,200 structures had they been destroyed beyond repair. Several property owners unable to build on their oceanfront lots because of the construction restrictions filed suits arguing that the restrictions constituted an unlawful takings of private property by the state. SCCC currently faces some 60 takings suits.

Other controversies arose from the methodologies used to establish baselines--although the SCCC made every effort to use the best technical and scientific data on shoreline change over the past 40 years available, line setting techniques could not precisely predict future shoreline movement--and provisions in the BMA that prohibited the seaward movement of the baselines even where renourishment projects were in place.

Just a year after the SCCC began to implement the BMA, Hugo struck the South Carolina coast. Fortunately, the SCCC had already set most of the baselines and setbacks lines on an interim basis; contingency contracts with engineering firms helped the SCCC to survey damaged property to determine which structures were destroyed beyond repair in a timely fashion. Although in the storm's aftermath only about 125 structures in the dead zone were found to be "destroyed beyond repair" and so could not be rebuilt in their original foot print, the storm consolidated opinion in South Carolina that amendments to the BMA were necessary.

1990 Beachfront Management Act Amendments.
After intense debate over the future of beach management in South Carolina--one set of amendments would have deleted all reference to a retreat policy and removed the BMA's strictures on erosion control devices--the General Assembly passed amendments to the BMA in June 1990. The most significant changes include:

- Elimination of the Dead Zone. The General Assembly eliminated the dead zone immediately landward of the baseline, thus allowing limited construction on many lots that were unbuildable under the 1988 law.

- Erosion Control Devices. The prohibitions against erosion control structures were strengthened by prohibiting the construction of all erosion control devices, not just vertical structures, and by clarifying definitions of seawall and bulkhead damage. However, the requirement that all vertical devices be removed within 30 years was dropped, and a gradual approach to removing erosion control devices destroyed

beyond repair adopted. Until 1995, seawalls more than 80% destroyed above grade must be removed and may not be rebuilt. From 1995 to 2005, seawalls more than two-thirds destroyed above grade must be removed, and after 2005, seawalls more than 50% destroyed above grade must be removed.

* Special Permits. In an effort to avoid future takings cases, the General Assembly provided the SCCC with the discretion to issue a special permit when the location of the baseline and its restriction on development seaward of the line would render a lot unbuildable. The owners of structures allowed under such a special exemption, however, must remove the structure if it becomes situated on the active beach through erosion processes; the SCCC may impose other restrictions consistent with the goals of the BMA. In no case, however, may a structure be built on the active beach or primary dune, nor may erosion control structures be built or rebuilt under special exemption permits. The SCCC currently is drafting regulations that would allow only for a very narrow application of special permit authority.

* Non-Habitable Structures Seaward of the Baseline. Walkways, small decks (less than 144 square feet), public fishing piers, dune walkovers, and the like now may be constructed seaward of the baseline subject to SCCC permit review and approval.

WISCONSIN

Lakefront Setback.
The Wisconsin Shorelands and Wetlands Act requires a minimum 75-foot setback from shorelines and wetlands. At least one-half of the affected counties, however, have implemented 100-foot setbacks to guard against periodic high lake levels.

CHAPTER IV
RESEARCH, PLANNING, TECHNICAL ASSISTANCE, AND EDUCATION

Introduction.
Although managing development along shorelines is the most effective way to reduce exposure to coastal hazards in the long term, it is equally important to educate the public, conduct basic research about geologic processes, buildings' resistance to severe storms and other factors of importance in the land-sea boundary, and to provide technical assistance to property owners and other agencies.

Hazards Mitigation Technical Assistance.
Many states have programs to provide technical assistance to local governments and property owners on geologic processes, beach profiling, renourishment, local beach management planning, and other mitigation measures. These run the gamut from providing the technical expertise necessary to evaluate a renourishment project to assisting with dune construction efforts to providing advice to property owners who wish to plant native dune stabilizing grasses.

Public Information and Education.
Educating the public about coastal hazards and mitigation, from explaining hurricane evacuation plans to pointing out the dangers of unwise development on barrier islands, is an important part of long-term efforts to reduce risks from hazards. Making the public aware of the risks of building too close to the water's edge or on unstable beaches underpins efforts to manage development in those areas. Outreach programs range from elementary school curricula to hazard mitigation seminars for private landowners.

Planning and Research.
Using federal coastal zone management funds, states conduct a variety of research and planning activities. Most states have taken the obvious step of developing evacuation and emergency response plans. But a great deal of work remains to more fully understand erosion rates, the potential effects of sea and lake level rise, the efficacy of hazard mitigation-based building codes, land use planning, early warning systems, better hazards prediction models, and the like.

The State Response.
State activities in planning, research, education and technical assistance follow.

AMERICAN SAMOA

Landslide Mitigation Planning.
The American Samoa Coastal Management Program (ASCMP) is developing the Landslide Mitigation Feasibility Plan. The ASCMP has contracted with the US Department of Agriculture's Soil Conservation Service (SCS) to conduct preliminary field research for a study of rock and soil types, slope zones, vegetative cover, and other factors related to landslides. SCS will also produce maps and supporting data to determine additional study requirements for effective landslide mitigation efforts. Upon completion, the report will provide a basis for a review of mitigation options and special construction standards for high hazard zones.

Coastal Zone Documentary.
The ASCMP funded a one-hour documentary on Coastal Zone Management in American Samoa. The discussion of coastal hazards in this film has heightened public awareness. Local television has broadcast the program; it is also used frequently in outreach efforts and interagency workshops. In order to reach the entire population, the film is available in both English and Samoan.

CALIFORNIA

Technical Publications.
The California Coastal Commission prepares Local Assistance Notes, a newsletter to provide technical information to local governments. Some of the topics the Notes have addressed include the effects of accelerated sea level rise on the California coast; impacts of induced seismicity and subsidence within the California coastal zone; and assistance for review of seawall permits. The Commission circulates Notes to interested parties nationwide.

Coastal Erosion Conference.
In 1985, the Commission sponsored a conference on coastal erosion and published the proceedings in a report entitled "California's Battered Coast." In 1990, the Commission will sponsor a workshop on the Malibu Coast Fault.

CONNECTICUT

Erosion and Flood Planning.
The Connecticut coastal program, administered by the Department of Environmental Protection (DEP), provides technical assistance to individuals and municipalities on coastal flooding and erosion and undertakes ongoing flood and erosion hazard planning.

* Through the Coastal Site Plan Review process, coastal program staff routinely work with coastal municipalities to assess coastal hazards mitigation planning when reviewing development permit applications.

* The DEP provides technical assistance to municipalities, private property owners and water dependent businesses, such as marinas, to address coastal hazard problems.

The Connecticut program also provides extensive technical assistance and/or takes lead responsibility, where appropriate, for several state-sponsored coastal hazard-related studies and projects such as beach erosion control measures at Compo Cove in Westport and at Hammonasset State Park.

DELAWARE

Beaches 2000.
The DCMP, with assistance from University of Delaware scientists, government officials, and interested citizens, prepared "Beaches 2000" and submitted the report to the governor in 1988. "Beaches 2000" assesses management alternatives to address shoreline erosion along Delaware's Atlantic coast over the next decade. The report concluded that a policy of retreat from the coast was the only viable long-term option, but also proposed a short-term action plan, since implemented, to renourish beaches where economically justified. Significantly, "Beaches 2000" makes clear renourishment is only a temporary solution to erosion and recommends that communities' share of the cost of renourishment projects vary depending on the degree to which the public, not just beachfront property owners, benefits.

Public Education: The Hugo Experience.
DCMP produced a slide show illustrating Hurricane Hugo's effects on a variety of structural and non-structural erosion control measures and showing the effects such a storm might have on the Delaware coast.

FLORIDA

Coastal High Hazard Areas Research.
Coastal management program grants have been used by the Department of Natural Resources to research shoreline change, storm surge, wave impacts, dune/bluff erosion predictions, and ways to avoid or minimize public and private losses on barrier islands and high erosion shorelines. This research provided support for 1985 legislation which prohibits construction of a major development seaward of the 30-year erosion zone and prohibits subsidies for public infrastructure in locally designated coastal high-hazard areas. It has also been used to set state coastal construction standards and regulations.

Coastal Storm Structural Damage Assessment and Appraisal.
The Department of Natural Resources used a coastal program grant to review agency structural damage assessment and appraisal procedures following hurricanes. Based on study findings, the Department revised its format to simplify property damage assessments and developed an emergency permitting plan.

Sea Level Rise.
The Florida Coastal Citizen's Advisory Committee has developed different sea level rise scenarios and begun planning for their effects. Recently, the Committee distributed a public information flyer explaining the concept of sea level rise throughout the state. The committee has sent out a survey of local cities, counties, and regional planning entities; responses will be discussed at an upcoming coastal conference sponsored by the Florida Coastal Program in September 1990.

Hurricane Evacuation Planning.
The potential for loss of life and life from natural hazards such as hurricanes, flooding, and erosion is enormous along Florida's heavily developed coastal shoreline. The Florida coastal management program has funded hurricane evacuation plans on a regional basis. Projects in South Florida, Tampa Bay, and other regions have helped the state prepare for major storms and develop techniques to minimize losses. The funds have been used to develop baseline hurricane impact plans and evacuation plan revisions based on hurricane evacuation exercises and population changes.

The success of this planning effort was evident in the 1985 hurricane season. During Hurricanes Kate and Elena, emergency officials evacuated Pinellas County and the Panama City area quickly and safely. Well-marked evacuation routes, effective communication systems, easily available shelters, and a defined chain of command all prevented serious injuries and loss of life during these storms.

Hurricane Risk and Loss Studies.
The Tampa Bay Regional Planning Council used coastal management program funds to evaluate the economic risk to the region posed by hurricanes. The study projects that the structural loss from a "worst case" major storm will amount to over $9.6 billion. This information is critical for public officials concerned with disaster relief funding.

Regional planning councils in Florida received coastal grants to conduct hurricane loss studies which identified property loss estimates based on selected hurricane scenarios. Research included property vulnerability analyses; evaluations of projected structural loss; service and social disruption; and employment loss.

The hurricane risk studies have helped the state and coastal communities understand the potential public costs, both fiscal and social, that could result from a major hurricane along Florida's heavily populated coastal counties. As a result of the study findings, state

and coastal governments are examining ways to minimize further public investment risk through sound development and redevelopment policies.

HAWAII

Oahu Erosion Studies.
In June 1989, the Hawaii Coastal Zone Management Program completed the "Hawaii Shoreline Erosion Management Study." The study provided a comprehensive review of erosion management in Hawaii, a critical step toward developing consistent regulations governing the use of structural and non-structural measures to control erosion. It offered numerous recommendations to improve shoreline management, including a recommendation that the state coastal program play a preliminary role in developing a method to identify critical erosion-prone areas throughout the islands. The study further recommended that the Hawaii coastal program take the lead in working with county governments to develop local long-term erosion management plans for erosion-prone areas. Finally, it discussed the potential effects of a beachfront regulatory regime on selected beaches on Kauai and Oahu.

The coastal program also funded the "Oahu Shoreline Setback Study" to update erosion trends for Oahu beaches and to refine the methodology for establishing building setbacks for various beach types. Current and historic shoreline positions were plotted from aerial photographs. In addition, revised setbacks were proposed for the study area and a draft setback ordinance prepared.

MASSACHUSETTS

Portrait of the Coast.
The MCZMP funded a half-hour film, now also available on video cassette, entitled "Portrait of the Coast." The film depicts a coastal high hazard area over the course of a year, including the Blizzard of 1978. It is widely distributed in the state.

MARYLAND

Non-structural Technical Assistance.
Through the state's Non-structural Shore Erosion Control Program, the Maryland DNR provides 50-50 matching grants to shorefront property owners and local jurisdictions to restore degraded shorelines. Property owners apply to the DNR for restoration grants to grade shorelines to original contours and plant marsh grasses and other land-stabilizing vegetation. The DNR also provides other non-structural technical assistance.

MICHIGAN

Assistance for High Lake Levels.
The Michigan coastal program provides assistance to site inspectors, engineers, contractors, and others to manage the effects of high lake levels. The state also conducts Community Assistance Visits to help review and monitor local floodplain regulation implementation for compliance, and provides technical zoning assistance to local communities.

In 1990, coastal program staff will monitor 12 designated Flood Risk Area communities in a new effort to determine compliance with floodplain regulations established in local zoning ordinances, building codes, the Shorelands Protection and Management Act, and the National Flood Insurance Program. At least one of these communities was non-compliant during an initial visit in 1989. A return visit is scheduled to ensure compliance with floodplain regulations.

During the high lake level periods in 1986 and 1987, the Michigan Legislature authorized emergency programs to provide grants and subsidies to assist communities and property owners with flood and erosion mitigation projects. Coastal Management staff administered the program, which provided a 3% interest rate subsidy on loans used to relocate or elevate structures threatened by erosion or flood damage. Structural projects, such as seawalls and dikes, were eligible for the subsidy only if the dwelling could not be moved or elevated. The Emergency Management Division of the Michigan State Police administered a community grant program that made funds available to coastal communities for up to 85% of the cost of erosion or flooding prevention projects.

MISSISSIPPI

Sea Level Rise.
Since most of the Gulf coast is low-lying, sea level rise is of particular concern to Gulf states. The Mississippi coastal program, in cooperation with the Alabama coastal program, will host a two-day sea level rise conference in September 1990 focusing on the anticipated effects of sea level rise on marine life, estuarine resources, upland development, and coastal erosion.

The coastal program also has embarked on an ambitious demonstration program in Jackson County to address coastal hazards. The program is designed to evaluate state and local policy and ordinances relating to coastal hazards, and to inform the public about hazards and about state and local requirements for hazards mitigation. As part of the education campaign, the state coastal program will:

* Identify methods to disseminate hazards information;

* Develop an education plan and acquire the necessary education materials;

* Implement the plan through seminars with realtors, contractors, insurance agents, and bank loan officers.

Finally, the state will prepare a written report which evaluates the current coastal hazard and floodplain management policy and regulatory framework.

NEW HAMPSHIRE

Preparing for Sea Level Rise in New Hampshire.
The coastal program in New Hampshire co-sponsored a workshop with NOAA Sea Grant on sea level rise in 1987 and published conference proceedings. The program commissioned "Rise in Sea Level and Coastal Zone Planning," a study of sea level rise and its potential effects on New Hampshire, and distributed the study to all coastal local governments.

NEW JERSEY

Educating the Public About Shoreline Erosion.
The New Jersey coastal program funded a video in conjunction with public television's New Jersey Network News entitled "Migrating Shores." This 30-minute presentation, which aired on New Jersey public television in October 1989, provided viewers with a description of coastal erosion processes, and a critical assessment of techniques used to try to control erosion.

Dune Protection.
As part of its Shore Protection Program, the New Jersey program assists municipalities in dune protection efforts. In Atlantic City, DCR funded dune vegetation plantings and sand fence installations along a 28-block section of the beach to stabilize and create dunes. In exchange, the city adopted a dune protection ordinance. DCR has worked with 14 other coastal communities to achieve similar results.

In 1984, the NJCMP administered $2 million in emergency federal funds to 15 towns for beach and dune restoration, walkway construction, research on restoration techniques, and land acquisitions. Although it discourages the construction of shore protection structures, the NJCMP occasionally provides technical assistance for innovative protection structures. Sea Isle City, for example, receives funding from NJCMP to study the efficacy of an artificial reef system the town installed to trap sand that would otherwise move offshore.

Finally, whenever the NJCMP undertakes a beach renourishment project, the benefiting

community must, as a condition of receiving the renourishment, comply with a series of DCR beach management policies. These include improved public access, dune creation and improvement, and dune protection practices such as walkover construction.

OREGON

Erosion Risk Assessment.
In 1989, the Oregon Coastal Management Program (OCMP) funded a preliminary assessment of potential coastal erosion in Oregon and the adequacy of state and local policies for managing development in erosion-prone areas. As part of this effort, OCMP is developing an action plan for the Oregon Task Force on Global Warming, which is concerned with, among other issues, the effects of accelerated sea level rise on the coast.

PENNSYLVANIA

Bluff Stabilization.
Efforts to stabilize receding bluff areas are hampered by heavy groundwater flows at midbluff, which undermine the upper portions of the bluff face. The use of traditional mitigation techniques has not been successful in addressing this problem.

The Pennsylvania Coastal Zone Management Program (PCZMP) is obtaining technical training in "Biotechnical Slope Stabilization," a technique for stabilizing bluffs. The goal of this technique, which combines vegetative and engineered biodegradable structures, is to control midbluff groundwater, recreate natural contours, and reestablish indigenous vegetation.

Technical Assistance.
The PCZMP provides technical assistance on structural and non-structural methods of shore protection and bluff stabilization to lakeshore property owners in the Lake Erie coastal zone. In carrying out this responsibility, the PCZMP has developed the Site Analysis and Recommendations (SAR) Service. The SAR Service includes a site visit by the PCZMP, usually accompanied by coordinating agencies, and includes recommendations as to what measures the owner can implement to reduce the rate of bluff recession. The recommendations are given orally at the site. Property owners receiving only oral recommendations are contacted shortly after the site survey to confirm the recommendations. If the erosion problems are severe, additional recommendations in the form of a detailed report are sent to the property owner within 30 days. All site visits are videotaped and maintained in the PCZMP files.

Approximately 300 property owners have received the SAR Service and close to 180 detailed reports have been written.

PUERTO RICO

Coastal Flood Hazard Mitigation.
According to estimates from the Department of Natural Resources (DNR), nearly 300,000 acres in the Commonwealth are subject to severe flooding. The DNR predicts that over one-quarter of the total population of Puerto Rico, as of 1980, lived in areas exposed to flooding.

Flood hazard mitigation, along with aspects of other hazard-related planning, has been an important element of the Puerto Rico Coastal Management Program (PRCMP) since it was approved in 1980. An island-wide hazard mitigation plan was prepared in 1980, updated in 1986 and revised in 1987 to include Executive Order 4974-E, which created the Flood Hazard Management and Mitigation Program within the DNR, and an Interagency Flood Hazard Mitigation Committee chaired by the DNR secretary.

Working with the Committee, sixteen area-specific coastal flood hazard mitigation plans have been prepared under the PRCMP. The planning process identified priority watersheds and provided recommendations for population relocation from hazardous areas. The highest priority project, relocation within the Rio Grande de Loiza area, is now being accomplished under a five-year effort using $51 million appropriated by the Legislative Assembly.

Predicting Riverine Flooding.
Using both Federal and Commonwealth funds, Puerto Rico has installed a series of automatic rain gauge reporting systems in basins facing flood hazards. When completed, the system will cover 33 stream basins around Puerto Rico and include 47 rain gauges and 24 stream-flow sensors. The rain gauges report by radio directly to a terminal through which information is fed into a special computer connected to the DNR, the National Weather Service and the Civil Defense Agency. Data from the stream-flow sensors are transmitted directly via satellite to the Hydrologic Division of the U.S. Geologic Survey (USGS) in Reston, Virginia, then re-transmitted to the USGS in San Juan and to the DNR as needed. According to the DNR, this network produces a continuous record of rainfall and run-off at various critical points in Puerto Rico. Information provided by this network is critical to the safety of Puerto Ricans living in areas of high flood potential.

Predicting Storm Surge.
The south and east coasts of Puerto Rico are often exposed to hurricane storm surges. Certain critical areas on the south coast are exposed to both river and ocean flooding. To complete flood management plans for these critical areas, the PRCMP funded a study by the Department of Marine Sciences of the University of Puerto Rico at Mayaguez to determine potential storm surges using the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model of the National Weather Service. Transects indicating bathymetry, terrain, ground cover and coastal development were taken to help

supplement SLOSH predictions. With this information, it is possible to determine potential inland penetration of the storm surge-plus-wave heights at given points, greatly improving the Commonwealth's ability to predict and plan for coastal hazard areas.

Public Information and Planning.
For the past several years, the PRCMP has sponsored an annual Hurricane Conference oriented toward public officials (Corps of Engineers, Geological Service, Civil Defense, Soil Conservation Service, and others), and the general public. The success of these conferences over the years was one factor in Puerto Rico's ability to deal quickly with the aftermath of Hurricane Hugo which passed over the island in September 1989.

RHODE ISLAND

Sea Level Rise Modeling.
The Coastal Resources Management Council has developed a computer program to simulate the effects of sea level rise. The program overlays the predicted effects of sea level rise on annual erosion rates and FEMA flood zones. Local and state planners use the program as an evacuation planning tool; the program also is used to help make the public aware of the consequences of sea level rise.

SOUTH CAROLINA

Beach Management on Public TV.
In conjunction with South Carolina Educational Television, the South Carolina Coastal Council produced "Who Owns the Beach?," a 90-minute film on beach and hazards management issues. The program was aired statewide in 1989.

WASHINGTON

Accretion, Erosion and Sea Level Rise.
In December 1989, the Washington coastal program held a sea level rise conference in Seattle. The conference attracted over 170 local and state planners, scientists, consultants, and state and federal agency representatives, who met to discuss the physical, ecological and economic effects in the Northwest of a further rise in sea level.

The coastal program also is funding an update of a 1978 accretion and erosion study to identify coastal areas subject to short- and long-term recession or accretion and sponsored Pacific County's Dunes Management Advisory Committee, which issued a draft management plan in June 1989.

WISCONSIN

Hazards Management in Urban Areas.
The Wisconsin coastal program funded development of a hazards management strategy in the town of La Pointe to identify and evaluate cost-effective alternatives for managing hazards risks. The strategy will make available land management information to island property owners. The hazards management strategy will result in an erosion hazard setback ordinance amendment to the town zoning ordinance, and a revised official zoning map that reflects the amendment.

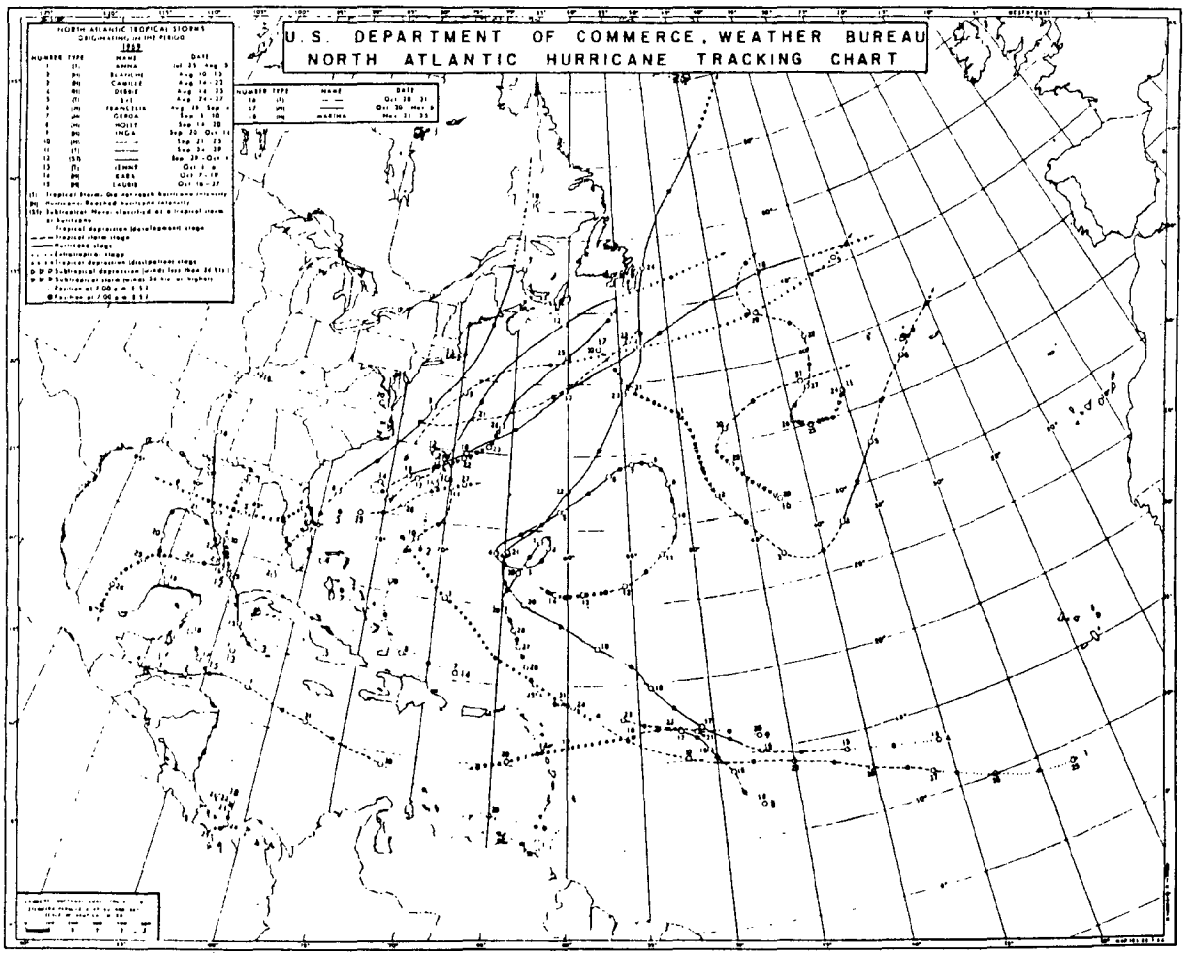
Coastal Processes Workbook and Video.
In 1987, the Wisconsin coastal program provided federal CZM funds to the University of Wisconsin Sea Grant Institute to publish a coastal processes workbook and video. The materials describe techniques for evaluating the effects of lake level changes, storm surges, wave run-up, and shoreline recession on Great Lakes coastal property. The procedures outlined in the workbook and video are designed to help:

* improve information available to lenders and buyers investing in coastal property, and

* local administrators and members of coastal planning and zoning commissions make better management decisions.

Part C

Appendices



APPENDIX A

A Listing of State Coastal Zone Management Programs

Alabama
Coastal Resources Div.
Dept. of Economic and Community Affairs
P.O. Box 2939
Montgomery, AL 36105
(205) 284-8778

Alaska
Division of Governmental Coordination
431 North Franklin
Juneau, AK 99811-0165
(907) 465-3562

American Samoa
Development Planning Office
Government of American Samoa
Pago, AS 96799
(684) 633-5155

California
California Coastal Commission
631 Howard Street, 4th floor
San Francisco, CA 94105
(415) 543-8555

Connecticut
Dept. of Environmental Protection
18-20 Trinity Street
Hartford, CT 06106
(203) 566-7404

Delaware
Dept. of Natural Resources
and Environmental Control
89 Kings Highway
Dover, DE 19903
(302) 736-4403

Florida
Dept. of Environmental Regulation
Twin Towers Office Bldg.
2600 Blair Stone Road
Tallahassee, FL 32301
(904) 488-6221

Guam
Bureau of Planning
P.O. Box 2950
Agana, GU 96910
(671) 472-4201

Hawaii
Office of State Planning
State Capitol, Room 700
Honolulu, HI 96813
(808) 548-3026

Louisiana
Coastal Mgmt. Div.
Dept. of Natural Resources
P.O. Box 44487
Baton Rouge, LA 70804
(504) 342-7591

Maine
State Planning Office
State House Station #38
Augusta, ME 04333
(207) 289-3261

Maryland
Coastal Resources Div.
Dept. of Natural Resources
Tawes State Office Bldg.
Annapolis, MD 21401
(301) 974-2784

Massachusetts
Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202
(617) 727-9530

Michigan
Land & Water Mgmt. Div.
Dept. of Natural Resources
P.O. Box 30028
Lansing, MI 48909
(517) 373-1950

Mississippi
Coastal Programs
Bureau of Marine Resources
2620 West Beach Blvd.
Biloxi, MS 39531
(601) 385-5860

New Hampshire
Office of State Planning
2 1/2 Beacon Street
Concord, NH 03301
(603) 271-2155

New Jersey
Dept. of Environmental
Protection, CN 401
Trenton, NJ 08625
(609) 292-2795

New York
Department of State
162 Washington Street
Albany, NY 12231
(518) 474-3643

North Carolina
Div. of Coastal Mgmt.
Dept. of Environment, Health, and Natural
Resources
512 N. Salisbury Street
Raleigh, NC 27611
(919) 733-2293

Northern Mariana Islands
Coastal Resources Mgmt. Office
Nauru Building
Saipan, MP 96950
(670) 234-6623

Ohio
Dept. of Natural Resources
Fountain Square
1930 Belcher Drive
Columbus, OH 43224
(614) 265-6877

Oregon
Dept. of Land Conservation
and Development
1175 Court Street, N.E.
Salem, OR 97310
(503) 378-4017

Pennsylvania
Div. of Coastal Zone Mgmt.
Dept. of Env. Resources
P.O. Box 1467
Harrisburg, PA 17120
(717) 541-7808

Puerto Rico
Dept. of Natural Resources
P.O. Box 5887
Puerta de Tierra, PR 00906
(809) 724-5516

Rhode Island
Coastal Resource Mgmt. Council
Stedman Office Bldg.
Tower Hill Road
Wakefield, RI 02879
(401) 277-2476

San Francisco Bay Conservation & Development Commission
30 Van Ness Avenue, Room 2011
San Francisco, CA 94102
(415) 557-3686

South Carolina
S.C. Coastal Council
AT&T Capitol Center
1201 Main Street, Suite 1520
Columbia, SC 29201
(803) 737-0880

U.S. Virgin Islands
Dept. of Planning and Natural Resources
Nisky Center, Suite 231
No.45A Estate Nisky
St. Thomas, VI 00802
(809) 774-3320

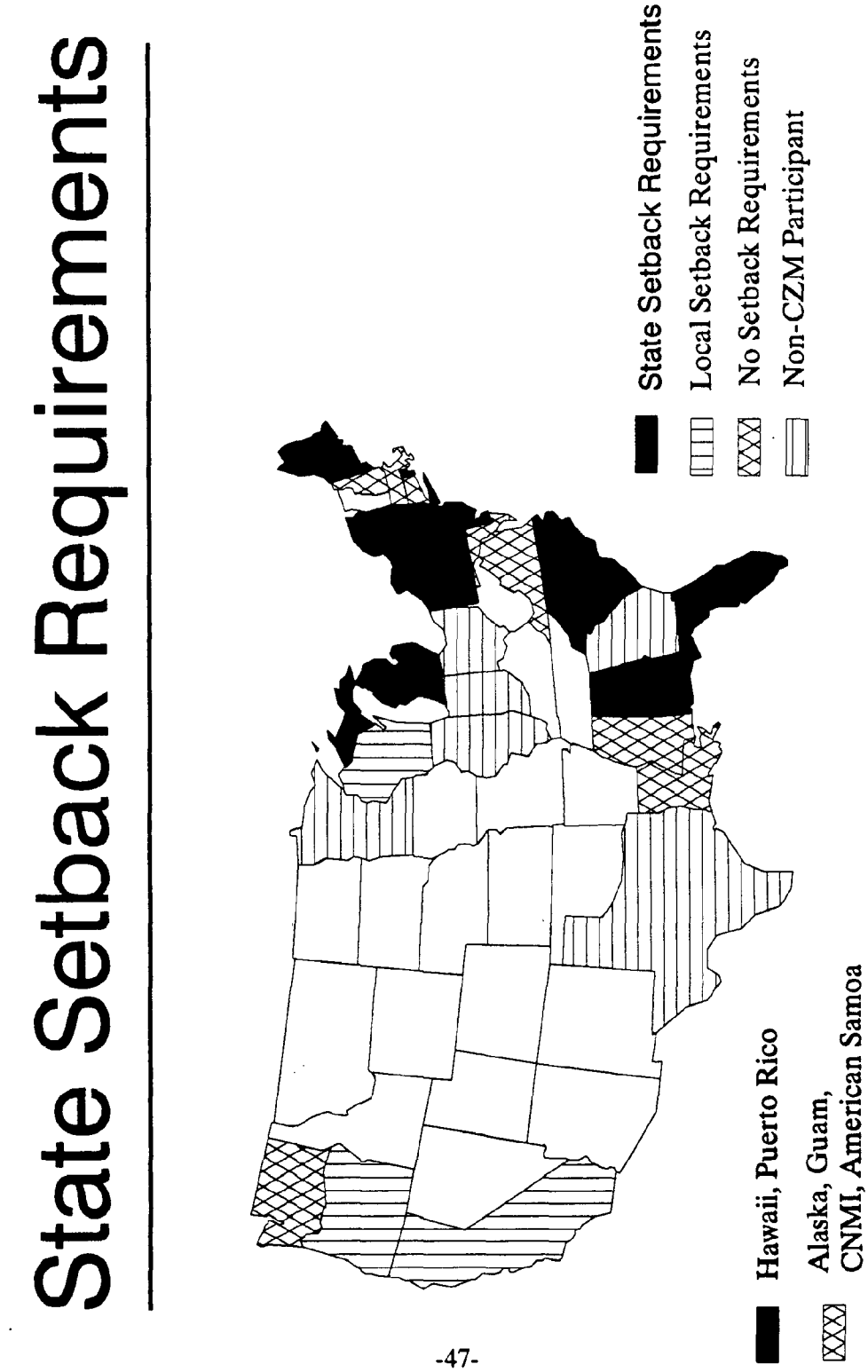
Virginia
VA Council on the Environment
903 Ninth St. Office Bldg.
Richmond, VA 23219
(804) 786-4500

Washington
Department of Ecology
State of Washington (PV-11)
Olympia, WA 98504
(206) 459-6777

Wisconsin
Coastal Mgmt. Program
Dept. of Administration
101 South Webster, 6th floor
Madison, WI 53707
(608) 266-3687

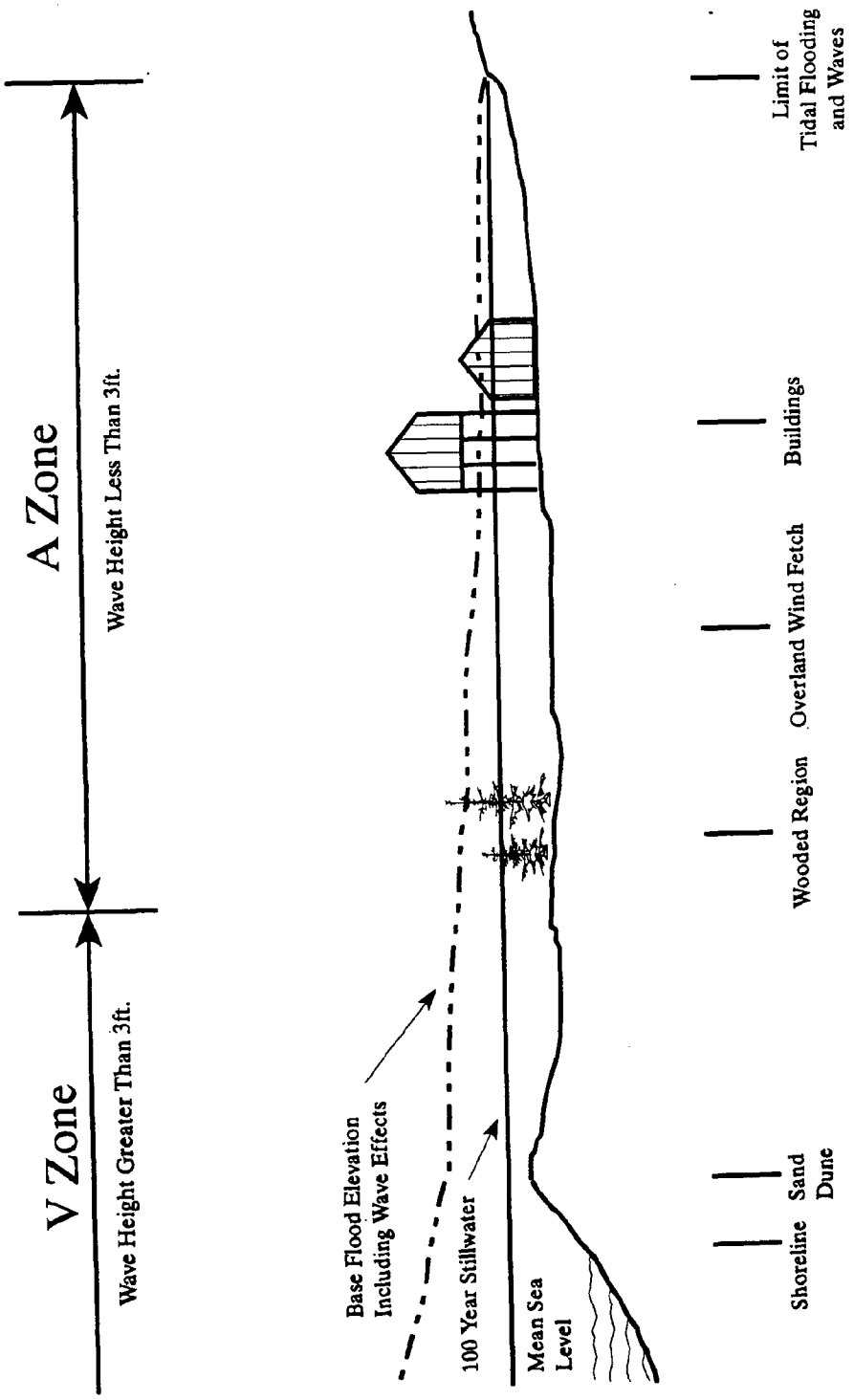
APPENDIX B

Map of States with Setback Requirements



APPENDIX C

Diagram of FEMA Coastal Flood Zones



FEMA V-Zone and A-Zone Criteria

Source: Managing Coastal Erosion by the National Research Council

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