PREPARING FOR HURRICANES AND COASTAL FLOODING: A Handbook for Local Officials

FEDERAL EMERGENCY MANAGEMENT AGENCY

and

OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
U.S. DEPARTMENT OF COMMERCE, NOAA

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1983

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August 29, 1983

Ms. Delores Clark
Coordinator, CZIE
Office of Ocean and Coastal Resource Management
NOAA
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

Dear Ms. Clark:

The attached publication was just publised by FEMA. We had prepared the document some time earlier under a contract with OCZM but funds were not available through NOAA to publish it. After some modification FEMA agreed to bear the publication costs.

I am passing it along for your review. You might want to include it in the next issue of the CZM INFORMATION EXCHANGE. Copies may be obtained from FEMA Headquarters or through FEMA Regional Offices.

If you wish any additional information, please feel free to call.

Sincerely yours,

Ralph M. Field

RMF:mj
Enclosure

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Prepared By:

RALPH M. FIELD ASSOCIATES, INC.

Westport, Connecticut

March 1983

EXECUTIVE SUMMARY

The Nature of Coastal Hazards

Property damages that can be expected from hurricanes and coastal flooding are increasing year by year. In many places threat to life is increasing also. Most coastal communities are vulnerable to one or more different kinds of flooding and related hazards:

- frequent flooding from storm tides, inadequate storm drainage, or overflow of coastal streams
- hurricane storm surge and winds, particularly if the community is located on the Gulf or Atlantic coast
- storm-caused erosion of bluffs and beaches

This Handbook for Local Officials focuses on two of the most common of these coastal hazards: tidal flooding and hurricanes. The Handbook also focuses on the Atlantic and Gulf coasts, although much of the material on coastal flooding is just as relevant to the Pacific coast.

Deciding How to Prepare For Hurricanes and Coastal Flooding

There are many measures that a community can take to help reduce damages from hurricanes and coastal flooding. Before deciding which measures are appropriate to your situation, it is essential to be aware of the nature of the problem in your community, along with the responses already undertaken and their effectiveness. A community can draw on many sources of information to obtain this information -- including local, state, and federal agencies, as well as private individuals and groups. *Chapter 1 of the Handbook explains how to go about this task of information gathering and evaluation.*

Techniques for Responding to Coastal Hazards

A wide range of techniques can be used to respond to your community's coastal hazards:

- Keeping new development from hazardous areas, through regulations, acquisition of undeveloped areas, or persuasion.
- Promoting safe construction of development that does occur in hazardous areas, through regulations or by providing technical or financial assistance.
- Protecting natural systems, through regulations, beach nourishment, dune vegetation and maintenance, and protective structures such as groins and breakwaters.
- Protecting development from coastal flooding with structures such as seawalls, bulkheads, and revetments.
- Helping people leave risky areas before storms arrive through forecasting, warnings, and evacuation planning along with programs to increase public awareness of these systems and plans.
- Acquiring developed hazardous areas and relocating hurricane and flood victims to safer areas.
- Planning before disasters for post-disaster recovery actions that will reduce future losses.

Each of these types of response is discussed separately in Chapters 2 through 8.

Considerations in Deciding Which Techniques to Use

Many factors need to be considered in deciding which of these many techniques are most suitable for your community. Most communities will choose to use several of these measures in combination for greater effectiveness. Considerations to keep in mind when evaluating these measures include:

- Federal and state requirements, such as regulations of the National Flood Insurance Program, comprehensive state plans, model codes or ordinances, permit requirements, etc.
- Benefits, beginning with reduced threat to life and property, but including as well enhanced recreational and tourism opportunities, improved wildlife habitat, and support for on-going local planning efforts.

- The degree of risk, or how vulnerable your community is to a particular hazard.
- The effectiveness of a particular technique for limiting damage from hazard; for example, the capability of a protective structure to withstand hurricane forces.
- Costs of developing and implementing techniques.
- Public and political acceptability.
- Current level of awareness of the hazard.
- Legal limitations.
- Tax impacts.
- Availability of technical or financial assistance from state, federal and private sources.
- Availability of data needed to implement a response.
- Administrative enforcement and maintenance capabilities.
- Availability, or suitability, of alternatives.
- Impacts on natural coastal features and adjacent properties.

The importance of each of these factors varies considerably, depending on the techniques that are most appropriate to your community's circumstances. *Chapters 2 through 8 describe, in some detail, which factors are most relevant to each technqiue you may consider.*

Assistance for Responding to Coastal Hazards

Many communities will need financial or technical help in developing an approach for responding to coastal hazards. Assistance may be available from the state government or from federal agencies, or in limited cases from private sources. However, the availability of assistance varies a great deal from state to state, and the availability of federal aid is constantly shifting as federal budgetary priorities are revised. *Chapter 9 describes some selected assistance programs which have been used by communities in the past.*

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FOREWORD AND ACKNOWLEDGEMENTS

Begun in 1981, this Handbook went through several revisions in response to rapidly evolving changes in Federal and State programs in the field of hazards management. Hence, many individuals contributed to the preparation of this Handbook including numerous local officials throughout the country who provided the information needed for the case examples cited in the Handbook.

We are particularly grateful to Dr. Gene Zeizel of FEMA's Office of Natural and Technological Hazards for his careful reading and suggested improvements. Dick Rigby, formerly with OCZM, provided guidance and support to this effort, as did Dennis Carroll of NOAA's Coastal Hazard's Office. Representatives of State and Federal agencies and non-profit organizations reviewed earlier drafts and provided much valuable guidance. The following individuals deserve special mention in this respect:

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INTRODUCTION

Hurricanes and coastal flooding are far more serious problems than many people like to admit. Nationally, computer models indicate that annual damage from hurricane wind and storm surge will increase by over $3 billion, to approximately $5 billion in the year 2000. At the local level, hundreds of communities face the risk of hurricanes each year and many cope far more frequently with lesser coastal flooding. This handbook is designed to help communities prepare for these common coastal hazards.

THE FREQUENT FLOODING PROBLEM

Many coastal areas flood frequently from wind-driven storm tides, from rain-induced flooding of coastal streams, and from inadequate storm drainage. Certain types of shorelines or bays are more likely to be flooded than others. Coasts that are only a few feet above sea level, for example, and which may also be near river mouths, are especially susceptible to both salt water and fresh water flooding.

Though the dollar amount of damages from any single low-level flooding event may be small, frequent low-level flooding can result in a continual drain on municipal resources. Traffic disruption due to flooding can also have a major impact on the quality of community life, even though it may be difficult to put a dollar value on the disruption. Finally, even low-level flooding may cause health and safety problems for people living close to the water's edge.

A number of techniques are available to help communities keep damage and disruption from frequent flooding to a minimum. Some of these techniques can help your community prepare for hurricane wind and storm surge as well.

HURRICANE WIND AND STORM SURGE PROBLEMS

If your community is on the Gulf or Atlantic coast, there is some probability that a catastrophic hurricane will strike it; in many towns the probability is quite high. Figure 1 gives the historical frequency of hurricanes on these coasts; figure 2 provides some indication of the vulnerability of specific coastal areas to a life threatening hurricane. (Although hurricanes do strike the Pacific coast on rare occasions -- the last in 1939 -- the risk of hurricanes is much less than on the Atlantic or Gulf coasts.)

FIGURE 1 HISTORICAL FREQUENCY OF HURRICANES: 1900-1980

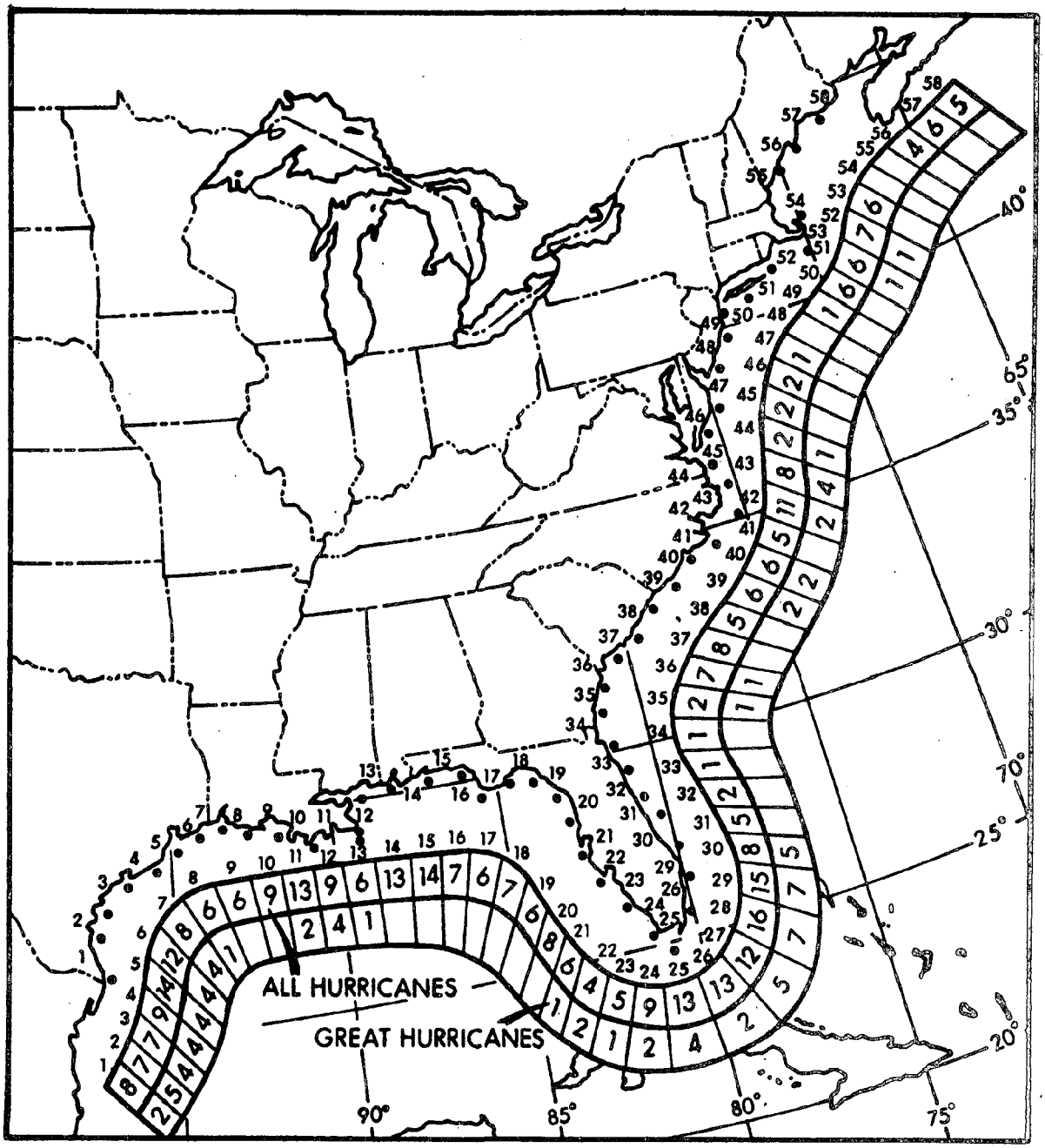
Area	Total Hurricanes	Average Frequency
Florida	52	every 1 1/2 years
Texas	32	2 1/2
Louisiana	20	4
New England	20	4
North Carolina	19	4
Georgia-South Carolina	15	5
Alabama-Mississippi	13	6
New York	7	11
Virginia-Maryland-Delaware-New Jersey	5	16

The kinds of impacts a hurricane or other severe coastal storm will have on your community, when it comes, depend on a host of factors, some of which you have no control over -- the direction the hurricane comes from, the general configuration of the shoreline, wind speed, and so on.

The damage caused by hurricanes comes from many sources, including:

- direct wind forces in excess of design criteria
- flying debris, consisting of loose objects, failed construction material, and temporary structures in the vicinity, including unsecured construction material at building sites

FIGURE 2: HURRICANE PROBABILITY ON THE EAST AND GULF COASTS



This map illustrates hurricane probability for the U.S. East and Gulf Coasts. The interior column shows the probability, by percentage, of a hurricane striking in any given year. The exterior column gives the probability (also by percentage) that a great hurricane will occur in any given year. Winds exceeding 73 mph constitute a hurricane and winds in excess of 125 mph compose a great hurricane. (After Simpson and Lawrence, 1971)

- penetration of wind driven, salt-laden water into the interior of the structure
- direct attack by high ocean waves and/or storm surges generated by the hurricane
- tornadoes spawned by hurricanes.

There are things you can do to reduce the impact of these natural hazards on your community, however, and in many cases to dramatically reduce the death toll from a major hurricane.

PREPARING FOR FLOODS AND HURRICANES: HOW TO USE THIS HANDBOOK

This handbook is designed to help communities choose a course of action to reduce damages from hurricanes and coastal flooding. Part I of this handbook provides an overview of the initial steps required to identify the actions your community could take to prepare for hurricanes and coastal floods, with particular attention to the information collection process.

Part II of the handbook focuses on evaluating opportunities for action. It describes basic measures to consider in preparing for coastal flooding, many of which will also be helpful in preparing for hurricanes. And it describes additional measures to consider in preparing specifically for hurricanes. Numerous examples of how communities (or states, in some cases) have used these types of measures are highlighted in "boxes" throughout the text.

In deciding whether to proceed with additional measures to respond to your community's coastal hazards, you may need to consider the assistance available to pursue particular options. Part III of the handbook describes some federal and state programs and activities that have helped communities in the past to manage their coastal hazard problems.

The appendices provide additional information on useful information contacts.

SCOPE OF THE HANDBOOK

Only the most common coastal hazards are addressed by the handbook -- hurricanes and tidal coastal flooding. Non-tidal coastal flooding -- from coastal streams and inadequate storm drainage -- can be an important problem for many coastal communities, but the ways to reduce the damage caused by non-tidal coastal flooding are largely the same as they would be for inland communities. Accordingly, general guidance on floodplain management and stormwater management is not contained in the body of this handbook. Useful references to these subjects are contained in Appendix B.

Problems caused by coastal erosion are most often impossible to separate from tidal flooding problems. As a result, some measures affecting erosion are discussed in the handbook. These measures are treated from a flood damage reduction perspective, however, and the treatment of erosion is accordingly not complete. Additional references on erosion control are also provided in Appendix B.

Finally, the handbook focuses on the Atlantic and Gulf coasts.

PART I: STEPS TO PREPARE FOR HURRICANES AND COASTAL FLOODING PROBLEMS

Part I of the handbook provides an overview of the steps required to identify actions your community could take to prepare for hurricanes and coastal floods, with particular attention to information collection. Part I consists of the following chapter:

CHAPTER 1 GATHERING INFORMATION AND EVALUATING OPTIONS

CHAPTER 1 GATHERING INFORMATION AND EVALUATING OPTIONS

Four steps are needed to identify ways to help a community prepare for hurricanes and coastal flooding. Two information gathering steps are necessary at the outset:

(1) Collect information on local coastal flooding and hurricane problems.

(2) Collect information on actions already being taken to address the problems, as well as on the people and government agencies taking those actions.

As a practical matter, you can hardly compile information on either of these subjects without learning about the other.

Once this information is gathered, two additional steps are necessary:

(3) Evaluate current responses: do they adequately address the problem?

(4) Where present actions fall short in any way, evaluate local options for further action.

Depending on the particular situation, the evaluation steps may be very sophisticated or very informal.

STEP 1: GATHERING INFORMATION ON COASTAL FLOODING AND HURRICANE PROBLEMS

In deciding how to prepare for coastal flooding and hurricanes, and to convince the community that preparations are worthwhile, you need a good description of the problem:

- Kinds of hazard problems. Hazard problems of many kinds may affect coastal communities: hurricane wind and storm surge, frequent flooding from low-level storm surge and from coastal streams, and coastal erosion

are the most common. Different kinds of coastal hazard problems require different kinds of solutions. Part II of the Handbook describes, in some detail, a range of actions communities can take for two different kinds of problems: frequent tidal flooding and hurricanes.

- Locations of problems. Your community's hazard problems may vary considerably from place to place. While one portion of the local shoreline may be especially exposed to high winds and storm surge, another area may be protected by its particular configuration from all but the worst storms. Still another area may be subject to a combination of tidal and riverine flooding. It is important to know exactly where problem areas are within the community.

- Seriousness of problems. Some problems are serious enough to require immediate attention; others may not be worth the effort of responding. There are a number of ways to measure the seriousness of hurricane and flooding problems. They may be serious because of how frequently they cause problems or because of the magnitude of the damage they cause, even though years may go by between storms. Or, problems may be serious enough to warrant attention simply because they cause frequent disruption even though the damage is not great. It is important to determine how serious your town's problems are.

In some communities, particularly those subject to frequent flooding and those recently hit by a hurricane, much of this information will be common knowledge. To evaluate possible future actions, however, you will need detailed information.

Likely Sources of Information

Although knowledgeable officials and local residents will probably be the only source of some needed information, you can save their time (and ask them better questions when you talk with them) by obtaining some basic material first, from a variety of sources, specifically:

(1) National Flood Insurance Program (NFIP)

Your community may participate in the National Flood Insurance Program. Chances are very great that it does (approximately 1,800 coastal communities were participating in 1981). If it does, the following information should be available from the local engineer, building inspector, or city clerk.

- Flood Hazard Boundary Map (FHBM): This is a map showing the approximate boundaries of the area in your community that is subject to flood damage. It is a preliminary document and should be considered a rough guide to the location of flooding problems. This map provides no information, however, on the relative severity of the flooding problem.

- Flood Insurance Rate Map (FIRM): This is a more precise map, based, in most cases, on detailed engineering studies. Officially, this map is used as the basis for determining flood insurance rates. It gives not only the location of potential flood problems but some indication of their frequency and anticipated flood heights.

THE NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was created in 1968 for two purposes:

- to make flood insurance available to property owners (residences and businesses) already located in floodprone areas, and
- to encourage state and local governments to make appropriate land use adjustments to reduce development of land exposed to flood damage and to minimize damages caused by floods.

At the federal level, the NFIP is administered by the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency. Ten regional offices are responsible for working with communities, and each state has designated a flood insurance coordinator to assist communities participating in the program. (See Appendix A.)

At the local level, each participating community has designated an individual responsible for program information and a location in the community where information related to the program is collected.

Copies of NFIP maps can be obtained free of charge by calling this toll-free number: 800-638-6620 or, in some states, by calling your state flood insurance coordinator (see Appendix A).

(2) Local planning and engineering data

Municipal planning and engineering departments can be consulted to see if they have studied your community's flood or hurricane problems. The planning department may have prepared general studies, for example, to provide a basis for floodplain regulations, or they may have obtained relevant studies prepared by county, regional, state or federal agencies. The town engineer may have conducted an analysis of flooding problems in connection with specific proposals for coastal construction. In many cases, however, neither the community planner nor the engineer will have relevant studies on coastal hazards, and you will have to rely on regional, state, and federal agencies. Your community's planner or engineer may be able to provide the name of someone to contact at the county, regional, or state level.

(3) County and regional agencies

At the county level, planning and public works departments can be contacted to see if they have prepared or are aware of any relevant reports on coastal hazards. In some states, a regional planning agency may have conducted studies that would help identify the nature and extent of your community's coastal flooding and hurricane problems.

> In New York, the Westchester County Department of Planning undertook a study of the county's floodprone areas. On the basis of soils maps and interviews with local engineers, the agency identified the locations of a number of specific flooding problems in each community, along with a general evaluation of the seriousness of each community's problems. The report went on to identify the regulations related to flooding in each community.

As this example implies, while collecting information on the extent of the coastal hazards problem, you are likely to come across information

needed for Step 2: Finding out what's being done about flooding, and who does it. County and regional officials can provide information on who they deal with at the state level on flood and hurricane related problems.

(4) State agencies*

At the state level, two important contact points are the state coastal zone management agency and the state flood insurance coordinator. Telephone numbers for these offices are provided in Appendix A. If your state does not have an agency devoted specifically to coastal area planning, the natural resources or environmental protection agency may be helpful.

> In Puerto Rico, the Department of Natural Resources has prepared a number of reports on hurricane and coastal flooding problems. One of the reports provides a general overview of the island's coastal hazard problems. Other site-specific reports have been prepared for areas hit especially hard by recent hurricanes.

(5) Federal agencies*

The Corps of Engineers provides planning and technical assistance to local communities through its Floodplain Management Services. Starting in 1960, the Corps began preparing a series of Floodplain Information Reports, which evaluated the local flood hazard for communities that requested such assistance. At times they have also prepared special studies at the request of state or local governments.

> In 1976 the Corps prepared a report for the state of Connecticut on the likely severity of damage to coastal communities from storm surge associated with hurricanes.

Appendix A provides telephone numbers for the Corps of Engineers Floodplain Management Services offices serving your area.

*Other types of assistance from state and federal agencies are discussed in Chapter 9.

The United States Geological Survey (USGS) has a program to map historical floods. Information on the availability of these maps can be obtained from the USGS District Office in your state. (See Appendix A.)

The National Oceanic and Atmospheric Administration (NOAA) provides historic severe weather data and has prepared evacuation maps and conducted storm surge modeling for some coastal areas. Information can be obtained from NOAA's Coastal Hazards Program Office.

(6) Other official and unofficial local sources

Finally, a variety of other people living and working on the coast will have information on how serious a problem flooding has been in the past. Operators of marinas, coastal residents, builders and construction companies that have worked along the shore, members of local chapters of the Audubon Society and the Sierra Club, for example, or local land trusts are all possible sources of information on local hurricane and flooding problems. Offices of the Red Cross, too, may have files on past storms in your area.

STEP 2: GATHERING INFORMATION ON ACTIONS ALREADY TAKEN

In addition to information on the nature, location, and extent of your community's flooding and hurricane problems, you need to collect information on ongoing hazard-related activities, as well as on what has been done in the past and who is responsible. In each case, plans for future action will be as important as the actions already taken.

Four different kinds of hazard-related projects and programs should be investigated: regulations, warning systems and evacuation plans, coastal protection structures, and plans prepared to guide actions following a disaster. In addition, any plans your community has for managing its coastal areas should be located, even though on the surface they may seem to be unrelated to hazards. For each category of action, possible contacts are suggested on the following pages.

Regulations

Many different kinds of regulations may have an impact on your community's coastal hazard areas, including:

- coastal flood hazard area permit regulations
- dune protection ordinances
- zoning regulations with special provision for coastal areas
- subdivision regulations with special provision for coastal hazard areas
- beach traffic restrictions
- building codes

Some of these regulations affect coastal construction; others affect a range of coastal activities. You need to determine what regulations your community has adopted that affect coastal areas, the specifics of these regulations, and whether or not the regulations are consistently enforced. If your community is in the National Flood Insurance Program, it must have some sort of regulation governing coastal construction; this may be a separate coastal hazard area permit ordinance, or it may be a section in an already existing zoning ordinance, subdivision regulation, or building code.

The building inspector, the local or regional planner, or the city clerk may be able to provide information about the existence of coastal hazard regulations. The parks department or the police department may be good contacts for regulations governing activities prohibited on beaches and dunes. A source of information on the full range of permits required for coastal construction could be someone in the community with development experience.

In a number of places, the state regulates construction in coastal areas, in addition to any local regulations which might apply.

> Florida has established a Coastal Construction Setback Line, seaward of which all construction must be approved by the state. The line is set on a county-by-county basis, taking the specific geographical characteristics of each county into account. When a local property owner applies for a building permit, the building inspector sends the application to the state Bureau of Beaches and Shores when the property is located in the regulated area.

To find out whether state regulations apply in your area, the local building inspector may be helpful; it will be his job to determine whether a state law or regulation is triggered by coastal development proposals.

Chapters 2 to 4 contain additional information which may be of assistance in determining what to ask about the regulations you find.

Warnings and Evacuation Planning

Civil defense or disaster preparedness officials at all levels of government are sources of information on local warning systems and evacuation plans. Someone in your community may be designated as a civil defense or disaster preparedness director, and this person should be contacted for information on local preparedness plans and procedures. The police and fire chiefs are other possible contacts.

Once it has been determined whether your community has a plan, it is important to examine it. The plan may be a formal one, or it may be quite brief and cover only a few of the possible topics.

> The evacuation plan for the Town of Topsail Beach, North Carolina, consists of a list of 11 items assigning responsibilities for ordering evacuation and notifying residents. A relocation center is designated and coordination between Topsail Beach and the neighboring town needing to use the same evacuation route is required. However, many details about who will do what remain unspecified.

If your town has no formal plan as such, speaking to local officials about how they would respond to a hurricane would be useful in establishing your community's needs for a formal plan.

States assign responsibilities for disaster preparedness and civil defense in various ways. In many places, counties or groups of counties have an important role to play; the county civil defense unit should be contacted to determine the situation in your area. The state also plays a role in disaster preparedness planning; for example, many states have prepared model plans that can be used as a guide to the preparation of local evacuation plans.

> The Georgia Civil Defense Agency has prepared a Natural Disasters Operation Plan, including a Coastal Georgia Hurricane Evacuation Plan. This plan is intended to be a guide to local governments, and consists of five elements: The Basic Plan, Operations, Evacuation, Re-entry and Cleanup, Disaster Assistance Program.

Coastal Protection Structures: Seawalls, Bulkheads, Revetments, Groins, Jetties, and Offshore Breakwaters

Much of the nation's coast is privately owned. Since a community can consider building coastal protection structures only where it owns coastal property, you will need to know which property along your coast is publicly owned. The town planner or tax assessor can provide information on public land ownership.

A field visit to identify existing structures in the area is a good first step. Pictures of shore protection structures in Chapter 5 may be helpful if you are not already familiar with these structures. Other sources of information on local coastal protection structures are the municipal engineer and the district office of the Corps of Engineers.

Your community's engineer should be contacted in any case to find out if your community is already planning to build a coastal protection structure of some kind. In addition, the county or state, or private property owners along the coast, may be planning structures that affect publicly owned shorelands. Because the Corps of Engineers must issue permits for coastal protection structures, they will likely be aware of structures planned by private property owners as well as public agencies.

Plans for Post-Disaster Recovery and Other Community Development Plans

Because the period immediately following a hurricane provides special opportunities for rebuilding in ways and places that will reduce your community's vulnerability to future hurricanes, some communities have prepared plans for post-hurricane recovery. The mayor, city manager or administrator, planner, or engineer in your community should be aware of such a plan, if one has been prepared.

Because actions to protect your community from hurricane and flood damage are related in one or more ways to a range of other community activities, it is also important to find out about non-hazard-related plans that affect coastal hazard areas. Transportation plans, recreation and open space plans, master plans, capital improvement plans -- all these may provide useful information in planning for coastal hazards and may be available from the appropriate local agency or department.

STEP 3: MEASURING YOUR COMMUNITY'S RESPONSE AGAINST ITS HURRICANE AND FLOODING PROBLEMS

Once you have obtained some idea of the nature and extent of your community's flooding and hurricane problems and the actions underway or planned to reduce future vulnerability, the next step is to evaluate whether current responses meet the problem and whether additional action is called for.

This evaluation process may be a very sophisticated process or it may be very informal, depending on the community's needs and resources. At one end of the spectrum are those communities who have used computer modelling or other technical analyses to examine their problems and the adequacy of existing responses. At the other end of the spectrum, an evening's informal discussion with other concerned officials may be sufficient to identify the need for additional action. This is especially likely in the wake of a recent hurricane or a recent near-miss. If your community has recently experienced a major coastal storm, gaps in the response to the hazard will likely be apparent. For example, if evacuation during the storm was confused and ineffective, you should probably look to preparing or improving an evacuation plan. Of, if following severe hurricane damage, coastal property owners rebuilt unsafe structures in obviously vulnerable areas, you may want to consider adopting hurricane construction standards in your building code or preparing a plan now to acquire similar properties in the future.

There are basically two ways in which your community's current response to its hurricane and flooding problems may fall short:

(1) Geographically: while some areas of the town may be adequately protected, others may remain vulnerable and in need of attention.

(2) Kind of response: for example, while your community may have sufficient regulations in place to ensure that future coastal construction will withstand predicted hurricane wind and coastal flooding, procedures to evacuate those already living in exposed locations may not exist.

These shortfalls in an adequate response represent your community's opportunities for improvement.

STEP 4: DETAILED EVALUATION OF LOCAL OPPORTUNITIES FOR ACTION

Once a preliminary identification of opportunities has been made, it is time to pursue your community's options for responding to its hurricane and coastal flooding problems in some detail. Chapters 2 through 8 of the Handbook provide a starting point for this evaluation, outlining possible actions of all kinds as well as factors to consider in evaluating each option.

For each possible response, the first question to ask is: will the response serve the purpose? In some cases the answer to this question is easy. For instance, if your community has not yet designated emergency shelters for hurricane evacuation, the identification of such shelters is clearly needed. In other cases, engineering or other technical assistance may be needed in order to evaluate the adequacy of a possible response. This is true, for instance, of the structural responses discussed in Chapters 4 and 5 and the establishment of setback lines discussed in Chapter 2.

The second question to ask is: how does the response compare to other identified opportunities? Alternative approaches to reducing flood and hurricane vulnerability should be considered alone and in combination. The effect of each kind of response is not necessarily additive, so the benefits and costs of combinations of responses should be carefully examined. Like Step 3, this process can be very simple and informal, involving rough estimates of the value to your community of a few of the responses that appear useful, or very sophisticated.

You may be able to obtain technical or planning assistance in evaluating your options from FEMA's State Assistance Program or through the Corps of Engineers' Floodplain Management Services. (See Chapter 9.)

Identification of an approach to your community's hurricane and flood problems is only a first step; adoption of the selected approach as policy by those in your community with the authority to commit community resources is needed. Going through this process of identifying problems and possible solutions effectively can be important preparation for presenting a persuasive case to your community's policymakers.

PART II: WAYS TO REDUCE DAMAGE FROM HURRICANES AND COASTAL FLOODING

Part II of the Handbook provides a detailed look at the techniques your community can use to reduce damages from hurricanes and coastal flooding. These opportunities for community action include regulations, acquisition, structural measures, dune vegetation, beach nourishment, evacuation planning, and others. For each type of opportunity, a brief description is included along with a discussion of factors that must be considered in evaluating each option. In most communities, an effective program to reduce damages from hurricanes and coastal flooding will include a combination of these techniques. Part II includes the following chapters:

CHAPTER 2 KEEPING NEW DEVELOPMENT FROM HAZARDOUS AREAS

CHAPTER 3 PROMOTING SAFE CONSTRUCTION IN HAZARDOUS AREAS

CHAPTER 4 PROTECTING NATURAL SYSTEMS

CHAPTER 5 STRUCTURES TO PROTECT AGAINST COASTAL FLOODING

CHAPTER 6 FORECASTING, WARNINGS, AND EVACUATION PLANNING

CHAPTER 7 RELOCATING HURRICANE AND FLOOD VICTIMS: ACQUISITION OF DEVELOPED AREAS

CHAPTER 8 PRE-DISASTER PLANNING FOR POST-DISASTER ACTIONS

CHAPTER 2 KEEPING NEW DEVELOPMENT FROM HAZARDOUS AREAS

There are several approaches available to keep new development away from hazardous areas along the coast:

- regulations
- acquisition
- persuasion

In deciding whether to use these approaches, you should consider several factors, including:

- National Flood Insurance Program (NFIP) requirements
- federal and state laws protecting natural features
- benefits
- costs and tax impacts
- legal limits

Many beach experts firmly believe that, on or adjacent to most beaches, no structures can survive for long periods of time. To these experts, the idea of "safe" construction on beaches or structures to "protect" coastal development is simply unworkable. Threats to life and property when construction occurs too near the shore, along with desires to preserve beaches in their open state, lead many coastal communities to consider keeping new development away from high hazard areas altogether.

Aside from important questions of costs and benefits, two key issues arise in considering this tactic -- how can development be kept from high hazard areas? and where should the boundary be drawn to separate areas too hazardous for construction from adjacent areas where the community might regulate but not prohibit construction?

In deciding to keep new construction away from certain areas, a choice must be made as to which hazardous areas should be closed to construction, for

example:

- the entire floodplain
- limited hazardous areas, such as a narrow strip right along the shore
- critical areas and natural features, such as dunes
- areas suitable for multiple purposes, such as flood reduction and recreation, if retained as open space

Three basic avenues are available to the community desiring to keep development away from its most hazardous coastal areas -- regulation, acquisition, and persuasion. A range of regulatory approaches to prohibiting development in hazardous areas is discussed below. Most of these use some sort of "setback line" which establishes a boundary seaward of which development is not permitted. Open space acquisition is also discussed below, while acquisition of developed coastal areas is discussed in Chapter 7. Finally, ways to encourage people not to build in hazardous areas, through education programs or the location of public facilities, are noted.

REGULATIONS

Restricting Coastal Development Through Regulations

Your community may have already established controls on coastal development in response to requirements of the National Flood Insurance Program (NFIP). With or without the NFIP, many communities impose controls on coastal development through zoning or subdivision regulations.

- With existing zoning. When communities already have zoning regulations in effect, the simplest way to establish new controls over coastal development may be the use of an "overlay zone". With an "overlay", minimum setback requirements for new construction can be established without otherwise affecting current zoning and its controls on density, permitted land uses, and so on. The state of Michigan, for example, recommends this technique to its coastal communities that want to assume local control of construction in high risk erosion areas.*

*State law in Michigan requires a special permit for all coastal construction. If local governments do not choose to administer the law, the state will issue necessary permits.

MAPPING SETBACK LINES: WHERE SHOULD DEVELOPMENT BE PROHIBITED?

In thinking about where your community should prohibit construction, consider the following rule of thumb: with rare exceptions, no construction should be allowed on beaches or on active dunes. However, beaches and dunes constantly move, and your community's setback line should ideally take that movement into account. This requires an estimate of the annual rate at which your beach is receding and a decision as to how many years of recession your setback line should take into account.

Because determining recession rates is not easy, many communities have opted for a fixed setback not related to the recession rate. Also, where the coast is neither bluff nor sandy beach, recession may be so slow that a fixed setback line is not a problem. But, if the setback distance is small compared to the actual recession rate, development allowed under the ordinance will likely suffer damage from coastal storms or erosion within a few years. If the setback distance is large, compared to the actual recession rate, development may be needlessly prohibited. As a result, determining the recession rate, although a difficult task, is worth some investment of community resources in areas with sandy beaches or coastal bluffs, or where erosion is known to be a problem.

In addition to establishing a recession rate, your community must decide what time period to be concerned about. A recommended minimum is thirty years or the life of an average mortgage. Your community has a longer life span than the average mortgage, however, and leading coastal experts recommend that your setback line should be measured from the anticipated beach location 50 to 70 years from the present.

Alternatively, a community may choose to amend its zoning regulation by establishing a special zone -- a "dune protection district" or "seashore conservancy zone", for example -- which will protect coastal areas as well as inland development by prohibiting development in beach and dune areas.

- Without existing zoning. In some coastal communities, zoning is not already in place. If your community is one of these, you still have several options:
  - establish a comprehensive zoning ordinance including provision for a "beach and dune protection zone";
  - adopt a "partial zoning" approach (if allowed by state enabling legislation) and establish a "beach and dune protection zone" alone; or

- adopt a police power ordinance restricting coastal development.

ESTABLISHING A BEACH AND DUNE PROTECTION DISTRICT

Glynn County, Georgia adopted a Beach and Dune Protection District in 1974, which paid special attention to the translation of dune formation and migration processes into workable development controls. A primary dune district, extending 40 feet inland from the landward side of the most seaward stable dune, was established by the ordinance. In this district, only fencing and elevated boardwalks are allowed. To the landward side of the primary dune district, a secondary dune field district was established in which conditional uses are allowed by special permit. In this district, elevation on pilings to at least 14 feet is required, and special road access restrictions are imposed during site plan review.

HAZARD ZONING IN RHODE ISLAND

In 1955, the Rhode Island Development Council prepared model hurricane zoning regulations which could be adopted by communities as amendments to existing zoning regulations. The model regulations suggest three types of hazard zones: beach zones in areas of extreme danger, commercial zones in areas of extreme danger, and areas of danger where uses are permitted according to prior zoning, but additional construction restrictions are imposed. Areas of extreme danger are those lands vulnerable to direct impact of hurricane waves and floods, and areas of danger are those lands vulnerable to hurricane flooding alone. For each danger zone, the model regulation suggests permitted uses and related provisions.

Regulations based on this model were subsequently adopted by a number of communities. For example, Warwick included sections on areas of extreme hurricane danger (specified lots) in its zoning ordinance in 1957. In areas of extreme hurricane danger, no building is allowed, except for specified purposes: non-commercial boat docks, beach cabanas, non-building uses such as farming, bathing beaches, picnic areas, and similar uses approved by the Zoning Board. In 1966, Providence adopted similar provisions for areas subject to hurricane tidal flooding. Areas subject to hurricane tidal flood lying 10 feet or less above mean sea level are not to be used except for limited purposes: public parks, non-building uses (e.g. bathing beach), beach cabanas, marinas, boat docks, launching ramps, lighthouses, seawalls, breakwaters, or jetties.

Factors Affecting Decisions to Regulate New Development

In deciding whether to adopt the regulatory approach to keeping new development from hazardous coastal areas, you should consider several factors:

(1) National Flood Insurance Program (NFIP) requirements

If your community is participating, or is planning to participate, in the National Flood Insurance Program, NFIP requirements on new coastal development must be satisfied. However, the NFIP imposes only a minimal requirement on the location of coastal development: participating communities must prohibit development seaward of the mean high tide line. (Other NFIP requirements on safe construction are discussed below in Chapter 3.)

(2) Federal and state laws protecting natural features

In addition to the NFIP requirements, your community may have to consider the effects of other federal or state requirements. In some cases, federal law may impose sufficient controls on development affecting certain natural features that additional local controls may not be needed; or additional local controls can be tailored to supplement existing federal controls. For example, the Corps of Engineers has significant authority to control development in wetlands under its "404 Program." Also, some states may prohibit development in certain coastal hazard areas -- such as wetlands or beaches -- or require local governments to adopt ordinances prohibiting such development.

(3) Benefits

Regulation of undeveloped coastal areas may serve multiple objectives for your community, in addition to reducing potential storm damages. These might include prevention of unsightly development, protection of sensitive features that buffer inland development as well as shorefront areas, enhancement of wildlife habitats. Public use, however, is not one of the benefits of regulation, though it is a benefit of acquiring high hazards areas. (See acquisition section below.)

(4) Costs

If your community already administers and enforces zoning regulations, additional costs to apply controls on setback lines or special coastal districts will be minimal. In the absence of existing zoning, administrative costs to carry out new controls on coastal development will be higher. The cost of establishing setback lines may be considerable, but technical or financial assistance for the necessary technical studies may be available.

(5) Public acceptance

If your community does not already have zoning, chances are good that a zoning ordinance will not be politically acceptable. However, if your community does contain some basis for developing support for comprehensive planning and zoning, you should certainly consider pursuing this approach. If this proves politically unacceptable to your community, other options are available. A "partial zoning" approach may well be politically palatable in places where comprehensive zoning is not, but this approach may not be allowed in your state.

Most local governments have the authority to adopt "police power ordinances" to promote public health, safety, and welfare. In some cases, such ordinances may be the most acceptable exercise of your local government's power to prevent development in hazardous areas.

(6) Legal limitations

Traditionally, zoning and other land use controls have been subject to some opposition concerning the "taking" of private property. This issue is more likely to arise in adopting regulations to prevent development entirely in coastal hazard areas than it is with regulations that impose strict construction standards but still allow development to take place. (See box.)

THE TAKING ISSUE*

One possible limit to a community's authority to regulate land uses, including use of coastal floodplain land, involves constitutional restrictions on the taking of private property for public purposes without just compensation.

The "taking issue" generally arises when a landowner considers his use of the land to be unduly restricted by floodplain or other land use regulations. While the issue is a complex one, a few basic points can be made on how floodplain use regulations may be affected:

- When the issue is raised, the individual landowner generally has a heavy burden of proving the "taking".
- Although general legal principles apply to resolution of the issue, each allegation is resolved on a case-by-case basis. As a result, the specific facts of each individual case are important.
- Local regulatory actions restricting land use are often supported by court decisions when they are based on a larger plan and related to protection of public health, safety, and welfare.
- In floodplain taking cases, two types of questions are usually relevant: is the regulated activity a nuisance use (i.e. harmful to public health or safety); and, how does the adverse effect of the regulation on the value of the land in question balance against the beneficial purposes of the regulation?

Local officials should be aware that, in many cases, community action to protect the public from flood dangers have been determined not to be a taking. Further legal advice from your town counsel or state Attorney General's office may be needed.

*Based on discussion in Flood Hazard Management and Natural Resource Protection, Training Institute Background Papers, FEMA, April 1980, pp. 177-181.

ACQUISITION

Acquiring Undeveloped Coastal Property

In some situations, your community may want to purchase undeveloped areas subject to flooding along the coast. Acquiring these types of coastal properties may serve a multitude of local objectives including but not limited to

the reduction of future damages from frequent flooding -- such as protection of valuable natural areas (dunes, beaches, estuaries), improvement of beach access, enhancement of recreational opportunities, and protection of wildlife.

Factors Affecting Decisions to Acquire Undeveloped Coastal Property

In deciding whether to acquire undeveloped coastal properties to reduce coastal hazards, and to obtain related benefits, the community will have to consider potential problems -- primarily high costs and loss of tax revenues -- as well as potential benefits.

(1) Potential benefits

As noted above, acquisition of undeveloped coastal lands can benefit your community in more ways than just reducing flood damages. It can:

- *Enhance local recreational opportunities:* The community may be able to utilize the undeveloped parcels as additions to its recreational lands --for recreational beaches or as parks, for example. (See box.)

- *Enhance tourism opportunities:* In addition to improving recreation for local residents, acquisition of undeveloped coastal land can provide additional recreational space for tourists. As noted below, increasing your community's attractiveness to tourists may balance anticipated tax losses from public acquisition of coastal open space.

- *Prevent hazardous or unsightly development:* Public acquisition of undeveloped coastal property can assure that it stays undeveloped. Building on the hazard-prone land can be prohibited with little or no opposition. If limited development of public facilities is desired, the community can determine exactly where and how construction occurs.

- *Protect sensitive natural features:* Undeveloped coastal property will likely include beaches, dunes, and/or wetlands -- natural

features that help protect the near-shore as well as inland properties. Acquiring these areas and maintaining them as open space will help assure that this natural protection continues.

ACQUIRING COASTAL OPEN SPACE: UPPER TAMPA BAY, FLORIDA

Hillsborough County, Florida recently purchased 596 acres of coastal wetlands to add to its regional park system. The acquired property, known as Upper Tampa Bay Park, is an area of extremely productive estuarine habitats on the north shore of Old Tampa Bay.

The Hillsborough County Park Board first identified the need to acquire waterfront park land in the Upper Tampa Bay area in the early 1960's. While early efforts to obtain funds for the project were unsuccessful, a 1968 application to the Department of Housing and Urban Development for an Open Space Grant was well-received. The threat of an extremely large development on Upper Tampa Bay proposed park lands triggered increased local pressure on the county to acquire these valuable coastal wetlands, and, in 1969, Hillsborough County received a $450,000 grant from HUD to acquire the land on a 50/50 matching basis. The county used these funds to purchase 409 acres from the Tampa Bay Port Authority. An additional 187 acres for the Upper Tampa Bay Park were purchased in 1976 with funds from a county bond issue, added to a match from the Land and Water Conservation Fund.

Although the first plan for the Park showed considerable development of the area (marinas, camping and picnicking areas, beach facilities), a citizen group pressed for uses that give greater weight to the preservation of environmental values, and the Park is scheduled to be opened sometime in 1981 as an environmental education center with minimal facilities -- a classroom, some boardwalks, nature trails, observation platforms and limited picnicking.

(2) Cost

Public acquisition of floodplains is often considered beyond the financial reach of inland communities; the cost of coastal properties -- even though undeveloped -- is astronomical in many places. Even though coastal property is subject to severe hazards, it has traditionally been very valuable and will often have a high market value. In addition to the initial costs of acquiring the property, the community will have to plan for the costs of maintaining the property, even if the intended use is minimal. However, these costs should be weighed against costs the community might alternatively have to pay for control devices or beach nourishment, and disaster assistance if development were allowed to occur.

A community can reduce the costs of acquiring and managing coastal property with funds from state and federal governments, private foundations, and local land trusts.

(3) Loss of tax revenues

Anticipated loss of property tax revenues is a common barrier to consideration of open space acquisition by coastal communities. Even if the property is undeveloped, the owner will have been paying some local property taxes. Taxes from coastal property, where development is anticipated, could be substantial, and removal of the property from the local tax roll may be perceived to be significant.

In considering possible impacts on local taxes, the community should examine the overall impacts of possible acquisition projects. It may find that, when tourism opportunities are enhanced by public acquisition of coastal areas, the local tax base may increase rather than decrease.

(4) Availability of assistance

A variety of state and federal programs provide financial assistance which may, in some cases, be used to support acquisition of undeveloped coastal floodplains. These include programs to support open space and recreation goals, to protect and maintain wildlife habitat, to improve beach access, to protect and restore wetlands, and others. Some of these which have been used by communities in the past are described in Chapter 9.

Though funding for these programs, along with other federal and state assistance programs, is likely to be reduced during an era of shrinking budgets, private sources of assistance may still be available and should be pursued. Private foundations or individuals may donate money -- or land itself -- to the community that embarks on a program of acquiring hazardous property.

Acquisition of less than full interests in the property may also help to reduce costs. Purchase of "conservation" easements that restrict future development is one example of this approach.

(5) Availability of alternatives

Acquisition is most likely to be a sensible approach when potential damages are high and when the community wants to make some public use of the coastal property. (When potential damages are very high or pose significant threat to life, it may even be sensible to purchase properties that are already developed; this is especially likely after a damaging hurricane or other severe storm and is discussed in Chapter 7.) When possible future damages pose less of a problem, the desire for public use of undeveloped coastal areas may still be great enough by itself to encourage local purchase of these floodprone lands.

Your community may want to consider acquisition as an alternative to regulation of hazard-prone areas. Public acquisition is generally a more permanent solution than imposing regulatory controls on use of property. Also, where regulations on development in hazardous areas are imposed, there may very well be public opposition to what is considered a "taking" of private property, even though the regulation might easily stand up in court. Particularly in the most hazardous areas, controls on building or rebuilding must be quite strict to be effective. Acquisition of the property by the community may prove more acceptable to landowners than imposition of these strict controls, and problems faced by the community in enforcing tough regulatory standards would be eliminated.

As a first step in evaluating your community's options to acquire coastal property, you will have to consider the community's potential need for these undeveloped shorelands -- for recreation space, for example. These needs may be fairly well established already, through community development planning or related efforts. Second, you will have to consider how vulnerable to hazards these undeveloped shorelands are and whether they would be acceptable for the uses (recreation, habitat improvement, etc.) that the community has in mind. Third, you will have to make a preliminary exploration of possible sources of funds to acquire these properties. Local sources -- such as local land trusts or municipal open space agencies --

may be the best ones to look at first. State and federal sources also need to be explored.

PERSUASION OR ENCOURAGEMENT

Discouraging Development in Hazardous Areas

In addition to establishing regulatory controls and acquiring coastal open space to keep development from hazardous areas, communities can simply attempt to discourage people from undertaking new development in coastal hazard areas through a variety of means.

- Public awareness or information programs may be helpful in persuading people not to build in hazardous areas. For communities participating in the NFIP, federally-insured lending institutions must inform mortgage applicants that the property is located in a flood hazard area and that the buyer must purchase flood insurance in order to obtain a loan. If your community is already participating in the NFIP, programs to support and expand on public information related to hazardous areas may be helpful. Even communities not in the NFIP may want to develop general public information programs and consider encouraging banks to disclose hazard information. Real estate agents could play an important role in informing prospective buyers about the vulnerability of coastal properties, though they are unlikely to do so unless required by local ordinance. (See box.)

HAZARDS DISCLOSURE: SANTA CLARA COUNTY

Some localities have passed laws on disclosure of potential hazards to property buyers. Santa Clara County, California, for example, passed a law in 1978 which requires that a written statement of flood hazards, as well as landslide or seismic risk, be provided to property buyers. Regional and state realtor associations have prepared materials to help real estate agents comply with the disclosure law, including instruction booklets, contract forms and, most important, indexed street maps showing one or more of the hazards. The maps do not give official hazard identification, but provide a first step in locating hazard areas. Supplemental information can be obtained by realtors from state or local officials.

- Location of public facilities may discourage residents from building in hazardous areas. If your community adopts a policy not to locate any public facilities -- sewers, roads, sewage treatment plants, etc. -- in the most hazardous areas, this may discourage private owners from building in such areas as well.

Factors Affecting Decisions to Select the Persuasion Approach

In deciding whether to systematically encourage people not to develop hazardous areas, you should consider two basic factors: cost and effectiveness.

(1) Cost

While the costs of adminiistering regulations to control new development may or may not be significant, and the cost of acquisition is almost certain to be significant, the costs of promoting public awareness of the need to prevent coastal development in critical areas will ususally be low.

(2) Effectiveness

The effectiveness of this approach will depend a great deal on the attitude of your community's citizens and the alternatives available to them. In some areas, where pressure for new development of coastal areas is great, regulations or acquisition are almost certain to be needed to prevent such hazardous development. Even in these areas, persuasion may have some effect if vulnerability is great. On the other hand, if development pressures are low, and adequate non-developed areas are available in safer parts of town, the persuasion method may prove quite effective.

SOURCES OF DETAILED INFORMATION

- Public Acquisition of Floodplains and Wetlands: A Handbook on the Use of Acquisition in a Floodplain Management Program. Second Review Draft. Prepared by Ralph M. Field Associates, Inc., for U.S. Water Resources Council, May 1981.

A guidebook to assist state and local governments in determining whether floodplain/wetland acquisition would be an effective element of their floodplain management programs and in identifying ways in which acquisition programs can be successfully implemented. It is intended for state and local officials generally familiar with floodplain management, but without experience in floodplain acquisition. The handbook contains ten descriptive case histories of communities that have used acquisition under various programs, many examples of acquisition techniques, and a chapter on technical and financial assistance that may be available from state and federal governments for acquisition projects.

- Land Conservation and Preservation Techniques. U.S. Department of the Interior, Heritage Conservation and Recreation Service. March 1979.
  One in a series of handbooks prepared by the Heritage Conservation and Recreation Service to assist government agencies and non-profit organizations involved in recreation and heritage preservation to utilize limited funds for the greatest public benefit. The report discusses numerous ways of acquiring property for these activities -- from land donations to easements -- and includes brief notes on how the methods have been used by communities and states.

- The Taking Issue. An Analysis of the Constitutional Limits of Land Use Control, Fred Bosselman, David Callies and John Banta for the Council on Environmental Quality, 1973.

  Provides a comprehensive look at constitutional issues raised in regulation of land use. Includes a regional overview of the issue, as well as historical and current interpretations. Governmental strategies for coping with the issues are discussed and numerous cases are cited.

  Additional references following Chapter 3 include useful information on the regulatory approaches discussed in this chapter.

CHAPTER 3 PROMOTING SAFE CONSTRUCTION IN HAZARDOUS AREAS

Methods to promote safe construction in hazardous areas of your community include:

- regulations
- financial and technical assistance

In deciding whether to use these approaches, you should consider a number of factors; including:

- requirements of the National Flood Insurance Program (NFIP)
- state requirements
- model code provisions
- actual or perceived risk
- costs of compliance
- administrative requirements

There are a number of ways to provide some measure of protection from coastal flooding and hurricane winds for the development that does occur in hazardous areas: construction standards to limit damages from flooding (e.g. elevation, anchoring, breakaway walls, or floodproofing); construction standards to reduce wind damages; and land development practices (e.g. lot grading or setbacks to protect natural features).

Communities can use different techniques -- primarily regulations and technical or financial assistance -- to promote safe construction in coastal hazard areas. Since the early 1970's, many communities have adopted some type of floodplain regulation in response to requirements of the National Flood Insurance Program (NFIP). Other communities have gone beyond the NFIP requirements and developed innovative or more stringent approaches to reducing coastal flood or hurricane wind damage. Specific regulatory approaches to promoting safe construction -- to meet NFIP requirements or go beyond them -- are also varied. They can include provisions of zoning or subdivision regulations, building codes, or separate special-purpose regulations.

Measures to keep development away from hazardous areas (including setbacks) and measures to protect natural areas are discussed in Chapters 2 and 4. This chapter concentrates on techniques to promote the safe construction of development that does occur in hazardous areas.

REGULATIONS

Promoting Safe Construction through Regulations

There are a number of ways that communities can establish building standards or land development practices that protect development in hazardous areas from coastal flood and wind damage (see box). Communities can add provisions to existing local ordinances, such as building codes, subdivision regulations, or zoning ordinances. Or communities can adopt new special purpose flood hazard area permit regulations.

- Construction standards for resisting flood damage. Structures in coastal hazard areas may be subject to flood water damages from both increased tide levels and from wave action. Communities can attempt to reduce these types of damages by requiring:
  - elevation of new or rebuilt structures in coastal hazard areas to raise them above anticipated flood levels
  - adequate anchorage to prevent structures from floating off their foundations
  - use of open breakaway walls that will collapse under stress
  - dry floodproofing to keep storm waters from entering structures
  - wet floodproofing to allow the passage of waters through structures without causing structural damage.

  These types of construction standards can be fairly easily incorporated into local building codes, and they can be as specific as the community desires -- for example, a general requirement for pilings adequate to withstand a 100-year flood, to be certified by a registered engineer, can be established; or the use of certain construction materials for pilings that can better withstand flood waters could be specifically required.

EXAMPLES OF LOCAL REGULATIONS ON DEVELOPMENT IN FLOOD HAZARD AREAS*

South Kingstown, Rhode Island: A zoning ordinance combines minimum elevation requirments with a beach setback line and comprehensive wetland protection regulations.

Warwick, Rhode Island: A two-district coastal floodplain zoning ordinance includes a high velocity wave zone where most development is prohibited and an elevation requirement for backlying areas.

Gulf Shores, Alabama: Building regulations require elevation above the 100-year flood elevation, including wave heights, and piling standards.

Littleton, Colorado: Zoning and subdivision regulations, along with a building code, require a 200-foot setback from a water channel and the elevation of residential structures in outer areas to one foot above the 100-year flood elevation.

Sanibel, Florida: Development regulations specify performance standards within ecological zones to insure that flood-moderating functions are not impaired.

Fairfax County, Virginia: An erosion and sediment control ordinance requires conservation plans to prevent erosion, minimize sedimentation, and preserve floodplain vegetation.

Virginia Beach, Virginia: Floodplain regulations require new structures to be elevated one foot above the 100-year flood elevation, and development is prohibited in areas less than 6 feet above mean sea level. The community has adopted its own detailed flood maps at a scale of 1:100 and it has hired four coastal inspectors to monitor and enforce regulations. In addition, coastal wetlands and sand dune protection regulations require setbacks.

*Derived in part from Flood Hazard Management and Natural Resource Protection, Training Institute Background Papers, FEMA, April 1980. While some of these regulations are from inland communities, the approaches taken may be applicable to coastal situations.

- Construction standards to reduce wind damage. Structures in coastal hazard areas are subject to wind damages, as well as flood water damages. Communities can adopt wind-resistant building standards that are addressed to two problems: reducing damages from the high velocity winds themselves and reducing damages from wind-driven debris. Standards for resistance can range from specifications on roof design, to use of coverings (e.g. shutters) on windows and doors, to requirements for "tie-downs" for mobile homes.

Like building standards to reduce flood damages, communities can incorporate these types of standards into their building codes. Texas communities, in particular, have gone far in using wind-resistant standards in their building codes (see box on page 37).

- Land development practices. Another method communities can use to reduce storm damages to coastal development is to require certain land development practices. Lot grading to reduce flood damages, for example, can be required. Subdivision regulations, too, can be designed to include special considerations related to flood damage reduction, for example, the dedication of easements along drainageways or the design of roads and bridges to withstand specified flood velocities.

Factors Affecting Decisions to Require Safe Construction Standards

Your community should consider a number of factors in deciding how to regulate construction in coastal hazard areas:

(1) National Flood Insurance Program requirements

A basic decision your community will have to make in responding to coastal flooding, if it has not already done so, is whether or not to participate in the National Flood Insurance Program (NFIP). The NFIP brings with it certain minimum requirements related to local land use and management. Some elements of the NFIP require measures to prevent development in hazardous areas, and are discussed in Chapter 2. However, the NFIP is focused primarily on promoting safe construction, rather than prohibition of construction.

As part of the NFIP, a community's floodplain areas are divided into different zones, depending on the risk of flooding. Coastal areas most vulnerable to flooding are identified as either A zones or V zones. A zones are subject to the 100-year flood (a flood with a 1 percent chance of occurring in any given year), but not (in theory) subject to high velocity wave action. V zones are a fairly narrow strip along the shore clearly subject to high-velocity wave action, and thus the most vulnerable of the coastal hazard zones.

The minimum NFIP standards for construction in coastal hazard areas are different for A zones and V zones:

- In coastal A zones, new construction or substantial improvements of residential structures, at a minimum, must have the lowest floor (including basements) elevated to or above the 100-year flood elevation through use of fill, raised foundations, piles, or columns. In coastal A zones, the community's Flood Insurance Rate Maps (FIRMs) will identify the 100-year flood elevation. Although the A zone is that portion of the 100-year coastal floodplain which is less subject to turbulent wave action, it is important to note that high velocity water may be experienced due to the forward momentum of breaking waves, especially in the vicinity of the V zone/A zone boundary. Land in the A zone may also be subject to wave action during flood events which are more severe than the 100-year flood.

- The minimum requirements for construction in V zones differ significantly from those that apply in coastal A zones. In V zones, all new construction and substantial improvements to existing structures must be elevated on adequately anchored pilings or columns so that the bottom of the structural members supporting the lowest floor (excluding the pilings and columns) is elevated to or above the 100-year flood elevation. A registered professional engineer or architect must certify that the structure is securely fastened to adequately anchored pilings or columns in order to withstand high velocity waters and hurricane wave wash forces. In addition, the space below the lowest floor must not be used for human habitation and must be free of obstructions. It may be enclosed with breakaway walls, however, such as open latticework intended to collapse under load without jeopardizing the structural support of the building.

At this time, most FIRMs for coastal communities show the stillwater elevation of the 100-year flood but do not show the height of the 100-year flood including wave heights. (See box.) Until wave height elevations are shown on FIRMs, NFIP regulations can be satisfied by elevation to the stillwater 100-year flood elevation alone.

Additional NFIP standards for V zones require that fill not be used for the structural support of new or substantially improved structures. (In addition, sand dunes and mangrove stands may not be altered so as to increase the potential for flood damage. See Chapter 4.)

A summary of FNIP requirements is included in Table. 1.

TABLE 1

NFIP PROGRAM REQUIREMENTS SUMMARY*

DATA AVAILABLE TO COMMUNITY	SUMMARY OF ADDITIONAL PROGRAM REQUIREMENTS
EMERGENCY PROGRAM	
Flood Prone - No Map	1. Community-wide building permit system allowing case-by-case evaluation of flood hazard. 2. General performance standard applicable to activity in flood-prone areas to ensure: • structural safety; • minimization of damage; • protection of utilities.
Flood Prone with Flood Hazard Boundary Map	3. Obtain base flood elevation data from best available source. 4. Application of elevation and/or floodproofing requirements to new construction and substantial improvement and repair in flood-prone areas (based on best available data). 5. Mobile home anchorage requirements. 6. Maintain carrying capacity of channel. 7. Notify adjacent communities of alterations in water course.
REGULAR PROGRAM	
Base Flood Elevation Provided - No Floodway or Coastal High Hazard Area Identified	8. Elevation and/or floodproofing requirements for new construction for substantial rehabilitation and repair, and for mobile homes. 9. Certification of structural integrity or floodproofing by professional engineer. 10. Demonstrate that new developments in 100-year floodplain do not increase base flood more than one foot.
Base Flood Elevation Plus Designation of Floodway	11. Adopt regulatory floodway. 12. Prohibit any activity inside regulatory floodway which would raise base flood. 13. No new mobile homes in mobile home parks in floodway.
Base Flood Elevation Plus Coastal High Hazard Area (Velocity Zone)	14. Anchorage plus certification of structural integrity by engineer. 15. Elevation above wave height. 16. Use of open breakaway walls in space below lowest floor. 17. No use of fill for elevation in Velocity Zone. 18. Protection of mangrove stands and sand dunes.

*This chart merely summarizes requirements. It does not list all of them, nor does it make necessary regulatory distinctions between residential and non-residential development, or between existing and new structures. For a fuller description of requirements, see NFIP program regulations.

SOURCE: Flood Hazard Management and Natural Resources Protection, Community Action Guide, FEMA, Washington, D.C., pp. 15-16.

WAVE HEIGHTS

Storm surge, or the storm-generated rise of water above mean sea level, is composed of the astronomical tide, wind set-up or the piling-up effect of storm winds on waves, and wave set-up or the effect of offshore topography on wave height. Because much of the damage from coastal storms is caused by waves, and because waves are considerably elevated above stillwater elevations, it is important to know how high storm waves are likely to be when designing coastal construction. Until 1979, maps of coastal flood hazard areas prepared for the NFIP showed only the stillwater height of the 100-year flood. Following agreement on a methodology to calculate wave heights, FIA has begun preparing new maps for all coastal communities in the NFIP.

Through remapping, FIA will add wave height information to most existing FIRM's published prior to the development of the new wave height study methodologies. Information on potential sources of wave height information, when such information is not included on the FIRM, can be obtained from FEMA regional offices. (See Appendix A.)

(2) State requirements

Some states establish standards on construction in coastal hazard areas that local communities must comply with (see box), or require that communities adopt their own standards. For example, Wisconsin's statewide floodplain zoning regulation, which requires local communities to adopt floodplain zoning ordinances, includes minimum use standards, such as elevation on fill of residential structures located in flood fringe areas. State regulations in North Carolina establish use standards which must be met as permit conditions in areas of critical environmental concern, including dunes and beaches.

(3) Model codes

In some areas, communities customarily use provisions from model construction codes formally as their own construction codes or informally as technical guides. Some model building codes include guidance on construction standards to reduce storm damages. A study done in the early 1970's found that the major national model building codes lacked floodproofing standards, although the Southern Standard Building Code did include wind protection standards.

FLORIDA COASTAL CONSTRUCTION SETBACK LINE

The Florida Legislature enacted the Coastal Construction Setback Line Law (CCSBL Law) in 1971 in order to "prevent beach encroachment that would endanger the existing beach-dune system and to help prevent existing and future structures from being unreasonably subject to great and irreparable harm". The Florida Department of Natural Resources is responsible for establishing the CCSBL for each county with sandy coastal beaches, based on the individual characteristics of each county. On the basis of opinions aired during public hearings and on the recommendations of the Coastal and Oceanographic Engineering Laboratory of the University of Florida, the Florida State Cabinet approves the legal CCSBL for each county. Until setback lines are so designated, builders are required to stay 50 feet back from the beach vegetation line. The law also provides that, after the CCSBL has been approved, variances may be granted for structures provided that they are designed to withstand the 100-year hurricane and will have a minimum adverse impact on the beach/dune system.

Since that time, several attempts to develop or refine hurricane building standards have been made. Texas has developed a model building code which includes four different hazard zones: the most severe is subject to storm surge, wave battering, wave scour, and wind; the least severe zone is subject only to wind. (See box.) South Florida and Mississippi also have building codes specifically designed for hurricanes.

TEXAS MODEL MINIMUM HURRICANE RESISTANT BUILDING STANDARD

A 1975 resolution passed by the Texas Legislature required the development of model minimum building standards for high-risk coastal areas. The work in developing the standards was performed by the Texas Coastal and Marine Council.

As a first step, four hazard zones reflecting different levels of exposure to hurricane forces were identified:

- Zone A is subject to scour, battering with debris, flooding and wind (140 mph)
- Zone B is subject to battering with debris, flooding and wind (140 mph)
- Zone C is subject to flooding and wind (140 mph)
- Zone D is subject to wind forces alone.

The model minimum standard, which is presented as an amendment to a city building code, includes an inspection checklist for various parts of the construction, as well as specific design parameters. A chapter on wave and scour action presents design standards for bulkheads, seawalls, piers, docks, groins, jetties, breakwaters and boathouses, while a chapter on battering addresses the effects of debris. Specific standards are also given for slabs, columns, pile foundations, plastic materials, seams, pipes, joints, etc. The use of various classes of materials, heating, air conditioning and ventilating systems, and hot water, electric and plumbing systems are also discussed. Another chapter is devoted to wind loading for maximum design wind velocities up to 140 mph taking into account the shape parameters of the structures. Additional chapters address design and construction of foundations, use of masonry walls, steel and iron, wood, and concrete, as well as roof coverings.

The Southern Standard Building Code is currently being revised to incorporate hurricane protection provisions based on the Texas model minimum hurricane resistant standards.

Once your community has considered these three factors -- NFIP requirements, state requirements, and model codes -- some thought should be given to what the remaining opportunities are: Should your community opt for minimum NFIP or state standards or adopt stricter construction standards? Will minimum standards provide sufficient protection to construction in your community's most vulnerable locations?

The NFIP minimum floodplain management requirements have no effect locally until local ordinances meeting them are adopted by a community wishing to participate in the program. More than 16,000 communities (approximately 1,800 of them in coastal areas) have adopted such ordinances and are currently participating in the NFIP. These local regulations meeting NFIP floodplain management standards are often the first flood protection standards adopted by a community, and most are designed simply to meet the minimum requirements.

Other communities, however, have adopted regulatory standards that go beyond the minimum requirements. These regulatory techniques include stricter elevation requirements, or restrictions on floodproofing as an alternative to elevation, standards on construction materials, and others. Going beyond the minimum NFIP requirements may be particularly appropriate in responding to the hurricane hazard. In evaluating these opportunities, you should consider the following additional factors:

(4) Risk

The local community will have to weigh a number of considerations in deciding how far to go in promoting safer construction in coastal hazard areas. One of the most important is risk. For example, minimum NFIP requirements are different in V zones and A zones. But, as noted above, structures in the A zone may, in some storm situations, be subjected to high velocity waves or to wave action during floods greater than the 100-year event (to which NFIP requirements are addressed). Your community may decide that the risk to these areas is great enough to warrant stricter than minimum construction standards.

As noted above, until the Federal Insurance Administration finishes its remapping program, many coastal communities will be without Flood Insurance Rate Maps that show wave height information. For these communities, compliance with minimum NFIP regulations will leave V zone residents exposed to the full force of storm waves. As a result, communities without wave height data on their FIRM's may still want to consider requiring elevation above 100 year wave height levels, based on the

best available information. If no information on the magnitude of wave heights is available, some estimate can be developed. Consideration of wave heights is also important to enable certification by a professional engineer or architect. Finally, elevation above anticipated wave heights will often significantly reduce the insurance premiums.

The NFIP requirements on safe construction are designed to reduce damages from storm waves and flood waters; they do not include standards for reducing wind damages from coastal storms. Some coastal areas may suffer more severe damages from wind than from floods. Also, elevation of structures to avoid water damage may inadvertantly lead to an increased possibility of wind damages. For example, required elevation may result in a roof more than 30 feet above ground level; a roof of that height is subject to greater wind uplift forces, and rafter connections and other structural components will receive greater stress. Also, higher elevation may increase the possibility of a structure being blown over by horizontal wind forces. Studies in Texas have shown that the use of hurricane-resistant building standards can bring significant benefits, reducing wind damages by 45 to 60 percent.

(5) Cost of compliance

In addition to considering the risks that may make safe construction standards desirable, coastal communities must consider (a) costs of meeting any chosen minimum standards, and (b) additional costs of stricter standards determined to be desirable.

A Texas study has estimated the costs of meeting Texas hurricane-resistant building standards, based on using five types of structures and various design elements. As noted above, the Texas model building standards contain both hurricane-resistant wind and flood requirements and were designed to complement the Southern Standard Building Code (SSBC). Results of the study showed that application of the standards, as an adjunct to commonly-used codes such as the SSBC, increased structural costs 3 to 8 percent over the basic structural cost of a building designed to meet the SSBC (a 1 to 3 percent increase to the overall finished cost

of the structure). As noted above, benefits in reduced damages may be considerable, likely outweighing building costs in many instances.

The primary alternative to promoting safer construction in coastal hazard areas -- either to or beyond the NFIP standards -- is to prohibit construction in such areas. The community and individual homeowners may want to compare the increased costs of building to safe standards with the impact of a complete prohibition on building in coastal hazard areas. Communities failing to adopt even minimum standards, on the other hand, run the risk of catastrophic damages combined with a failure to qualify for federal disaster assistance following a major disaster.

(6) Administrative considerations

As noted above, communities have a wide range of methods to choose from to assure safer construction in hazardous areas. Most commonly, communities add provisions to existing local ordinances, such as building codes or subdivision regulations, although the content and scope of these codes may vary widely from community to community. In these cases, the costs of administering new provisions may be fairly low. In other cases, communities may adopt special-purpose permit requirements for flood hazard areas, possibly needing new administrative mechanisms to implement them.

Also, some process of monitoring and enforcement of the standards is essential, bringing additional administrative costs. Where floodproofing of structures below the 100-year flood elevation is allowed, monitoring during construction to ensure that approved plans are followed is particularly important. For example, following Hurricane Eloise in 1975, it was discovered that a number of beachfront buildings were not constructed to plan specifications. One high-rise nearing completion in Panama City Beach was found to be missing the concrete from most of its steel-reinforced concrete pilings, leaving the building without one-third of its structural support.

TECHNICAL AND FINANCIAL ASSISTANCE

Providing Local Assistance to Residents

As noted above, model codes -- such as the Model Minimum Hurricane-Resistant Building Standard developed in Texas -- provide guidance to communities in meeting and going beyond NFIP standards. Other technical assistance may also be available to your community, such as help from your state flood insurance coordinator. (See Appendix A.) Communities, in turn, have a responsibility to help local property owners meet local requirements for safe construction.

Many coastal residents, especially people recently relocated from inland states, will be unaware of the possibilities for safer construction in coastal hazard areas. In many cases, the availability of technical and/or financial help may be essential to persuade local property owners to improve structural standards in their buildings.

Some communities have responded to this need by developing special programs directed at individual property owners. These may involve making local building department officials available for consultations or providing low-cost loans for floodproofing (see box) or working with local banks to provide information on hazards to potential buyers of coastal property.

HOWARD COUNTY FLOODPROOFING LOAN PROGRAM

In 1974, Howard County, Maryland established a Countywide Revolving Loan Fund for floodproofing dwelling units in accordance with federal, state and county guidelines. The loans (a maximum of $6,000 per improved property) are available to property owners having a minimum of $25,000 of flood insurance; they have a 20-year maximum period of amortization. Interest rates are 1 percent higher than the average interest rate obtained at the most recent sale of County Government obligation bonds. Application forms for this loan program are available through the County Storm Water Management Division of the Department of Public Works.

Factors Affecting Decisions to Provide Financial or Technical Assistance

In deciding whether to undertake a program of local technical or financial assistance, you should consider the following factors:

(1) Relationship to enforcement

In many situations, safe construction standards may fall short of ensuring adequate construction because property owners lack sufficient funds or knowledge to meet the standards and because strict enforcement can be politically difficult. In these circumstances, technical and/or financial assistance may ease enforcement difficulties by helping coastal property owners meet strict standards. At the same time, enforcement becomes less of a political problem when meeting requirements imposes less of a hardship. Even where technical assistance alone is provided, both "how to" information and projections of savings from safe construction can significantly increase the acceptability of strict standards and reduce the difficulty of enforcing them.

(2) Cost

The cost or providing financial assistance (e.g. floodproofing loans) to coastal property owners must be weighed against the public benefits of safe construction along the coast. The costs of providing technical assistance (such as construction manuals, workshops led by building officials, etc.) are often quite low, however, and your community may be able to obtain useful materials or other help from state or federal agencies. FEMA and various state Sea Grant programs, for example, have published guidebooks on safe construction practices.

SOURCES OF DETAILED INFORMATION

- Kusler, Jon A. and Lee, Thomas M. Regulations for Flood Plains, Chicago: American Society of Planning Officials. Planning Advisory Service, Report No. 277. February 1972.

This report is geared to aid local public officials who are faced with the responsibility of developing floodplain regulations. Local floodplain zoning ordinances -- and their place in comprehensive floodplain management -- receive primary attention. Describes terms used in floodplain regulations; includes summaries of case law findings on floodplain regulations; classifies kinds and sources of hydraulic data and describes the utility of the data for developing legally valid ordinances. Includes text for a local floodplain zoning ordinance, with modifications to fit the conditions of four hypothetical communities.

- U.S. Water Resources Council, Regulation of Flood Hazard Areas to Reduce Flood Losses. Volume One, 1971 and Volume Two, 1972.

  This report explores selected issues in the regulation of private and public land uses to reduce flood losses and presents draft statutes and local ordinances for regulation of land uses in riverine and coastal flood hazard areas. Discussion of draft statutes that supplement existing zoning and subdivision regulations as well as of state enabling acts to specifically authorize local adoption of flood hazard ordinances and regulations is included. General problems and specific legal consideration in utilizing flood hazard area regulations at the state and local levels are addressed.

- U.S. Department of Housing and Urban Development, Office of Policy Development and Research, and Federal Emergency Management Agency, Federal Insurance Administration, Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas, January 1981.

  This manual is intended for use by designers, home builders, community leaders, local officials and home owners who wish to build prudently in areas of high hazard due to coastal flooding and to meet the requirements of the National Flood Insurance Program. It focuses on unique factors and conditions found in coastal environments as the basis for design and construction recommendations. Among the subjects discussed are background information on the NFIP, the hazards associated with building in the coastal floodplain, a review of alternative approaches for housing built on raised foundations, recommended performance criteria for the construction of foundation systems in flood hazard areas, and some indications of design solutions. It includes an extensive bibliography.

- Walton, Todd L. Jr. Hurricane - Resistant Construction for Homes. Florida Sea Grant Publication, Marine Advisory Program. University of Florida, August 1976.

  This pamphlet is intended to familiarize the home builder and home owner with federal and local regulations dealing with construction in hazardous coastal areas of Florida and to suggest construction guidelines to "hurricane-proof" homes (both new and existing) for wood frame, masonry and brick, and pole construction. The pamphlet also includes a brief review of types and causes of hurricane damages and probabilities, and includes an extensive list of technical references.

- Texas Coastal and Marine Council, Model Minimum Hurricane-Resistant Building Standards for the Texas Gulf Coast. September, 1976.

  This report presents minimum building standards that can reduce the hurricane risk to life and reduce the risk to property to an acceptable level. Principal elements of the report include: a discussion of the hurricane-related forces impacting the Texas coast; a description of the nature and magnitude of the destructive forces associated with hurricanes; an analytical procedure for spatially delineating the varying degrees of exposure to the design hurricane's destructive forces in coastal areas; i.e. establishing "hazard zones"; a set of minimum performance criteria for structures in each of the hazard zones; and a draft minimum model building standard to implement the performance criteria in each hazard zone.

- Bureau of Disaster Preparedness, Florida Dept. of Community Affairs and Dept. of Urban and Regional Planning, Florida State University, Hurricane Hazard Mitigation at the Local Government Level. The Roles of the Building Code and Other Development Management Strategies. October 1980.

  Study prepared to provide local governments with guidelines to address long-term mitigation of hurricane hazards. Includes three major chapters: hazards of a hurricane, the use of building codes to reduce hurricane hazards, and the use of other non-structural techniques governing the location of development (regulations, acquisition, etc.) as hazard mitigation measures. The focus is on assisting local governments in Florida (e.g. one appendix is on Florida's vulnerability to a hurricane), but sections are generally useful to other coastal areas. The chapter on building codes is quite thorough, addressing problems with codes commonly used in

Florida, what a hurricane protection code should ideally address, ways to insert hurricane provisions into a code, and the types of problems that can be expected.

- Federal Emergency Management Agency. Ways of Estimating Wave Heights in Coastal High Hazard Areas. April 1981.

  A collection of three separate documents concerning wave height calculations. The first, "Field Manual for Estimating Wave Heights in Coastal High Hazard Areas in Atlantic and Gulf Coast Regions", is a simplified version of the method FIA uses to calculate wave heights in its new flood insurance studies. Step-by-step procedures are provided as well as data forms. A more detailed version of the methodology is provided in the second document, "Users Manual for Wave Height Analysis". The third document provides the technical background for the procedures.

CHAPTER 4 PROTECTING NATURAL SYSTEMS

A variety of approaches are available to protect natural coastal systems in your community:

- regulations
- beach nourishment
- dune vegetation and maintenance
- protective structures

In deciding whether to use these approaches, you should consider several factors, including:

- effectiveness
- public acceptance
- availability of alternatives
- implementation and enforcement difficulties
- legal limitations
- costs
- impacts on the neighboring shoreline

Scientists and engineers have come to agree that the best protection for coastal development lies with the natural protective system of beaches and dunes. Beaches can absorb much of the destructive energy of storm surge, while dunes provide the innermost line of natural defense. Beach and dune systems can afford partial or complete protection to land areas behind them. Even when breached by major storm waves, dunes will gradually rebuild. If dunes are adequately protected, they can provide much protection to coastal development; additional structural measures may not be needed.

As a result, protection of these natural features frequently has the effect of reducing flood damages, even where flood loss reduction is not the primary objective. Some coastal states and localities, however, have adopted measures explicitly directed to reducing storm damage by protecting natural systems. Such programs may, at the same time, enhance local recreational and tourism development opportunities.

A variety of regulatory and other programs that may fit your community's needs to protect natural features are discussed in this chapter. Techniques which protect natural features by preventing construction in coastal areas through setbacks or other means are discussed in Chapter 2 above.

REGULATIONS

Kinds of Regulations to Protect Natural Systems

If your community participates in the National Flood Insurance Program, it will have to meet minimum NFIP requirements on protection of natural systems (in addition to NFIP requirements on safe construction in hazardous areas, as described in Chapter 3). Beyond the NFIP requirements, there are a variety of regulatory approaches to protecting beaches and dunes. These include controls on traffic or other activities on beaches and dunes, as well as controls on the removal of sand.

- NFIP requirements. The National Flood Insurance Program requires protection of two types of natural features that are effective in reducing losses from coastal storms. Communities participating in the regular phase of the insurance program must prohibit man-made alterations of both sand dunes and mangrove stands within V zones* which would increase potential flood damages. Sand dunes may be found in A zones, as well as V zones, however, and therefore, in many communities, additional controls are necessary to adequately protect dunes.

- Beach and dune protection ordinances. Your community can choose from a variety of regulations to protect its dunes and beaches. The simplest and most general type of restriction is one which simply prohibits any alteration of the dune. Onslow County, North Carolina, enacted a good example of this kind of ordinance in 1968. (See box.)

  Beach and dune protection regulations may be contained as part of the community's zoning ordinance (particularly ones establishing coastal conservancy objectives, such as wildlife and scenic beauty protection), or

*V zones and A zones are described on page 32.

they may be adopted as special purpose regulations. If a zoning approach is taken, different beach and dune use restrictions can be easily imposed on different portions of the coastal area.

ONSLOW COUNTY SAND DUNE PROTECTION ORDINANCE

The Sand Dune Protection Ordinance of Onslow County, North Carolina makes it unlawful for anyone to damage, destroy or remove any sand dune or portion thereof lying on the ocean side of a "shore protection line" which is precisely defined in the ordinance. It also makes it a crime to kill, destroy, or remove trees, shrubbery or other vegetation growing on sand dunes without a permit from a shoreline protection officer (the county surveyor, county sheriff, or sheriff's deputies) authorizing such alteration. Permits are not issued for any action which might materially weaken the dune or reduce its effectiveness in protecting the shore from the effects of wind and water. Failure to comply with the provisions of this ordinance is a misdemeanor punishable by a fine of $50 to $500; failure to repair damage to dunes and vegetation is a separate violation.

Ordinances may also be directed specifically at the prevention of particular activities which threaten beaches and dunes, such as excavation and traffic. As a minimum, excavation of beaches and dunes should be controlled. Such controls might, for instance, require a permit for mining of sand and impose minimum standards for the size and shape of the dunes remaining after sand removal. (See box.) Taking sand from shallow underwater areas may also have to be controlled since extractors may move to these sources to avoid prohibitions on beach sand removal. Regulating sand removal from this near shore area is important because beach erosion will simply increase to replace any sand extracted there.

Both pedestrian and vehicular traffic can damage dunes and beaches, and both may be restricted by local ordinance. In order to effectively restrict pedestrian traffic on dunes, it is often necessary to construct walkways over them; this is inexpensive and is usually more effective than simply forbidding walking on the dunes. In some areas, ordinances restricting the use of off-road vehicles (e.g. dune buggies) on dunes may be needed.

REGULATION OF DUNE SAND EXTRACTION IN PUERTO RICO

The Puerto Rico Department of Natural Resources administers a regulation on the extraction of materials from the earth's crust, including sand, gravel, clay, etc., on public and private property. In order to obtain a permit, the applicant must submit information on the extraction operation, including a map and detailed sketch, a marine chart (if extraction in coastal waters will occur), a recent air photo, and a description of facilities to be installed to prevent water or air pollution and to preserve the natural resources in the immediate or adjacent area. Special conditions may be applied to any permit. In cases where removal of sand from dunes is requested, additional information (a topographic survey) must be submitted. The regulation also specifies requirements that apply to residual dunes resulting from extraction: not less than 10 meters in width, minimum altitude of 8 meters with specified slope, and a final elevation of the excavated area of not less than one meter above mean sea level.

OFF ROAD VEHICLE REGULATION: ALABAMA

Act No. 755 approved September 1973 by the Alabama Legislature prohibits operation of vehicles in certain counties on coastal sand dunes located fifty feet or further from the water line without written permission of the landowner. The penalty for violation of this act (a misdemeanor) is a maximum fine of $1,000 and/or a maximum term of imprisonment of 1 year. Failure to see public notices of this act posted along applicable beaches is not a defense to violations of this act.

- Other regulations. While beach and dune protection ordinances are most common, other types of regulations also address the protection of natural coastal features. For example, regulations that protect offshore coral reefs can help reduce the impacts of storm waves on the shore. Regulations designed to protect coastal wetlands can also minimize the effects of coastal storms.

Factors Affecting Decisions to Regulate Protection of Natural Systems

In deciding whether regulatory measures may be useful in protecting natural features in your community, you should consider several factors:

(1) Effectiveness

If building on or adjacent to beaches and dunes has already occurred,

or if dunes have already been destroyed, protective regulations are likely to be ineffective. In this case, the beach nourishment approaches discussed below may be the only available method of employing natural systems to protect your coast. However, if your beaches and dunes are basically intact or only partially eroded or damaged, regulatory approaches can be quite effective and may be sufficient to protect them from further harm.

(2) Public acceptance

Restriction of public recreational use of beach and dune areas may lead to considerable public opposition, even though these areas are very vulnerable to damage. In particular, there may be conflicts with recreational goals of increasing public access to coastal areas. Accordingly, restrictions on use of beach and dune areas may need to be combined with increased public access to less vulnerable recreational lands.

(3) Enforcement problems

Proper implementation and strict enforcement of local beach and dune protection regulations are essential to their effectiveness. Both sand extraction and beach traffic can cause damage in short periods of time and they may occur at night. Since signs identifying illegal activities are rarely sufficient, some sort of patrolling effort is usually necessary. Appropriate penalties must be available to impose on offenders.

(4) Legal limitations

In places where dunes can be privately owned, legal questions may arise over whether dune regulations constitute a "taking" of private property. For example, where lots are very small (which is the case in many coastal communities), prohibiting alteration of the dune may, in effect, prohibit all use of the lot and may be perceived as "taking" (see page 21).

BEACH NOURISHMENT

Methods to Build Beaches

Eroding beaches can be built up to provide protection against coastal flooding by placing sand on the shore through mechanical means. The sand used as fill may come from behind the beach, from offshore, or from other sources farther away. As noted above, sand from the nearshore zone should not be used to replenish the beach because removing sand from this area will simply result in faster erosion of the beach. To protect against hurricanes as well as more frequent flooding, dune construction through mechanical means may be undertaken in addition to beach nourishment. Engineering techniques must be used to determine the beach dimensions needed to withstand anticipated storm damages, as well as the required replenishment rate.

Factors Affecting Decisions to Build Beaches

In deciding whether to mechanically reconstruct your community's beaches, or rebuild its dunes, you should explore several factors:

(1) Availability of alternatives

If your community's beaches and dunes are currently intact, or if they have been only partially eroded, adopting one of the regulatory approaches discussed above may serve your community well. In many towns, however, dunes are largely destroyed and beaches have been seriously eroded. In these cases, beach nourishment and dune replenishment programs may be the only way to restore natural protective systems.

(2) Technical feasibility

Beach nourishment is technically complex, requiring an engineering evaluation of:

- direction of longshore transport of sand
- amound of sand needed, taking the natural supply into account
- characteristics of native beach material
- characteristics of borrow material (sand, stone, or organic material) to be used
- beach characteristics, such as height and width of berm.

(3) Cost

If conditions are suitable, the costs of beach nourishment may be relatively low compared to methods using structures to protect beaches. Generally, beach nourishment is more economically feasible and more practical for longer stretches of beach. Protection of small stretches of beach is, as a rule, too expensive since the newly-widened beach is exposed to the sea and erodes rapidly, making maintenance costs very high. Maintenance costs for annual additions of sand can be high for long stretches of beach as well and should always be considered in addition to initial costs. Constructing dunes to protect against hurricanes, while feasible in some instances, is generally quite expensive, often beyond the reach of coastal communities even with state and federal assistance.

COSTS OF BEACH NOURISHMENT

Costs of beach nourishment depend upon proximity of the borrow site, sand type of borrow site, time of the year work is to be done (winter work will elevate costs), quantity of material available at the borrow site (additional sites will elevate costs), exposure of the native beach, and extent of any mitigation measures required to lessen adverse environmental impacts on borrow sites.

If it is a large project (fill for a two-mile stretch or more), several million cubic yards of sand may need to be obtained. The cost of transporting this sand from an ocean area by means of an hydraulic dredge may reach $5 to $10 per cubic yard in some states (1981 prices). This price fluctuates with the price of oil and depends on whether marine equipment is required. Costs of a beach nourishment project in Westhampton, Long Island, under good conditions, were estimated at $4 to $5 per cubic yard of sand in a 1981 study. An emergency fill project at Moriches Inlet, New York, which extended into the winter months, was much more costly -- ranging from $9 to $11 per cubic yard of sand used (1981 prices). On the North Carolina coast the cost of pumping sand ashore by hydraulic dredge has been estimated at $1.50 to $3.00 per cubic yard (1981 prices).

For projects where sand can be transported via truck from nearby land areas, the cost can be considerably less; the exact cost depends on the distance the sand is hauled. In the winter of 1981, Westport, Connecticut, built up a 2,000-foot stretch of municipal beach with 2,000 cubic yards of sand obtained one-quarter mile away. The cost of this small beach nourishment project was approximately $2.75 per cubic yard.

Obtaining an adequate supply of suitable sand is critical to beach restoration projects. It may be difficult, in many cases, to find a source of borrow material that has the desired characteristics, as well as being economic to utilize. As noted above, borrow material can be hauled over land to the beach or pumped from an offshore floating dredge through a pipeline to the beach. Beach nourishment projects undertaken in recent years have relied more heavily on offshore deposits as a source of borrow material. Sand deposits in bays and lagoons are easily depleted; removal from estuarine areas may be ecologically unacceptable.

(4) Availability of assistance

Financial assistance for beach nourishment projects may be available from the Corps of Engineers to towns for projects on publicly-owned beaches, but projects must meet strict benefit/cost guidelines. Though Corps assistance will reduce the cost to your town, the community will still have to pay 50 percent of the project's cost if the project is defined as beach erosion control or 30 percent if the project is designed to provide hurricane protection. In addition, waiting periods for Corps projects are often extremely long.

DUNE VEGETATION AND MAINTENANCE

Methods of Dune Vegetation and Maintenance

Where development encroaches on the dunes or the dunes are partially removed (e.g., sand extracted for construction or to make accessways), the capability of the dune system to withstand storm waves is greatly reduced. Regulatory approaches and beach nourishment are two methods to protect or replace natural dunes and are discussed above. A third method is to rebuild natural dunes using fences, vegetation, or similar low-cost methods.

If your dunes have been destroyed by storm or development, reconstructing them can be an effective means of providing some protection to your shoreline development. To build dunes, fences are commonly installed to trap sand, and vegetation is planted to hold it in place. Replacement dunes should be built above the high tide line and on slopes that face the ocean. These same techniques can be used to maintain existing dunes.

- Dune maintenance. Structures, such as snow fences, can be used to build and protect dunes, or fencelike structures that serve the same purposes as snow fences can be constructed from materials such as discarded Christmas trees or brush. (See box.) Once dunes are protected with fencing, vegetation should be placed on the dunes to enhance stability. The rate at which dunes can be built varies depending upon local conditions. In some places dune establishment may take several years, while, in others, a four foot dune may be built in less than a year.

  While long linear fences can be used in wide open beach areas to build long linear dunes, in more populated areas different configurations of fencing may be more effective. For instances, on Long Beach Island, New Jersey, the state has used fences perpendicular to the dune line to trap the sand moving along the dune followed by zig-zag fencing which catches sand from all angles of the wind.

CHRISTMAS TREES AND THE PREVENTION OF COASTAL EROSION IN JACKSONVILLE, FLORIDA

Thousands of Jacksonville's Christmas trees are being buried along the beaches. Officials of the Jacksonville Marine Institute hoped that the trees would stop beach erosion caused by winds and by beach buggies that had killed beach vegetation. Much to the surprise of the Institute, thousands of residents of this northeastern Florida city donated their trees to the project.

- Dune vegetation stabilizes sandy beaches and dunes by trapping windblown beach material. As a result, it is effective only in areas where sand volume is considerable.

  Dune vegetation generally should be planted parallel to the high-tide line, in the path of blowing sand. Of course, the location of plantings must take into account the direction of local prevailing winds. Because dunes grow toward the sand supply, which is often near the surf zone, it is a good idea to locate plantings as far as possible from the water. Sand fencing can be placed in the planting areas temporarily while the plants get started.

Beach Wetgrass is commonly used along the Atlantic Coast, south to North Carolina, and in the Great Lakes. New England and New Jersey have also had success with American beachgrass. Further south along the Atlantic, Sea Oats are common and along the Gulf Coast, Sea Oats, Dune Panic Grass, and Salt Meadow Cord Grass are commonly used. State offices of the Soil Conservation Service should be consulted for information on the exact species that are best adapted to your community.

Factors Affecting Decisions to Maintain Dunes

In deciding whether to place fences or like materials or to plant vegetation on dunes, you should consider a few factors:

(1) Ease of use

Both dune vegetation and maintenance are fairly simple methods of shore protection. They can usually be accomplished on a small scale -- by the community, by groups of property owners, or by individual property owners. Non-technical materials explaining how to install dune protection fences or similar devices and how to plant dune grasses are usually available.

(2) Cost

In addition to being fairly simple methods of protection, dune vegetation and maintenance are usually low-cost. Costs for vegetation planting may be as low as $10 per foot, depending on the species used and the areas to be covered. However, vegetation on dunes may be destroyed during storms and have to be replaced frequently.

Building beaches and constructing dunes by mechanically dumping sand may be prohibitively expensive in areas where sand is in short supply, and in certain locations the rate of erosion may require replenishment year after year. By comparison, the capital costs of dune vegetation and snow fences are very low, though they are impermanent and require frequent replacement. Where development has not yet taken over your beaches, there are few limitations to the use of these labor-intensive, low cost protection methods.

PROTECTIVE STRUCTURES*

Engineering Approaches to Strengthen Natural Protection

Another method your community can consider is the engineering approach to strengthening natural protective systems. This approach does have major drawbacks, however; since it works by disrupting natural processes, adverse side effects often outweigh anticipated benefits.

- Groins -- "dams for sand" or barriers extending from the backshore into the littoral zone of sand movement -- are the primary engineering tool used to maintain beaches. They do so by interrupting the natural flow of sand along the shore, and trapping it in the desired place.**

  Groins are made of timber, steel, concrete, or rock. They may be long or short, high or low, permeable or impermeable. Low groins allow sand to pass over the top; permeable groins allow sand to pass through.

  High groins extending beyond the breaker zone may have exceptionally severe downdrift impacts by diverting the course of littoral drift past adjacent beaches. In many cases, sand may be artifically placed between the groins to solve sand supply problems.

- Offshore breakwaters are structures designed to protect an area from wave action. They are placed in deeper water than the seaward edge of jetties or groins and are not tied to the shore. The purpose of the offshore breakwater may be to protect a section of shore, to aid navigation (by providing a protected harbor), as a trap for littoral drift, or some combination of these purposes. In some areas, offshore breakwaters have been built in conjunction with on-shore seawalls as a first line of defense against storm waves. Offshore breakwaters dissipate wave forces and cause littoral drift to deposit on the shore.

*Other types of structures designed to directly protect coastal development include seawalls, bulkheads, and revetments. These are discussed in Chapter 5.

**Jetties are similar to groins in that they dam the littoral flow of sand. They are used primarily in conjunction with navigation projects, however, to prevent the flow of sand into a navigation channel.

In almost all cases, offshore breakwaters are of rubble-mound construction. Steel sheet-pile is sometimes used in the Great Lakes where the breakwater is not exposed to the action of the open ocean.

Factors Affecting Decisions to Build Protective Structures

In deciding whether your community should build structures such as groins or offshore breakwaters, you should consider several factors:

(1) Effectiveness

Groins have a high rate of failure to achieve their intended purpose. Several conditions are required for the success of groin systems: there must be a significant volume of littoral drift, and the drift must carry coarse materials greater than 0.2mm. In the case of offshore breakwaters, effectiveness depends in great part on their height in relation to wave action and water level variations. They are most effective when no significant wave overtopping will occur. Still, even the partial barrier of a submerged breakwater may be desirable in some instances.

In any case, a widespread view of many coastal scientists and environmentalists is that these types of structures are basically ineffective at protecting beaches and dunes. In addition, because of their effects on neighboring shorelines (see item 3 below), many beach experts feel that they should not be used at all.

(2) Cost

The cost of groins has been estimated at several hundred dollars per foot (1981 prices) depending on exposure to wave action, range of tide, accessibility of buildng materials, the height of the apron, and the distance the groin will extend from the shore. In North Carolina, a 450 foot long rubble and stone groin with a maximum water depth of six feet would cost approximately $250,000 to build (1981 prices), or $550 per linear foot. The cost of sand to fill between groins is extra.

The cost of offshore breakwaters depends on the depth of water, availability of materials, and wave action, and it is generally greater than on-shore structures. Typical construction costs (1981 prices) have

been estimated at $300 to $500 per foot for a stone breakwater in water depths of 6 to 10 feet and $3500 per linear foot for construction in water depths of 10 to 15 feet.

(3) Impacts on neighboring shoreline

Beaches are dynamic landforms in constant motion. Sand is always moving offshore, onshore, and along the coast with longshore currents. By continuously shifting, sandy beaches naturally adjust to changes in tide, sea level, and sediment supply. Constructing shore protection devices inevitably interferes with these natural processes, often causing the aesthetic and recreational benefits of natural beaches in the vicinity to be reduced, or disappear. Accordingly, the effects on natural features and adjacent properties must be taken into account when considering employing structures to protect your coast.

Groins and offshore breakwaters may increase the rate of destruction of downdrift beaches since they interrupt the natural flow and deposition of sand. These impacts may be dramatic. Since offshore breakwaters intercept littoral drift and cause sand to deposit onshore updrift from the breakwater, erosion downdrift is common. Similarly, an adjacent property owner's groin may cut off the sand supply needed to maintain your town's beach. As noted above, sand may have to be artifically placed between groins to solve the sand supply problem.

(4) Availability of alternative approaches

Nonstructural approaches to beach replenishment and maintenance cost less, work better in many situations, and impose fewer hardships on downdrift beaches, than their structural counterparts. As a result, coastal communities should generally look first to regulatory programs to protect natural systems, and to vegetative and maintenance programs or beach nourishment approaches to strengthen existing natural systems. Only if these "natural" approaches have proven ineffective, or if they need to be supplemented, should engineering means to strengthen natural protection systems be considered.

SOURCES OF DETAILED INFORMATION

- The Conservation Foundation. Coastal Environmental Management; Guidelines for Conservation of Resources and Protection Against Storm Hazards. 1980.
  This guidebook offers a comprehensive set of physical management policies for coastal communities and a description of relevant federal and state programs. It includes recommendations for specific areas: coastal uplands, coastal floodlands, saltwater wetlands, banks and bluffs, dunelands, beaches, coastal waters and basins. The aim of the guidebook is to help communities create effective programs that conserve resources and, at the same time, protect property and life against natural hazards. Part I addresses principles and policies for ecological and hazards management and practical ways in which federal programs and laws affect implementation. Part II describes the current regulation and program structures of the federal agencies with major responsibility for the areas of environmental management.

- Department of the Army, Corps of Engineers. Shore Protection Guidelines. A Part of the National Shoreline Study. August 1971.
  These guidelines describe typical erosion control measures and present examples of shore protection facilities and criteria for planning shore protection programs. They are intended for general use by officials who are interested in suitable and economical methods of shore protection.

- U.S. Army Coastal Engineering Research Center. Shore Protection Manual Volume II. 1977.
  One of a two-volume publication (Volume I introduces more technical aspects of coastal engineering), this report describes planning analysis, structural features, physical factors of structural design, and case studies of shore protection. It is an extensive work which is fairly technical in nature and contains an extensive bibliography.

- Kaufman, Wallace and Pilkey, Orrin. The Beaches Are Moving: The Drowning of America's Shoreline. Garden City, N.Y. Anchor Press/Doubleday. 1979. 26 pages.

  This book offers a very readable discussion of the natural changing nature of the nation's shoreline. It begins with the effects of rising sea levels and continues with a description of the meterological, geological, and hydrological processes affecting beach dynamics. With this understanding as a base, the authors address the issues surrounding the use of engineering works for shore protection. Examples drawn from all the nation's coasts are used throughout. Advice on successful living with beaches concludes the book.

CHAPTER 5 STRUCTURES TO PROTECT AGAINST COASTAL FLOODING

One way to reduce damages from coastal flooding is to build structures that directly protect coastal development: seawalls, bulkheads, revetments.

In deciding whether structures are appropriate for your community, you should consider several factors, including:

- the availability of alternative protection measures
- effects on natural features and adjacent property
- costs of construction, maintenance, and reconstruction
- availability of financial and technical assistance
- insufficiency of structures in hurricanes.

KINDS OF STRUCTURES AVAILABLE TO PROTECT AGAINST COASTAL FLOODING*

Seawalls, bulkheads, and revetments are structures placed parallel, or nearly parallel, to the shoreline, to separate a land area from a water area. They are typically placed on the upper part of the beach. Historically, these structures have been the traditional response of coastal property owners -- individuals, commercial enterprises, and communities -- to flooding and erosion problems. The structures discussed in this chapter generally serve a dual purpose -- preventing or reducing coastal erosion, and reducing coastal flood damage -- and it is nearly impossible to consider one without the other. However, this chapter is concerned primarily with their direct or indirect effects on reducing coastal flooding. As noted in Chapter 1, a full treatment of coastal erosion control is beyond the scope of this handbook. A number of information sources that do specifically address coastal erosion are included in Appendix B.

*Derived from: Corps of Engineers, Shore Protection Manual, Volume II, 1975. Other kinds of structures -- groins and offshore breakwaters -- protect coastal development indirectly by protecting natural features. These are discussed in Chapter 3.

The distinction between seawalls, bulkheads, and revetments is mainly a matter of purpose. Specific design features are determined at the functional planning stage, and the structure is named to suit its intended purpose. Often the same type of structure in different localities bears a different name. Some general distinctions can be made, however:

- Seawalls are generally the most massive, and thus usually quite expensive. They are generally only suitable for special situations. The primary purpose of a seawall is to protect land and upland property from damage by waves in areas of high wave action, with incidental functions as a retaining wall or bulkhead.

- Bulkheads are usually smaller than seawalls and are built to retain fill. Unlike seawalls, they are generally not exposed to severe wave action. While the primary purpose of the bulkhead is to retain or prevent sliding of the land, it does afford some protection to upland areas against wave damage. There are three basic structural types of bulkheads -- concrete, steel, and timber.

- Revetments are generally the lightest type of the traditional structural shore protection devices and the least expensive. Like the seawall, revetments are designed primarily to withstand wave damage and control erosion, but in areas of light wave action or currents. Revetments are structurally of two types: rigid, cast-in-place concrete or flexible (such as stone riprap).

Shoreline conditions will affect the selection of a structural type for a seawall, bulkhead, or revetment. Foundation material must be compatible with the type of structure. For example, a structure that must penetrate the underlying foundation for stability is not suited to a rock bottom. In addition, the effect on the foundation of a seawall, bulkhead or revetment itself must be considered; they may induce bottom scour causing settlement

of the structure, and the initial placement and design of the structure must take this into account. As noted above, exposure to wave action also affects both the choice of structural type and design. For example, in areas of severe wave action, light structures such as timber crib or light riprap revetments should not be used.

Availability of materials, too, can be a major factor affecting the choice of structural type, as well as construction and maintenance costs. If materials are not available near the construction site, or are in short supply, a particular types of seawall or bulkhead may not be economically feasible.

Design considerations for seawalls, bulkheads, and revetments include: use and overall shape of the structure, location with respect to the shoreline, length, height, and stability of the soil, and ground and water level seaward and landward of the wall.

Table 2 summarizes the major advantages and disadvantages of these types of structures, as well as maintenance requirements.

FACTORS AFFECTING DECISIONS TO BUILD STRUCTURES

In deciding whether structures may be useful in preparing your community for coastal flooding, you should explore several factors:

(1) Availability of alternative protection measures

When a community's beaches have already been eroded away and the sea is approaching existing development, structures may be one of the few opportunities to reduce damage. To protect developed areas, some communities find it beneficial to build and maintain structures that are quite costly. (See box.)

Artificial construction of beaches and dunes and public acquisition of developed coastal properties are the other remaining opportunities to protect fully developed coastlines, and these options each have serious drawbacks themselves. (See Chapters 4 and 7.)

TABLE 2

SUMMARY OF SEAWALLS AND REVETMENTS

Vertical Seawalls of Flat Slab or Sheet Piles with Toe Penetration and Tie-Backs to Anchor

	General - Seawalls	Precast Concrete Slab	Steel Sheet Pile	Wood Sheet Pile	Massive Free-Standing Gravity Seawall
ADVANTAGES	a) Relatively fast construction time. b) Provides good protection for eroding or unstable shoreline. c) Low maintenance costs. d) Widely used. Experienced designers and contractors are available. e) Vertical face provides for easy mooring or lifting facilities for boats, or deeper water close to shore for fishermen.	a) See all advantages listed under "General - Seawalls." b) Concrete is usually more durable for the same or less cost.	a) See all advantages listed under "General - Seawalls." b) Steel has more strength per pound, requiring less tonnage of material transported to the job site. c) Often the only practical alternative where long piles are required. d) Steel may be driven immediately without curing, shortening the construction time. e) May be driven or jetted.	a) See all advantages listed under "General - Seawalls." b) Wood is usually the lowest cost material. c) Wood appearance blends better with natural surroundings. d) Wood is easier to cut and shape.	a) Provides protection from severe wave attack. b) Low maintenance cost. c) May provide suitable base for roadway or walkway along crest.
DISADVANTAGES	a) Structural security depends upon adequate i) toe penetration and protection ii) tie-back rod strength and anchorage iii) maintenance of supporting backfill behind the wall. b) Vertical walls induce scour at toe. c) Complex engineering design problem. d) Construction requires special pile driving skills and equipment. e) Limits access and use of beach. f) Incompatible with conditions required for some forms of natural animal and plant shore life.	a) See all disadvantages listed under "General - Seawalls." b) Concrete used in marine environment requires special skill in design and construction. c) Concrete slabs require either extra time for on-site curing or hauling heavy slabs from stock pile. d) Slabs usually jetted into place to avoid spalling or cracking under driving hammer blows.	a) See all disadvantages listed under "General - Seawalls." b) Subject to corrosion if not kept adequately coated. (Marine resistant steel composition and cathodic protection may reduce corrosion)	a) See all disadvantages listed under "General - Seawalls." b) Subject to attack by marine borers and fungi if not properly treated or coated.	a) Usually very expensive. b) Security depends upon adequate foundation and protection of foundation material. c) Downward component of deflected wave energy induces scour at the toe. d) Complex design and construction problems require special skills and equipment. e) Limits access and use of beach. f) Incompatible with some forms of natural animal and plant shore life.
COST	(All costs are estimated for a Construction Cost Index of 2100.	$43/LF to $130/LF	$220/LF to $330/LF	$60/LF to $120/LF	$300/LF to over $1100/LF

TABLE 2 - continued

Revetments

	General - Revetments	Precast Concrete Checkerboard Revetment	Stone Revetment	Revetment of Nylon Bags Filled with Cement Grout	Revetment of Stone-Filled Wire-Cage Gabions
ADVANTAGES	a) Usually the least expensive hardened protection for the shoreline. b) Constructed of individual articulating units able to accommodate some settlement. c) Provides sloping surface and more surface area on individual units to accommodate more forms of natural animal and plant shore life. d) Sloping surface is more acceptable to state agencies due to less adverse effect on shoreline.	a) See all advantages listed under "General - Revetments." b) Provides for access to beach over easily traversed slope. c) Indented pattern may trap sand and become covered with beach.	a) See all advantages listed under "General - Revetments." b) Natural stone provides most surface area for accommodation of marine shore life. c) Repairs often require only the addition of more stone. d) Rough surface is most effective in dissipating wave energy. Reduces wave run-up. e) Suitable for stage construction.	a) See all advantages listed under "General - Revetments." b) Requires only small equipment and mostly unskilled labor. c) Suitable for stage construction. d) Low initial cost. e) Rounded, non-hazardous surfaces f) Blends well with surroundings. g) Repairs are easy, add more bags.	a) See all advantages listed under "General - Revetments." b) No special equipment required. Suitable for do-it-yourself. c) Flexible, easily repaired. d) Low first cost.
DISADVANTAGES	a) The light armor facing depends for stability upon the underlying base. b) If surface is not sufficiently rough to dissipate the wave energy, the upward deflection of the sloping face may cause overtopping. c) If the filter fails, the underlying material is easily lost through the open joints. d) An underlying cushion of gravel over the filter cloth is required to prevent puncture by sharp projections on rough units or to prevent uplift under smooth units.	a) See all disadvantages listed under "General - Revetments." b) Units are light weight and depend on keying action for stability under wave attack. c) Gravel layer is required between concrete and filter to prevent uplift. d) Loss of supporting material may require disassembly of revetment to restore contour. e) Severe wave attack along Florida's east coast has led to some failures.	a) See all disadvantages listed under "General - Revetments." b) Hard dense igneous rock is not native to Florida and must be imported in scarce gondola cars causing extra expense and scheduling problems. c) Sharp projecting surfaces make beach access difficult and hazardous. d) Underlying gravel over filter cloth is required or rock may sink. e) Heavy equipment required for construction.	a) See all disadvantages listed under "General - Revetments." b) Smooth surfaces do not interlock. (Reinforcing rod dowels may be installed to compensate.) c) Smooth rounded surfaces may become slippery and hazardous for pedestrian footing.	a) Wire cage gabion subject to corrosion if coating not maintained. b) High level of maintenance effort often is required.
COST	(All costs are estimated for a Construction Cost Index of 2100.	$300/LF to $500/LF	$30/LF to $110/LF (about $25/ton)	$90/LF to $130/LF	$30/LF to $80/LF

Source: Collier, Courtland A. Seawall and Revetment Effectiveness, Cost and Construction. Florida Sea Grant Program. Report No. 6. May 1975.

BULKHEAD CONSTRUCTION: FAIRFIELD, CONNECTICUT

The town of Fairfield, Connecticut recently built an 800-foot timber bulkhead in order to prevent flooding of approximately 25 residential structures built on a barrier beach on Long Island Sound. Frequent flooding had been caused by the rising waters of Pine Creek. Built on the lee side of the sand barrier (facing Pine Creek), the structure is a wooden bulkhead combined with a 1000-foot earthen dike. The estimated cost of the bulkhead -- $300 per linear foot (1978 dollars) for a total of $240,000 -- was met with local funds. The town hired an independent structural engineer experienced in coastal construction and a private contractor to construct the bulkhead.

SEAWALL REPAIR: LONGPORT, NEW JERSEY

The state of New Jersey is preparing to repair a 3,700 foot long seawall in Longport. Built in the 1930's with state and local funds, this reinforced concrete seawall reaches 10 feet above mean low water. Years of wave action has caused the concrete to chip off the face of the wall, thus exposing the reinforcement rods. $41.2 million (50% state, 50% local) will be required to repair its 3700 foot length. The repair, which is expected to take 4 months, will include the raising of its elevation 2 feet along the entire length and the replacing of exposed reinforcement rods which have begun to erode. In addition to replacing the rods, six inches of concrete will be poured into the wall.

For a wholly undeveloped coastline, expenditures on structural measures are far less likely to be warranted. Regulations to protect undeveloped coastal hazard areas from inappropriate development may be quite effective (see Chapter 2), and beach and dune protection measures can be used to protect undeveloped shorelines from erosion (see Chapter 4). In cases where communities can meet important recreational needs by acquiring coastal property, acquisition provides still another alternative to structures (see Chapter 2).

On partially developed coasts where some beach remains, alternatives to structural protection include beach and dune protection ordinances, beach and dune replenishment and maintenance programs, and regulations to prevent inappropriate development.

(2) Effects on natural features and adjacent property

As discussed in Chapter 4, constructing shore protection devices inevitably interferes with natural beach building processes, often adversely affecting natural features and adjacent properties. These problems must be taken into account when considering the use of structures to protect your coast. While seawalls, bulkheads, and revetments afford protection to the land immediately behind them, they do not protect adjacent areas up- or downcoast. When these structures are built on receding shorelines, beach recession will continue and may even be accelerated on adjacent shores. Loss of beach material in front of such a structure also may increase. As a result, companion works may be needed to maintain a beach in the immediate vicinity of such structures, and sand replenishment measures may be needed to maintain the beach in front of the structure.

(3) Economic costs of planning, construction, maintenance

Initial construction of these structures is expensive. Seawalls may cost up to $800 per foot; revetments may cost up to $500 per foot. (See box.)

COSTS OF SEAWALLS AND BULKHEADS

The four most commonly built types of seawalls and bulkheads are constructed of concrete, steel, timber, or dumped rock, with concrete being the most expensive structures and dumped rock being the least expensive. Following are approximate estimates of 1980 costs per linear foot of construction in New England:

- concrete - $700 - $800 for height of 15 feet
- steel (sheeting) - $600 to $700 for height of 15 feet
- timber - $350 for height of 5 or 6 feet
- dumped rock - $175 for height of 7 feet

Periodic maintenance of these types of protective devices is critical to continued effectiveness of the devices to protect the shore. Even so-called "maintenance free" stone revetments must be carefully inspected at least twice a year; timber or concrete jetties or walls must also be carefully inspected. In some cases more material may have to be added to compensate for settling of the structure. Also, repairs may have to be

made following storms. The expense of continuously battling natural processes has prevented construction of some proposed structures and led to abandonment of others. These ongoing repair and maintenance costs must be considered as well.

(4) Availability of financial and technical assistance

Because costs often preclude communities undertaking this approach on their own, many have looked to the state and federal governments. Some states have programs to assist towns in protecting their coasts. The federal government has a program to help communities build shore protection stuctures, both to prevent flood damage from coastal storms and to prevent erosion. Such aid does not come quickly, however; the average waiting period in a recent study of Corps projects was found to be 18 years. Corps District Offices can be contacted to find out if your community has ever had a study of the feasibility of protection from hurricanes or coastal flooding. The Corps of Engineers may also be able to provide technical or planning assistance to communities considering the use of shore protection structures. Chapter 9 provides a brief description of how Corps programs work.

If a structural solution looks like a significant possibility for your community, engineering assistance to evaluate the structural option in more detail will likely be needed. The advice of a structural engineer experienced in the planning and supervision of coastal construction is essential in most cases. An experienced marine contractor will also be needed.

(5) Inability of structures to provide adequate protection from hurricanes

In many cases, structures large enough to protect against the storm surge generated by hurricanes are simply impractical. Even where it is technically feasible to build hurricane protection structures, only the storm surge is affected; hurricane protection structures offer no protection against wind. Finally, the possibility that storm surge will overtop the hurricane protection structure is always present. As a result, in addition to any structures your community invests in, your community will want to

consider promoting safe construction (see Chapter 4) and forecasting, warning, and evacuation plans (see Chapter 6) to reduce potential hurricane damages.

(6) Permit requirements

Prior to construction of bulkheads or other structures at or below the mean high water line, and prior to any excavation or filling between mean high water and the annual floodmark, a permit must be obtained from the U.S. Army Corps of Engineers. In many locations, state and/or local permits are required in addition to Corps permits. In most cases, the Corps will not process a permit application prior to state approval. Corps regulations give protection of wetlands a high priority, stating "Unless the public interest requires otherwise, no permit shall be granted for work in wetlands." State agencies may impose strict standards on coastal construction, even where such construction meets Corps permit requirements.

SOURCES OF DETAILED INFORMATION

- Collier, Courtland A. Seawall and Revetment Effectiveness, Cost and Construction. Florida Sea Grant Program. Report No. 6. May 1975. This publication is designed to give owners of waterfront property an easily-understood reference guide explaining the types of shore protection structures that are commonly available, as well as the relative merits and costs of each.

For additional sources, see those listed in Chapter 4

CHAPTER 6 FORECASTING, WARNINGS, AND EVACUATION PLANNING

One method of reducing threats to life and property from coastal storms is to adequately inform coastal residents of an approaching storm and to help people most vulnerable to the storm leave the exposed area through:

- forecasting and warning systems
- evacuation planning
- public awareness programs

In deciding how to use these methods, you should consider several factors, including:

- benefits
- other current planning and awareness efforts
- data availability
- cost
- availability of assistance
- physical feasibility

One of the most important tools available to your community to save lives in the event of a hurricane or other disastrous storm is the ability to warn residents of an approaching storm and to evacuate those in most danger. With adequate forecasting and warning time, many emergency measures can be put into effect in anticipation of huricane winds and flooding. Emergency measures include evacuation, provision of shelter, and rescue operations, as well as emergency floodproofing or preparing structures to resist wind damage.

Local governments should play a major role in developing evacuation and shelter plans and in disseminating information to the public on the nature of the hurricane hazard, as well as on hurricane warnings and evacuation plans, both prior to and during a hurricane. Generally, the more localized a warning and evacuation plan is, the more effective it will be.

The illustrations in the Introduction show how vulnerable many coastal communities are to being hit by hurricane force winds and storm surge. Portions

of many coastal communities are low-lying, heavily developed areas where alternative approaches to reducing damage from hurricane wind and storm surge are simply not possible. It may be too late to control development (except new development) through restrictive regulations; acquisition of numerous developed properties would be prohibitively expensive. In these areas, providing enough advance warning to allow people to evacuate high hazard areas, in accordance with a plan to guide the evacuation, may be the only feasible solution. In addition, providing information to coastal residents about the community's vulnerability to hurricanes in advance of such a disaster is important. Increasing public awareness of the hazard beforehand can lead to better response to warnings and evacuation advisories in the event a hurricane does strike.

FORECASTS AND WARNINGS

Kinds of Forecasting and Warning Systems

Warnings enable both coastal residents and government agencies to take appropriate actions before the hurricane occurs. If residents of a hurricane hazard area are warned sufficiently in advance, they can evacuate their homes or businesses, move some possessions to upper levels of the structures, or take other appropriate actions.

NOAA's National Weather Service (NWS), through its National Hurricane Center in Florida, takes the lead in issuing hurricane forecasts and warnings. The national hurricane warning system provides information on the anticipated time and location of hurricane landfall, as well as the severity of flooding and storm surge that can be expected. (See box.) However, local agencies are responsible for assuring that local residents are made aware of the situation and informed of what to do to assure their safety in the event a hurricane does strike.

Even NWS's sophisticated warning system is limited: 24 hours or less before anticipated landfall, about 300 miles of coastline will be placed under warning (the average landfall forecast error at 24 hours is 100 miles).

NWS HURRICANE ADVISORIES

The National Weather Service weather advisories include two types of releases on approaching hurricanes:

- A HURRICANE WATCH is issued 36 hours or less before expected landfall (although it may be issued 48 hours ahead of anticipated landfall before weekends or holidays). It alerts officials and residents that a hurricane poses a possible threat to coastal and island communities.
- A HURRICANE WARNING is issued 24 hours or less before (a) sustained winds of at least 74 miles an hour and/or (b) dangerously high water or a combination of high water and exceptionally high waves (even though winds may be less than hurricane force) are expected in a specified coastal area.

Often, coastal residents are unwilling to evacuate their homes until it is too late. Rising storm waters can flood coastal roads used for evacuation routes long before the worst part of a storm strikes. For these reasons, the effectiveness of hurricane warnings and evacuation plans depends upon how well the community has made the public aware of the hurricane hazard, how effective the local government is in spreading the actual warnings, the time available, and the actions taken in response.

Coastal offices of the National Weather Service (NWS) issue Local Statements which inform the public about current and anticipated storm effects and serve to expand on the information in the Hurricane Advisories and Bulletins. Local Statements, Advisories and Bulletins are available to the media and state and local officials via a dedicated teletype system known as NOAA Weather Wire and/or continuous radio broadcasts known as NOAA Weather Radio. Information is available directly to any individual through NOAA Weather Radio. As circumstances permit, information is passed directly from the local NWS office to the appropriate local government official by telephone or local radio communications.

The manner in which warnings -- including advisories to evacuate -- are then provided to local residents varies considerably from town to town. In many areas, the amount of official and unofficial information is a source of confusion to local residents, who may hear conflicting information passed on by radio

or TV and who have no central information facility to contact. To avoid confusion, it is essential for local officials and the media to agree on a central source for official information during disasters. The local civil defense coordinator or other appointed agency or individual may take charge of transmitting official warnings and evacuation orders to the broadcast media (radio, TV, newspapers). For example, in Lee County, Florida, local disaster preparedness officials keep in touch with the National Hurricane Center and the state Office of Disaster Preparedness, and issue (over local radio and TV) local action statements that include directions to residents on evacuation and shelters. The local police or fire department may play a role in touring coastal neighborhoods to advise residents to leave, or a telephone system of passing warnings along may be utilized. Telephone systems are vulnerable to disruption during storms, however, unlike radio communication systems.

Factors Affecting Decisions to Use Warnings Systems

In deciding whether to implement or improve a local warning system, you should consider several factors:

(1) Benefits

Providing adequate advance local warnings of an approaching hurricane can reduce significantly the chances of damage to property and threat to human life. While NOAA is responsible for providing reliable forecasts of hurricane landfall and expected storm surge, a local system for effectively and clearly communicating warnings can assure that local residents are forewarned of the danger and are able to take necessary precautions. Properly informed residents taking even simple measures -- such as removing outdoor furniture -- can reduce damages significantly, in this case from flying debris.

(2) Legal considerations

Until recently, few communities have had to deal with issues of legal responsibility for providing reliable local flood warnings or of public liability for damages following inadequate warnings. However, changing

notions of governmental liability may make these problems more common in the future. Also, there may be challenges to the legal authority of local officials to order individuals to leave their homes and businesses; often people are simply advised to leave instead, with the the final decision to evacuate left to the individual.

EVACUATION PLANNING

Types of Evacuation Plans

An evacuation plan generally addresses three basic elements of emergency response: warnings, the logistics of evacuation itself, and the provision of shelters.

- Warnings. The plan should address all the elements of warning transmission discussed above -- how NOAA hurricane forecasts will be received and transmitted by state and local agencies, who will be responsible for making these known to the general public (e.g., through the broadcast media), how the emergency communication system will work, how the public can confirm information, who issues evacuation orders and how, etc.

- Evacuation. The plan should address, as specifically as possible, when and how evacuation will take place, what evacuation routes should be used, and how residents can get to shelters and refuges most easily.

- Shelters. The plan should provide specific instruction as to when public shelter should be sought, who provides usable shelter space, who is responsible for shelter preparedness and management, specific shelters for specific neighborhoods, etc.

Other issues, too, need to be addressed in an evacuation plan, including: local resources to be called on in the event of an emergency, coordination among private and public agencies, and ways to evaluate a program once it is put into effect.

Some areas (including Miami and New Orleans) have considered "vertical evacuation", namely the use of high-rise buildings in hazardous areas near the shore as an alternative or adjunct to evacuation inland. However, this approach is generally

considered only as a last resort due to a number of serious concerns, primarily unresolved questions of liability (e.g., municipal liability to owners of buildings used in the event of damages incurred), difficulty in locating suitable, structurally-sound buildings (e.g., ones outside of the high-velocity zone), and the possibility of discouraging earlier evacuation to safe inland shelters.

As noted above, the role of the community is critical to the success of storm warnings and evacuation. Actual arrangements for preparation of evacuation plans may vary from place to place:

- local areas may prepare plans on their own
- local areas can undertake evacuation planning with state help
- local areas can undertake evacuation planning with federal help
- a local area may be covered by a regional warning/evacuation plan
- a local area may be covered by a state-wide emergency plan which deals with warnings and evacuation.

Regardless of the particular arrangements used, local involvement in plan preparation is an important key to plan success.

TAMPA BAY REGION, FLORIDA: HURRICANE EVACUATION PLAN (JUNE 1981)

The Tampa Bay Regional Planning Council has prepared a comprehensive regional hurricane evacuation plan for the 4-county Tampa Bay region, one of the areas of the nation most vulnerable to hurricanes and tropical depressions. Intended to provide a model for multi-county evacuation planning, primary funding was provided by the Jacksonville District Corps of Engineers through its Floodplain Management Services Program, with additional funding from NOAA and participating local governments.

Initiated in January 1980, the Plan provides a quantitative regional framework for implementation by the local governments. The technical report, developed in large part through computer modeling, includes: analysis of potential hazards, identification of vulnerable areas and populations, delineation of evacuation zones, behavioral tendencies of potential evacuees, analysis of shelter stability and capacity and procedures for overall coordination. The Regional Plan also includes four county implementation reports and public awareness tabloids.

The Plan was successfully tested during an exercise in May 1982. Beginning in October 1983, revisions are to be considered in response to increases in population, changes in transportation, and in shelter availability, as well as in response to new hurricane hazard analysis techniques.

Factors Affecting Decisions to Prepare an Evacuation Plan

In deciding whether your community needs to prepare a local evacuation plan, you should consider several factors:

(1) Benefits

The benefits of having an effective evacuation plan are substantial, though often hard to measure precisely. Reduced loss of life is certainly the major objective of evacuation planning. During Hurricane Camille in 1969, for instance, 175,000 people were evacuated from along the Gulf coast. Although 6,000 homes were destroyed by the storm and another 30,000 damaged, there were only 150 fatalities. It has been suggested that this figure would probably have been in the thousands if not for the wide-spread evacuation that took place. In 1980, the evacuation prior to the landfall of Hurricane Allen was wide-spread and effective. (See box.)

(2) Integration with other local efforts

A variety of types of emergency response planning may be undertaken by coastal communities in addition to hurricane evacuation planning, including planning for hazardous materials emergencies, crisis relocation planning, and planning for nuclear reactor emergencies. Significant savings in cost and labor can result from coordinating these emergency response planning efforts. In some instances, identical tasks must be performed for each kind of plan (traffic studies for instance) and, with adequate coordination, need be done only once. (Of course, each kind of plan also involves unique tasks, and one cannot be substituted for another.)

(3) Availability of data

The nature of an evacuation plan may vary considerably from place to place, depending on the amount of technical data available for plan preparation, as well as the level of technical detail desired by the community. If state and/or federal help is available, an evacuation plan based on detailed analysis of storm surge probabilities, expected flood heights vs. elevation of possible evacuation routes, population, evacuation traffic that can be expected with various lead times, and other factors can be

prepared. Routes to shelters for various sectors of town can be mapped and detailed information distributed to all residents of coastal hazard areas.

EVACUATION IN THE TEXAS COAST: HURRICANE ALLEN

When Hurricane Allen threatened to strike the Texas coast in August 1980, surprising numbers of coastal residents took early heed of warnings and prepared for the storm's arrival; many others evacuated the area, in many cases well before the hurricane warning was issued. Although Allen never did strike the coast with its full fury, the experience is a valuable one.

FEMA is conducting a study of the public's response to Hurricane Allen. Some of the preliminary findings are as follows:

- The public seemed to be quite willing to evacuate the area well before being encouraged to do so by officials and the posting of a Hurricane Watch. Such willingness may be attributed to the area's experience with a major hurricane ten years earlier, plus the publicity Allen received as being a major storm of record proportions. Thousands of people -- such as those living 20 miles inland and 30 feet above sea level -- may have fled from relatively safe dwellings in search of even safer shelters.
- Preliminary figures indicate that over 70,000 people moved into over 194 shelters, while another 200,000 people left the coast to stay overnight in motels or in the inland homes of friends and relatives.
- Generally, the public appeared to be better prepared and more responsive to the changing situation than the officials and government entities. Fortunately, "Allen" was a gentleman, and the selective track of the storm failed to expose the lack of comprehensive emergency preparedness of a few governmental organizations.

(Disaster Information, FEMA, September 1980)

However, a few problems were also apparent. FEMA's study has noted that since a number of coastal shelters did not open until late in the day (after many coastal residents had left the area) or because the shelters' locations were not known, many people evacuated several hundred miles northward rather than utilizing nearby shelters. Also, some residents unknowingly evacuated from one danger area to another because of a lack of information about the extent of the watch/warning area.

Ideally, every community would have an evacuation plan based on reliable engineering and technical data. Plans prepared with an adequate data base increase the likelihood of efficient evacuation in all the necessary circumstances, and in only the most necessary situations. However, many coastal communities may find themselves unable to obtain outside help for evacuation planning and with limited local technical capabilities, but still wishing to do something. In these cases, minimal action may still be possible; this could include identification of a few shelters that are clearly on safer ground, and designation of local police or fire departments to issue evacuation advisories.

(4) Cost

The costs of preparing a hurricane evacuation plan can vary widely depending on the availability of technical data (on vulnerability, storm surge, etc.), the level of detail to be included, and the area covered by the plan. As an example, Lee County, Florida's evacuation plan, which covers an area of 785 square miles, cost approximately $45,000 and took about one year to prepare. The Southwest Florida Regional Evacuation Plan, prepared with assistance from the Sea Grant Program and the Office of Coastal Zone Management, covers 6,663 square miles and cost $115,000 to prepare, including federal and local matching funds.

(5) Availability of assistance

Local officials wishing to develop or revise a local evacuation plan are most likely to encounter problems obtaining all the technical data required to prepare adequate evacuation plans. As a result, state or federal assistance is often sought in preparing an evacuation plan -- both as a source of funds for obtaining data and a source of technical assistance in developing needed data. For example, NOAA has prepared maps that show coastal routes that will be inundated at various levels of storm surge for most of the Gulf and Atlantic coasts. NOAA has also prepared storm simulation models in a few areas to illustrate the coastal storm surges and inland flooding that can be expected from hypothetical storms and based on historical storm tracks. Studies are now complete for Tampa Bay, Lake Ponchatrain, Charlotte Harbor in Florida and Galveston, Texas. In addition, NOAA's

Coastal Hazards Program can provide various kinds of technical assistance in risk analysis, coastal mapping, etc. The Corps of Engineers has prepared detailed evacuation plans for a handful of areas across the country, including Lee County, Florida (see box). FEMA's Hurricane preparedness program provides financial and technical assistance for the entire preparedness effort. This preparedness program has assisted in Tampa Bay and the coastal counties of Georgia and includes involvement in twenty High-Risk High-Population areas through FY 1989.

LEE COUNTY, FLORIDA, FLOOD EMERGENCY EVACUATION PLAN

The Lee County Flood Emergency Evacuation Plan was prepared by the Jacksonville District of the Corps of Engineers and the Southwest Florida Regional Planning Council at the request of the Board of County Commissioners of Lee County. It was published in May 1979. The Florida Division of Disaster Preparedness and the Lee County Disaster Preparedness Coordinators also cooperated in preparing the plan.

This Flood Emergency Plan consists of three documents:

- A public information handout describes courses of action that residents should take in event of a hurricane. Flood emergency maps are included which describe evacuation routes, break down the county into evacuation zones, and detail routes to Red Cross shelters. Important telephone numbers and addresses are included.
- An implementation plan provides for an orderly and coordinated emergency system to minimize the effects of flooding on residents and visitors of Lee County, Florida. It is designed specifically for use in hurricane situations and addresses three elements of emergency response: warnings (a comprehensive system for on-going public information, early recognition of impending storms, and public dissemination of emergency warning); evacuation (a countywide procedure for orderly evacuation); and shelter (a comprehensive system of shelters of adequate capacity and accessibility).
- A technical data report establishes guidelines and makes recommendations for the successful implementation of the evacuation plan. The report includes: recommendations for the future development of a postflood recovery plan for Lee County, guidelines for periodic review and updating of plan elements, recommendations for testing and evaluation of plan elements through local simulation procedures.

This plan is now being updated as part of the Southwest Florida Regional Evacuation Plan.

(6) Physical feasibility

Some hurricane prone areas may be so physically situated that, if population increases, evacuation may be physically impossible in the amount of time

usually available once warnings are issued. Some communities facing this problem have attempted to limit growth in hurricane prone areas to the extent of their capabilities to evacuate the residents. Sanibel Island, off Florida's Gulf Coast, determined how many people could be safely evacuated off the island during the approach of a "typical hurricane", then established policies and regulations that limit population growth and future development in keeping with this capacity to evacuate. (See box.)

SANIBEL ISLAND: GROWTH LIMITATIONS VS. EVACUATION CAPABILITIES

Although Sanibel Island is part of Lee County, Florida (for which the Corps completed a detailed evacuation plan in 1979), the City of Sanibel has its own Emergency Preparedness, Evacuation, and Relief Team (EPERT) plan for Sanibel and Captiva Islands. Sanibel's EPERT plan (which pre-dated the County-wide plan by three years) includes sections on notification procedures, evacuation routes, and shelters to be used. Evacuation instructions are also reprinted periodically in the local newspaper.

The unique aspect of Sanibel's evacuation plan is its relationship to growth limitations on the island. Sanibel Island is a 12-mile long barrier island with an average ground elevation of five feet of less. Evacuation into elevated buildings was considered unacceptable, except as an emergency measure, due to the probability of isolation and hazardous conditions after a storm. There is one evacuation route -- a causeway to the mainland, which connects to an evacuation route also used by mainlanders. In light of these factors, local officials decided to plan for evacuation of all persons on the island in the event of a hurricane warning.

Planners determined the number of people that could be safely evacuated from the island in a "typical hurricane" (based on warning time and timing of potential flooding or other blockage of the evacuation route): a total of 4900 to 6250 cars, depending on the severity of the storm. (In addition, it was determined that an evacuation order was needed 15 to 19 hours before landfall, depending on storm intensity, to safely evacuate the island's inhabitants.) A population density ceiling based on that figure was adopted, along with a rate-of-growth ordinance allowing only 180 new units to be built per year, through the next 20 years, in order not to exceed the population limit.

As a result, The Sanibel Plan for development of the island includes an element on hurricanes, which incorporates detailed policies and plans on evacuation, population limit; on-island refuge, building codes, and capital improvements.

This evacuation plan is now being updated to include hazard mitigation techniques. See page 96.

"Vertical evacuation" deserves consideration in very developed areas where evacuation of the entire exposed population is physically not possible, or as a contingency plan used, for example, when a hurricane shifts unexpectedly and there is not enough time for inland evacuation. However, there are many serious problems with "vertical evacuation". One critical concern is the need to select buildings that are structurally sound and can be expected to withstand hurricane forces. Certifying the structural integrity of high-rise structures may be very difficult. The possibility of partial failure, such as extensive breakage of windows must be considered as well. Following the hurricane, high-rise structures in hazardous areas, such as barrier islands, may be in a highly vulnerable situation, for example, isolated by flood waters from medical help. Another problem is that the existence of high-rise shelters may encourage residents to stay in the hazardous area, thinking that there is a safe last-minute shelter, rather than evacuating inland. Vertical evacuation thus should be considered only as a last resort for most communities.

PUBLIC AWARENESS

Informing and Convincing the Public

Making the public aware of warning systems and evacuation plans, as well as your community's vulnerability to hurricanes, is particularly important. It is advisable to use a wide variety of methods to increase public awareness: radio, TV, disaster pamphlets, and so on. Public information materials usually include general information on what to do in case of a hurricane and maps of evacuation routes and shelters. The kinds of information and the ways they are distributed to the public will vary. (See box.)

Factors Affecting Decisions to Increase Public Awareness

In deciding whether your community should take steps to improve public awareness of the hazard from hurricanes and other coastal storms, you should consider the following factors:

(1) Benefits

Public response is absolutely essential to the success of any evacuation

plan. Preparing the best possible evacuation plan will help no one if your town's residents do not pay attention to it. As a result, efforts to improve public awareness of your town's action plan for disaster will likely be of great benefit. Even if your town has only a minimal plan or no warning system or evacuation plan, providing information to residents on basic hurricane preparedness (e.g., publication of standard printed material in the local newspaper or telephone book) can be beneficial.

PUBLIC AWARENESS INFORMATION

The Lee County, Florida evacuation plan includes (in addition to technical reports) a brief but comprehensive public handout on flood emergency evacuation, with the following information:

- who will most likely have to evacuate
- how residents will be informed
- step-by-step instructions on what to do if evacuation is ordered or if it is not
- preparedness tips for the season
- telephone numbers and addresses of shelters and refuges
- detailed maps and instructions on routes to shelters and routes to leave county.

This information is printed annually in all major newspaper hurricane supplements, and will be distributed from fire stations, government offices, and other appropriate public places as well.

Baytown, Texas distributes brochures on elevation and hurricane information, on what to do before, during, and after a storm, and maps at a scale of approximately 1:43,000 which show areas of rain flooding and tidal flooding and possible escape routes.

(2) Current level of awareness

Your town's residents may or may not have much awareness of how exposed they are to severe coastal storms. If your town has recently experienced a major hurricane, awareness will probably be high, but recent experience in some cases may discourage evacuation depending on the results of the experience. For example, residents of Cameron Parish, Louisiana were reluctant to evacuate during Hurricane Audrey in 1957 because they had successfully weathered earlier storms. Reluctance to evacuate was one of several mistakes leading to the death of close to 500 people.

On the other hand, if your town has not had a major hurricane in a number of years or if your town has many residents who have recently relocated from inland areas, many residents may be complacent or too young to remember the last storm. For this reason, distribution of materials at the beginning of the hurricane season is especially important. If your town has recently experienced rapid growth or has a large tourist population from non-coastal areas, public awareness activities are even more important.

(3) Costs

The cost to conduct a hazard awareness program can vary considerably, depending on the types and quantities of materials to be distributed and methods of distribution. The most basic steps can be taken at a minimal cost -- for example, making hazard awareness pamphlets from FEMA NOAA or the Red Cross available in public places or printing standard hurricane preparedness information in the local paper. If your town decides to undertake a more active public awareness program, and disseminate specific information on the hazards in your town, costs will be higher.

(4) Availability of assistance

Federal agencies, primarily NOAA and FEMA, as well as the Red Cross have a variety of materials on coastal hazards already available, ranging from standard information applicable everywhere on the coast to materials which can be used as a guide in tailoring your own program. Your state also may have prepared pamphlets or brochures for distribution or make technical or financial assistance available to local areas. Federal programs too may be a source of technical or financial help, including training and education programs in emergency management. These are described in Chapter 9.

THE ROLE OF THE RED CROSS

When hurricane winds or high tides begin to cause damage to land areas, Red Cross chapters along with national and division volunteers and paid staff assigned to the affected districts provide emergency mass care and emergency relief. Emergency mass care assistance includes food for disaster victims and emergency workers, temporary shelters, clothing, medical and nursing aid including blood and blood products. Once disaster victims can resume living as family units, the Red Cross will provide emergency assistance in the form of food, clothing, rent, transportation, temporary home repairs, medical and health needs, selected furnishings, and personal occupation supplies and equipment. Also, the Red Cross will help families apply for government-funded assistance for other recovery needs. The Red Cross district headquarters is responsible for establishing appropriate contact with local officials within each Red Cross chapter's geographical jurisdiction. The Red Cross often works closely with local governments and civil defense and emergency services agencies in disaster planning activities.

SOURCES OF DETAILED INFORMATION

- Baker, Earl J., editor. Hurricanes and Coastal Storms: Awareness, Evacuation, and Mitigation. Papers presented at a National Conference held in Orlando, Florida on May 29-31, 1979. Report No. 33, Florida Sea Grant College, April 1980.

  This series of papers was presented at a national conference which was cooperatively sponsored by FEMA, the Florida Sea Grant College, the Florida Bureau of Disaster Preparedness, the Florida Bureau of Beaches and Shores, the Florida Office of Coastal Management, Florida State University, and NOAA. The areas covered by these papers are warning and evacuation, local disaster response planning, the National Flood Insurance Program, land use and growth management, coastal construction, post disaster hazard mitigation, hurricane perception and awareness, public participation in policy formation, and computer models of disaster effects.

- Davenport, Sally S. and Waterstone, Penny. Hazard Awareness Guidebook: Planning for What Comes Naturally, Texas Coastal and Marine Council, October 1979.

  This guidebook is based on a national Hazard Awareness Workshop held in

Corpus Christi, Texas, March 22 and 23, 1979. It provides guidelines for future awareness efforts concerned with earthquakes, hurricanes, floods, tornadoes, or the other natural hazards with which people must learn to cope. It describes who should initiate a hazard awareness program, what the program should include, and ways to evaluate its effectiveness. Appendices include sample programs and questionnaires.

- U.S. Department of Commerce, National Oceanic and Atmospheric Administration. "Disaster Preparedness, Publications, Films, and Other Audio Visual Materials from the National Weather Service". June 1980.

  Lists and describes materials prepared by NWS which can be used in public education and awareness campaigns. Explains how to obtain the publications, films, etc.

The Federal Emergency Management Agency and National Oceanic and Atmospheric Administration "Hurricanes Awareness Resource Kit."

The Hurricane Awareness Resource Kit offers cloud charts for weather prediction, boat owner hints, hurricane tracking charts for schools and homes, preparedness tips for business and industry, and flood damage and tax form data. The Resource Kit can be the seed for an effective local Hurricane Safety Campaign. It has been compartmentalized for instant reference, including such specialized items as a program planner's package, based on practical field experience; media background materials; and camera-ready art for campaign leaders. The elements of the kit also include a mobile home owner's guide, industrial hurricane programs, safety checklists, hurricane posters, and storm survival tabloids. Radio, television spots, and feature articles are also important components of an awareness campaign, and FEMA has provided samples of regional PSAs for adaptation.

CHAPTER 7 RELOCATING HURRICANE AND FLOOD VICTIMS: ACQUISITION OF DEVELOPED AREAS

One method of reducing damages from hurricanes or other severe storms is to acquire developed coastal properties and relocate residences or businesses to safer areas.

In deciding whether to acquire developed coastal properties, you should consider several factors, including:

- post-disaster opportunities
- availability of alternatives
- cost
- availability of assistance
- multiple benefits

ACQUIRING DEVELOPED COASTAL PROPERTIES

The effectiveness of acquiring undeveloped coastal areas as a tool to manage coastal hazards is discussed in Chapter 2. Your community may also want to consider acquiring developed high hazard areas that are subject to severe damages or repeated damages. Acquisition of developed properties that are vulnerable to damage from hurricanes and other severe storms can be used to break the cycle of damage and rebuilding, and at the same time provide coastal recreation areas or open space for your community. But, acquisition of coastal property -- particularly developed shorefront property -- can be very expensive.

FACTORS AFFECTING DECISIONS TO ACQUIRE DEVELOPED COASTAL PROPERTIES

Although acquisition of hurricane-prone areas offers many potential benefits, your community will have to consider a number of factors in deciding whether to acquire these types of properties:

(1) Post-disaster opportunities

Communities most commonly consider acquiring developed coastal properties after they have been damaged by a hurricane or other severe storm. At that time, the costs of acquisition can be weighed against the available alternatives -- primarily rebuilding as before or rebuilding to stricter standards. Even though community resources are already stressed by the need for emergency services, the post-hurricane period may be a most opportune time for a community to initiate acquisition of coastal properties. (See box.)

The weeks following damage to structures from a hurricane or major storm provide special opportunities to communities interested in acquiring developed properties primarily because owners of flood-prone properties are most likely to be interested in selling during this period of heightened awareness of risk. The community may further encourage the sale of property by imposing stringent construction standards on those who decide to rebuild. Often, the sites of damaged structures are concentrated in a few areas, increasing their attractiveness to local governments considering acquisition.

Acquisition can also help trapped property owners. Some owners of flood-damaged property would like to move to safer ground but are unable to find private buyers for their property, so they are trapped into rebuilding on the same site -- where they may well be flooded again. Public purchase can enable these owners to move out of the hazardous area.

(2) Availability of alternatives

As noted above, your community is most likely to consider acquisition of developed properties after they have been damaged. The alternatives to acquisition in the post-disaster situation are limited: rebuild to pre-flood conditions, rebuild to meet safer standards (e.g., floodproof or elevate the structure), or set the structure a safer distance back from the shore.

GULF SHORES, ALABAMA: POST-HURRICANE ACQUISITION

Approximately 3,000 people live year round in Gulf Shores, Alabama, the central town on a 32-mile long barrier island known as Pleasure Island (increased from 909 in 1970). Another 1.5 million people visit the area each year. In September of 1979 Hurricane Frederic caused extensive damage in Gulf Shores destroying 400 structures and substantially damaging 50 more. The availability of funds shortly after Frederic struck permitted Gulf Shores to acquire valuable beachfront property for public use. Town officials worked with federal agencies to acquire several pieces of shorefront property and to prepare a plan for managing them:

- Through its "1362 Program", the Federal Emergency Management Agency (FEMA) acquired five formerly-developed beach properties (in the V-zone). These properties contained 15 building lots. The purchase added 200 feet to the public beachfront. The total cost of acquisition of the properties, which are between a narrow town-owned beach and the coastal highway, was $1,068,000 for the 3.5 acres. Titles were transferred to the town in November 1980.

- The Heritage Conservation and Recreation Service (HCRS) approved the town's application for $372,000 in Land and Water Conservation Fund monies to acquire another piece of property that was ineligible for the 1362 Program. A private foundation is providing the local matching share for the HCRS grant.

- The Office of Coastal Zone Management (OCZM) agreed to pay up to $25,000 through the Coastal Zone Management Program for the town to develop a Master Plan for re-use of the area, including the development of long-range acquisition goals.

In addition to the acquisition and related planning, the town adopted stricter floodplain regulations, including requirements for deeper pilings, bracing of pilings and incorporation of wave heights into elevation requirements. Stricter enforcement of regulations was also instituted.

Although rebuilding of damaged structures in hazardous areas may be permitted by your town's floodplain or zoning regulations, stricter controls than those which governed earlier construction will likely apply. For example, a rebuilt structure may have to be elevated above wave heights or meet new building code requirements on wind resistance. Or, a

rebuilt structure may now have to be set back a greater distance from the shoreline, requiring new foundation work.

Rebuilding may make the property less prone to future damage of one sort, but more likely to be damaged in other ways. For example, depending on the nature of local regulations, elevation of a structure may reduce future damages from storm surge, but increase the likelihood of wind damages by increasing exposure to wind.

In many instances, regulations can complement acquisition in a community's program to reduce damages from coastal flooding. This can happen in at least two ways:

(a) regulation of hazard fringe areas may be combined with acquisition in areas of extreme hazard to provide protection to the entire coastal hazard area. (See box.)

(b) strict regulations in high hazard areas may encourage the sale of coastal properties to local governments by increasing the cost of rebuilding.

(3) Multiple benefits

Since the cost of public acquisition of developed coastal property is often so high, it is generally most effective when used in conjunction with funding programs that serve broader community goals, such as recreation or community development, and when used in combination with a variety of other hurricane and flood damage reduction techniques, such as warnings, regulations, etc.

As noted in Chapter 2, acquisition of undeveloped coastal hazard areas may provide numerous benefits to your community -- increased recreation, open space, wildlife habitat, and others. Acquisition of developed coastal hazard areas may also serve these and other related community goals as well as eliminate future damages. Where acquisition results in the conversion of a developed shore to an undeveloped area, public benefits often include, among others, reduction of public expenditures

for roads and sewer lines, and reduction of public expenditures to reduce erosion caused by inappropriate development.

Acquisition of developed properties provides an additional benefit beyond those obtained by acquiring undeveloped properties: it can help communities correct past mistakes. Experience shows that many structures in floodplains should simply never have been built there. Regulations can control future development in unsafe locations, but they can't remove already existing development. Acquisition, however, can.

WARWICK, RHODE ISLAND: ACQUISITION COMBINED WITH COASTAL FLOODPLAIN ZONING

Warwick, Rhode Island is a coastal town of 86,000, with a comparatively long history of response to its coastal storm hazard. Warwick has focused its efforts on a two-zone regulatory approach, along with selective acquisition for recreational development.

A 1957 zoning ordinance prohibited rebuilding and new building in areas of extreme danger (roughly identified as areas devastated by a 1954 hurricane). Additional construction requirements were added to the zoning ordinance for areas of danger not subject to high velocity waves, but all prior uses remained acceptable in this backlying zone in the revised ordinance.

Rhode Island's Shore Development Act of 1955 authorized State participation in acquisition of hurricane danger areas. The Oakland Beach area of Warwick was certified as eligible, but a local bond issue for the acquisition failed by a narrow margin in 1957. Twelve acres were purchased without state assistance in 1958, and in 1961 a local bond referendum was finally passed and the state condemned the remaining 15 acres in 1963. The city purchased the lots from the state that same year and initiated the Oakland Beach Park project. Development of the Oakland Beach area, including 2500 feet of shore frontage, began in 1975 with funds from another local bond issue and from the Land and Water Conservation Fund. Parking and picnic facilities have been constructed at the rear of the beach area.

Improved beach access through previously developed areas is another important benefit. If developed coastal properties are acquired only after storm damage has occurred, it is likely that some individual

isolated parcels will be available for purchase. While acquiring scattered properties may make maintenance difficult, it can be very useful in providing needed access to the coast at a number of places.

(4) Costs

Acquisition of developed shorefront property is likely to be costly -- even more so than the purchase of undeveloped open space along the coast. It is possible, however, that costs will be lower after a disaster, for example, if a structure is nearly or completely destroyed. In any case, state or local funds alone may be insufficient, even to meet the matching share required by many federal acquisition programs. In addition, the community will likely need to estimate the costs and benefits of acquisition compared to other alternatives, such as rebuilding.

The community can reduce some of these costs by selectively acquiring only highly vulnerable areas, for example, or, as noted above, by packaging state or federal funding programs that serve multiple goals.

(5) Availability of assistance

Your community will have to consider the availability of both financial assistance to acquire coastal properties and technical assistance to undertake such projects. Since local funds alone may be insufficient to acquire coastal properties, state and federal programs are often looked to for supplemental assistance. Funds specifically earmarked for acquisition of developed floodplain properties are limited to a single program: FEMA's 1362 Program. However, a number of federal assistance programs that have, in the past, been used for traditional types of disaster assistance -- such as loans to rebuild a structure -- may now be used for relocation and/or acquisition itself in many cases. Low-interest loans from the Small Business Administration, for example, have recently been used to relocate structures from hazardous areas.

Like open space acquisition programs, an acquisition program focused on developed properties that is designed to serve multiple community goals has a wider range of possible funding sources. Community development block grants, for example, could be used to acquire hazard-prone properties that are not eligible for acquisition under FEMA's 1362 Program but contribute to an overall community development scheme. Other possible sources include Land and Water Conservation Fund monies, Fish and Wildlife Restoration funds, and similar programs for beach access, open space, etc.

The community may also want to consider private sources of funding, although these are likely to be limited also. Encouraging donation of privately-owned residential or commercial properties damaged by a hurricane, in order to obtain tax benefits, is one of the ways to obtain private financing of acquisition projects.

The community may not have the technical resources, or not have them soon enough after a storm, to implement an acquisition program -- for example, people who can select the most appropriate sites for acquisition from the standpoint of reducing future damages. There may be competing demands for local manpower to handle acquisition projects in the post-disaster situation, when many resources are needed to deal with emergency or immediate recovery needs. If the town does not act quickly, however, to apply for available funds, to propose the acquisition alternative to the landowner, to undertake appraisals, etc., -- rebuilding may occur, and the town may lose its opportunity to acquire. For these reasons, it may be important to request state or federal assistance in evaluating an acquisition program immediately following a hurricane or severe storm.

Developing local capability to respond quickly in a disaster situation through advance planning for acquisition also promises great benefits to communities that want to acquire developed shorefront properties or pursue other opportunities to reduce future damages following the next hurricane or damaging storm. (See Chapter 8.)

(6) Tax impacts

Acquisition may adversely impact local tax revenues by removing properties from the tax rolls. Anticipated tax losses may be even greater than actual losses. Politically, the threat of tax loss can create public and private opposition to acquisition projects. On the other hand, the value of properties adjoining newly-acquired public open space may rise. The net tax impacts of an acquisition project should be carefully assessed rather than assuming a significant negative impact at the outset.

SOURCES OF DETAILED INFORMATION

See sources listed in Chapter 2, page 27.

CHAPTER 8 PRE-DISASTER PLANNING FOR POST-DISASTER ACTIONS

One way to reduce the damage and disruption caused by severe storms is to plan ahead for actions to be taken following a disaster.

In deciding whether your community should undertake pre-disaster planning for post-disaster actions, you should consider several factors, including:

- benefits
- federal requirements and state plans
- costs
- availability of assistance
- degree of risk

PLANNING FOR POST-DISASTER ACTIONS

Many coastal communities have made no comprehensive effort to plan for a range of post-disaster actions prior to the occurrence of a disaster. As a result, decisions on what can, or should, be done to restore damaged properties, or to alleviate the potential for future damages, must be made after the disaster strikes. The post-disaster period, though, is a difficult time to have to make these kinds of decisions. Evaluation of coastal hazards prior to a disaster may identify opportunities for reducing future damages which could be overlooked immediately following a disaster. Identifying these opportunities ahead of time can provide a basis for decisions which would otherwise be difficult when political pressure to rebuild may be intense.

Some coastal communities have basic disaster preparedness plans that deal -- at least minimally -- with storm warnings, evacuation, and rescue. While a more comprehensive post-disaster action plan may address these aspects of a disaster, it should go further and distinguish between immediate relief activities where opportunities for reducing future damages are small and long-term recovery actions which often present major opportunities. Plan components will vary from town to town -- depending on the local physical situation and community goals, as well as the resources available for planning. Possible plan components -- some directed at short-term responses and others at longer-term recovery actions -- are briefly discussed below:

- Identification of responsibilities. Clear identification of "who is to do what" is essential to effective action after a disaster. Often local government agencies have no specific directives as far as disaster recovery -- particularly long-term recovery -- is concerned. Also, they may have conflicting responsibilities. For example, one agency may want to rebuild damaged roads as quickly as possible, while another may want to consider alternative locations or construction techniques in order to reduce future damages. Pre-disaster planning can establish, in advance, what each agency should do following a disaster; ideally, agreement would be obtained from relevant agencies on assigned roles and financial and other resources to be provided. Special task forces to deal with the emergency and community recovery can also be provided for.

- Disaster relief. Many communities undertake immediate disaster relief activities on an ad hoc basis. Pre-disaster planning can improve the ability of a community to quickly and more effectively provide or obtain this relief. Instructions on how to perform damage surveys that meet federal requirements can be incorporated in the plan, along with information on funds that may be available.

- Inventory of vulnerable areas. An inventory of properties potentially susceptible to flooding and wind damage from hurricanes and other coastal storms is the first step in identification of possible land use changes to be implemented following a disaster.

- Flood insurance. Pre-disaster planning can include a survey of insured and uninsured hazard-prone properties. Such surveys can provide the basis for promotion of federal flood insurance to reduce future needs for other public relief, and to reduce property owners' losses.

- Acquisition. Pre-disaster planning can identify hazardous areas that are particularly suitable for acquisition following severe flood or wind damage. Pre-disaster planning for this type of acquisition lets the community integrate community open space and recreation goals with hazard planning. Priorities for acquisition can be established, and background work completed, so that acquisition can be accomplished quickly following a disaster, before property owners opt to rebuild.

Specific potential funding sources can be identified so that eligibility is determined in advance for particular programs.

- Public education and awareness. Pre-disaster planning can provide for public education to inform property owners not only of the nature and magnitude of the hurricane hazard, but also of options available to them should a disaster occur. Public awareness before a disaster can often reduce public opposition to actions to be taken following a disaster.

LOCAL PLANNING FOR POST-DISASTER ACTION

The city of Sanibel, Florida is conducting a study on hurricane evacuation and hazard mitigation, funded in part, by the Federal Insurance Administration's State Assistance Program. The study has six elements:

- Warning. Recognizing that adequate lead time may not be provided by warnings from the National Hurricane Center, the study will evaluate the feasibility of a separate system of evacuation orders based on hurricane strike probability.
- Evacuation. This will focus on evacuation routes used in cooperation with mainland Lee County. Vertical evacuation and other shelters on Sanibel were rejected.
- Damage reduction. Development of construction standards to minimize property damage and facilitate post-hurricane recovery.
- Recovery. Measures to minimize the likelihood of future losses, including standards for the reconstruction of substantially-damaged structures.
- Coordination. Especially with other levels of government.
- Implementation. Integration of hazard mitigation with comprehensive planning, zoning, development regulations, and other land use controls; identification of needs for help beyond the local level in hazard mitigation.

FACTORS AFFECTING DECISIONS TO PLAN FOR POST-DISASTER ACTIONS

In considering whether or not your community should prepare a pre-disaster plan, you should consider the following factors:

(1) Federal requirements and state plans

As noted above, many coastal communities have no comprehensive plan

dealing with the post-disaster situation beyond the emergency phase. Often, coastal communities have simply responded in their disaster planning to federal and state programs which, until recently, have concentrated on the immediate pre- and post-disaster situations -- namely on storm warnings, search and rescue operations, and provision of disaster relief to restore pre-storm conditions. The Disaster Relief Act of 1974, for example, called for the development of state disaster preparedness plans. These plans tend to focus on evacuation, warnings, and rescue operations during an emergency. Even so, they are not specifically directed to flood or hurricane emergencies and often they do not adequately address the magnitude of the hurricane problem.

In other cases, localities that have recently experienced a severe storm or hurricane may have conducted hazard planning in response to requirements of the Federal Emergency Management Agency (FEMA) (under Section 406 of P.L. 93-288). FEMA now requires, as a condition of receiving federal disaster relief, state post-disaster planning to reduce vulnerability to future natural disasters in affected communities. Although this requirement is a step beyond earlier disaster planning because it looks beyond the emergency relief phase, the "406 plans" are only prepared in the post-disaster context, and they are only prepared by the state.

(2) Benefits

Pre-disaster planning for post-disaster recovery actions offers a number of benefits to the local community. Most important, it can provide a basis for sound decision-making at a time when local resources are stressed by emergency needs and when the most common attitude is often "just put things back together". Airing these plans prior to a disaster can make carrying out innovative measures more politically acceptable. The availability of a plan can make faster action possible and thereby increase the likelihood that actions to reduce future damages will take place.

(3) Availability of assistance

Often the lack of resources for pre-disaster planning -- funds or technical expertise -- can present major problems to the local official. However, federal financial or technical assistance to increase the capabilities of local officials to deal with natural hazards may be available. (See Chapter 9.) State or regional programs, in some instances, can also be tapped for pre-disaster planning. (See box.)

(4) Degree of risk

Pre-disaster planning for actions to be taken following a disaster is especially important for communities suffering repeated severe damage or particularly vulnerable to major hurricanes. The magnitude of damage from a single hurricane is generally greater than from frequent, low-intensity coastal flooding or long-term coastal erosion, and the opportunities for actions to reduce future damages may be greater.

Since there may be opposition to allocating scarce public resources to planning for "eventualities" which may not occur for many years, local leaders may have to be convinced first of the magnitude of the hurricane hazard before deciding to devote funds for pre-disaster planning.

SUB-STATE REGIONAL PLANNING FOR DISASTER PREPAREDNESS

The Georgia Coastal Area Planning and Development Commission has recently prepared a model for regional disaster preparedness planning for coastal areas under contract to FEMA. A broader-than-local effort was undertaken because local or county staff for preparedness planning is often minimal, with insufficient expertise regarding disaster preparedness. Civil defense officials, long the prime source of staff for disaster preparedness activities, are frequently part-time without the time or resources to adequately deal with disaster planning. This situation is particularly severe in small, rural communities.

The Georgia Coastal Commission set out to develop a model for use by sub-state regional agencies to assist local governments in dealing with disaster planning. The Commission's program suggests that disaster preparedness planning should contain four basic elements:

- planning
- mapping
- education and public awareness
- mitigation

It also defines several functional areas that should be addressed in the planning element: training and education; communication and warning; inventory of resources/coordination/emergency services; evacuation/transportation/re-entry; shelters; clean-up and recovery. Functional areas suggested for the mitigation element include zoning and regulations, building codes, acquisition and open space, warnings, and long-range planning, among others.

The Commission estimated financial resources necessary to undertake the model program, assuming that the comprehensive disaster preparedness program is a new one for the regional entity and requires a two-year start-up period. The estimate for year one is $84,019 (including full-time staff positions for a disaster preparedness coordinator and disaster preparedness/response planner, with supervision by a planning director and cartographic and secretarial assistance); the second year estimate is $92,592. Actual costs will vary depending on the available level of staff and agency work programs.

A chapter is included on the transferability of the model program to other geographic areas.

PART III: SOURCES OF ASSISTANCE

Part III of the Handbook describes selected federal and state assistance programs which have been used most commonly by communities in the past to plan or implement programs to reduce damages from hurricanes and coastal flooding. Part III includes the following chapter:

CHAPTER 9 TECHNICAL AND FINANCIAL AID FOR RESPONDING TO HURRICANES AND COASTAL FLOODING

CHAPTER 9 TECHNICAL AND FINANCIAL AID FOR RESPONDING TO HURRICANES AND COASTAL FLOODING

Many communities will need technical or financial assistance to manage their coastal hazards problems. This chapter includes descriptions of some state and federal programs that have provided help in the past to localities for:

- developing regulations
- acquisition projects
- forecasting, warning systems and evacuation planning
- pre- and post-disaster planning
- structural measures

Chapters 2 through 8 describe the types of measures that can be taken to respond to hurricane and coastal flooding problems. This range of techniques is likely to represent the basic set of opportunities available to your community for the foreseeable future, even though local government experience and technical or engineering advances may lead to some changes in the use of particular techniques. On the other hand, sources of technical and financial assistance to aid your community in implementing these techniques are constantly changing. The availability of funding and community eligibility for state and federal assistance varies from year to year and from state to state, depending on state priorities as well as federal budgetary constraints.

Two useful compilations of information on federal programs are available:

(1) Digest of Federal Disaster Assistance Programs

The third edition of this digest was published by FEMA in June 1980. It lists programs to assist in preparedness, emergency, long-range recovery and mitigation activities. The programs are grouped in 11 categories: agriculture, business, emergency services, fire suppression, flood prevention and protection, health services, housing, assistance

for individuals, preparedness planning, State and community assistance, and volunteer agencies. Brief descriptions of each program are provided along with a cross-reference to the Catalogue of Federal Domestic Assistance.

(2) Catalogue of Federal Domestic Assistance

This catalogue is published yearly by the Office of Management and Budget. It provides a comprehensive compilation of federal domestic assistance of all types, including programs relevant to preparing for hurricanes and coastal flooding. Programs are indexed by subject, by agency, and by applicant. Brief descriptions are provided for each program listed. Despite its comprehensiveness, not all relevant programs are included here.

REGULATIONS

Federal Assistance

- Floodplain Management Services (FPMS)

The Floodplain Management Services Program administered by the Army Corps of Engineers has provided assistance and information to states and communities for a variety of projects related to flood hazards. These technical services, for which there has been no set matching requirement, have included assistance in developing a technical basis for regulations, planning wise development of coastal hazards areas and evacuation planning.

States, and political subdivisions of states, have generally requested this type of assistance through a letter to the District Engineer.

For information, contact the District Engineer of the nearest U.S. Army Corps of Engineer District; Attn: FPMS (see Appendix A), or the Director of Civil Works, Attn: DAEN-CWP-F, Office of Chief of Engineers, Department of the Army, Washington, D.C. 20314. Telephone (202) 272-0169.

State Assistance

State flood insurance coordinators often have model ordinances adapted to the needs of individual states for assistance in writing local hazard regulations. A list of state flood insurance coordinators is included in Appendix A.

ACQUISITION

Federal Assistance

- Land and Water Conservation Fund (LaWCON)

The Land and Water Conservation Fund, formerly administered by the Department of Interior's Heritage Conservation and Recreation Service (HCRS), has provided for two types of activities -- direct acquisition of lands by federal agencies and grants to states. Grants to the states have been used for purposes of increasing public recreational opportunities through planning, acquisition of land, and development of outdoor recreational facilities.

The 50 percent matching grants have been made to designated state agencies to prepare and implement a State Comprehensive Outdoor Recreation Plan (SCORP) that identifies priorities for state and local recreation and open space projects. States have used annual grant funds to undertake state projects or to fund local acquisition or recreation development projects. In a number of coastal states, the state coastal zone agencies have recommended the use of LaWCON funds for recreational projects in hazardous areas. State Liaison Officers, appointed by the Governors, have acted on behalf of other state agencies, cities, counties, or park districts in applying to HCRS for LaWCON funding.

For information, contact your State Liaison Office or the National Park Service, DOI, 18th and C Streets, N.W., Washington, D.C. 20240. Telephone (202) 523-5152.

- Community Development Block Grants

Many communities have received formula grants for a wide range of community development projects through the Community Development Block Grant Program of the Department of Housing and Urban Development's Office of Community Planning and Development.

Community activities funded through this program have included: acquisition, rehabilitation or construction of certain public works facilities and improvements, clearance, housing rehabilitation, code enforcement,

relocation payments and assistance, administrative expenses, economic development, and completion of existing urban renewal projects. In addition, block grants have been used to meet the state or local matching share of some other federal programs, including the coastal zone management program. As noted above, property acquisition -- for rehabilitation, preservation, open space, public works, etc. -- has been funded, with minimal restrictions attached to future use or transfer of acquired properties. Block grant funds have been used in combination with other federal, state, or local programs to acquire property in coastal hazard areas.

For information, contact the appropriate HUD Area Office or Headquarters Office, Community Planning and Development, 451 7th Street, S.W., Washington, D.C. 20410. Telephone (202) 755-6587.

- Section 1362

A new program of financial and technical assistance, authorized by Section 1362 of the National Flood Insurance Act and initiated by FEMA in September 1979, is devoted specifically to acquisition of flooded properties. One hundred and seventy-three properties were acquired by FEMA, then transferred to a state or local government agency in the program's first two years. Funds, administrated by FEMA's Federal Insurance Administration (FIA), have been provided for the purchase of insured properties that meet one of the following damage criteria (in addition to community eligibility criteria):

- damaged "substantially beyond repair" by flood while covered under the NFIP;
- incurred significant flood damage on not less than three previous occasions within a five year period while covered under the NFIP; and on each occasion the cost of repair, on the average, was at least 25 percent of the value of the structure; or
- while covered under the NFIP, property has sustained damage from a "single casualty of any nature" so that a statute, ordinance or regulation precludes its repair or restoration or permits repair or restoration only at significantly increased cost.

Given the nature of these criteria, in some cases only scattered properties have qualified for Section 1362 assistance. As a result, some projects

have combined a variety of other programs with the use of Section 1362 funds in order to acquire additional floodprone properties.

For information, contact the appropriate FEMA regional Office (see Appendix A).

State Assistance

Some states have programs available for acquisition of coastal hazard areas. Many state programs for purchasing coastal hazard areas, or planning for that acquisition, have received funds from the federal government. The nature of these state programs varies considerably. Among these types of programs are: state coastal management programs (e.g. using federal coastal zone management funds); state fish and wildlife programs (e.g. using federal fish and wildlife management and restoration funds); and state recreation and open space programs (e.g. using Land and Water Conservation Fund monies).

Other state programs are funded directly by the states, and involve state acquisition of floodprone properties or provision of funds to localities for acquisition. These include open space acquisition programs, wetland preservation programs, and municipal grant-in-aid programs.

For information, contact agency in your state that is responsible for open space acquisition and the agency responsible for fish and wildlife management.

FORECASTING, WARNINGS, AND EVACUATION PLANNING

Federal Assistance

- Coastal Hazard Program

  The National Oceanic and Atmospheric Administration (NOAA) has initiated a Coastal Hazards Program to coordinate Federal grants, basic environmental data, technical information, land use management techniques, and local expertise in order to help local institutions develop hazard plans to fit their specific problems and requirements.

  Several NOAA elements are involved in this effort. The National Ocean Survey produces storm Evacuation Maps, showing evacuation routes, elevation data, and topographic features of coastal areas. The National

Weather Service Weather and Flood Warnings Coordination Staff develops preparedness guidelines and disseminates education information on hazard preparedness to the general public and to public officials. Local offices of the National Weather Service are frequently able to assist in local coastal hazard preparedness planning. The Sea Grant Marine Advisory Service conducts workshops and public meetings to educate local officials about coastal hazards and mitigation opportunities. The Environmental Data Information Service acquires, stores, and distributes environmental data that can be used as a base for preparedness planning.

NOAA has planned to establish 39 regional projects to develop plans and programs to deal with natural hazards in those regions by 1988. The proposed regional hazard plans would include a description of warning systems and a plan for evacuation, including maps showing road elevation and storm surge levels. These maps would be used to determine how long various routes will remain open during a storm. Priority areas for participation in the program have been established based on: the frequency and severity of hurricanes, tornadoes, storms and floods; population density and industrial development; and the state of development of the state's Coastal Management Program.

For information, contact the NOAA Coastal Hazards Office, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C. 20852. Telephone (301) 443-8860.

- State Assistance Program in Training and Education for Emergency Management

The Training and Education Office of FEMA conducts this program for state assistance in hazard related activities through cooperative agreements with participating states. The program was designed to promote comprehensive emergency management training, covering emergency preparedness planning, hazard mitigation, and disaster response and recovery. States have been encouraged to conduct several types of activities: training to meet emergency and disaster operational requirements; training programs to disseminate emergency management concepts; encourage inter-governmental operational response capability; provide management capability for emergency management staffs; motivate the general public to practice emergency self-help; and build self-confidence among public officials regarding their capability to successfully manage crisis.

Applications have been filed by the state agency responsible for comprehensive emergency management with the appropriate FEMA Regional Director.

For further information, contact your FEMA regional director (see Appendix A) or the Associate Director for Training and Education, Federal Emergency Management Agency, 1725 I Street, N.W., Washington, D.C. 20472. Telephone (301) 447-6671.

- Floodplain Management Services (FPMS)

  The Floodplain Management Services Program, administered by the Army Corps of Engineers, has provided assistance to local governments for the preparation of evacuation plans. This program is described above on page 102.

State Assistance

Many states offer some assistance -- technical or financial -- to local governments attempting to improve their emergency preparedness capabilities.

For information on assistance available in your state, contact the State's Civil Defense Agency (see Appendix A).

PRE-AND POST-DISASTER PLANNING

Federal Assistance

- Coastal Zone Management Program Administration (Section 306)

  The Department of Commerce's Office of Coastal Zone Management (OCZM) has provided matching grants (up to 80 percent federal) to coastal states to administer federally-approved coastal management programs. Grants have been used for a wide range of planning and management activities that are consistent with program policies. OCZM has encouraged the coastal states to undertake projects related to hazard mitigation in coastal areas. Funds have also been passed through by the designated state agencies to communities for local coastal planning or special projects related to hazards.

  For further information, contact: Director, Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, Department of Commerce, 3300 Whitehaven Street, N.W., Washington, D.C. 20235. Telephone (202) 634-1672, or the state agency designated by the Governor to administer the program (see Appendix A). Some communities may also have local contacts for the coastal management program.

- State Assistance Program -- NFIP

This program administered by the Federal Emergency Management Agency was designed to promote intergovernmental flood hazard mitigation actions and to help the states strengthen their capability to address NFIP and flood hazard mitigation issues. Three program elements have been identified: assessment of current state and local NFIP and flood hazard mitigation activities; development of state-wide information bases to promote understanding of the NFIP; and working with local governments in the mechanics of implementing and administering flood hazard mitigation programs.

Funds have been provided to the states through cooperative agreements with the state agency designated by the Governor as the Coordinating Agency for the NFIP, based on a formula which includes population in flood hazard areas, communities in the NFIP, and claims under the NFIP. Local governments have been responsible for informing the state of their needs so that they may be incorporated in the state's flood hazard mitigation program.

In an attempt to foster a broader view of emergency management, FEMA is encouraging for FY 83 the funding of this program through a combined cooperative agreement also including local civil defense and state disaster preparedness planning assistance programs.

For information, contact your State Coordinating Agency (see Appendix A) or Office of Emergency Management Programs, State and Local Programs and Support, Federal Emergency Management Agency, Washington, D.C. 20472. Telephone (202) 287-3891.

- Hurricane Plans and Preparedness

This Federal Emergency Management Agency program is designed to assist states in the development of capabilities to respond in an integrated fashion to the threat or consequences of severe hurricanes in high-risk, high-population areas. A final rule for this program was published on September 28, 1981, identifying 24 hurricane risk areas as examples of locations where this program could be applied. Through grants and

cooperative agreements with Texas and Florida, for example, the program has provided project funds for conducting vulnerability analyses in the Galveston and Tampa areas. Vulnerability analyses include determination and definition of the hazard area, identification of storm-surge rises, estimation of casualties and structural damage, and postulated impact on essential populations, operations, and resources.

Preparedness planning activities for evacuation, response and recovery, following the completion of vulnerability analyses, are also eligible for funding. Grants for vulnerability analysis and for preparedness planning may be awarded separately or combined. FEMA's regional offices generally work through state agencies and/or Governors' Offices which identify projects suitable for these types of activities.

For information, contact: Office of Natural and Technological Hazards, State and Local Programs and Support, Federal Emergency Management Agency, Washington, D.C. 20472. Telephone (202) 287-0254.

State Assistance

Some states may provide assistance to local governments for disaster planning, either focused on storm-related hazards or a range of natural and man-made hazards, through state civil defense or disaster preparedness agencies.

For information, contact your state Civil Defense or preparedness agency (see Appendix A).

STRUCTURAL MEASURES

Federal Assistance

- Civil Works Program - Hurricane Control

  The Corps of Engineers has built protective structures in a number of localities that have experienced hurricane damages. Following a series of severely-damaging hurricanes in the early 1950's, the Corps surveyed the Atlantic and Gulf coasts, and between 1955 and 1965 completed 77 reports on specific localities; 44 of these reports proposed structural protection measures, (of which 30 were authorized to be constructed). Economic feasibility -- defined simply as benefits exceeding costs --

is the primary criterion for determining the eligibility of such projects. Projects must be authorized by Congress. Up to 70 percent of the costs of projects on non-federal public land has been met by the federal government with the remainder paid for by state and local governments. Additional non-financial requirements are also imposed on participating local sponsors.

For information, contact your District Engineer (see Appendix A) or the Director of Civil Works, Office of the Chief of Engineers, Department of the Army, Washington, D.C. 20314. Telephone (202) 693-6869.

- Small Beach Erosion Control Projects

Under this program, the Corps of Engineers has designed and constructed projects to control beach and shore erosion in publicly-owned areas. Non-federal sponsoring agencies have been required to provide all necessary lands, easements, rights-of-way, and to assure public use of the beach and provide project maintenance, including maintenance of access roads, parking areas and other public facilities.

Federal participation has not exceeded $1 million or 70 percent of project costs. States, political subdivisions of states, or other responsible local agencies have applied for funds by formal letter to the District Engineer.

For information, contact your District Engineer (see Appendix A) or the Director of Civil Works, Office of the Chief of Engineers, Department of the Army, Washington, D.C. 20314. Telephone (202) 693-6869.

- Small Flood Control Projects

Through this program, the Corps has designed and built projects intended to reduce flood damages. Non-federal sponsoring agencies have been responsible for providing all lands, as well as project costs over $2 million, and project maintenance after completion. (Projects located in Presidentially-declared disaster areas have received federal funds up to $3 million.)

States, political subdivisions of states, and other local agencies have sponsored small flood control projects. Application has been by letter to the District Engineer.

For information, contact your District Engineer (see Appendix A) or Director of Civil Works, Office of the Chief of Engineers, Department of the Army, Attn: DAEN-CWP-A, Washington, D.C. 20314. Telephone (202) 693-6984.

- Community Development Block Grants

  Community Development Block Grants, administered by the Department of Housing and Urban Development, have been used for structural flood protection measures such as storm drainage. This program is described above on page 103.

State Assistance

Some states provide financial or technical assistance to local governments for shore protection structures. Such assistance may come from bond issues or legislative appropriations. To find out if your state has any such assistance available, contact the state agency concerned with shore protection or coastal management.

APPENDICES

The appendices of the handbook provide additional information on agency contacts for coastal hazard technical and financial assistance and source documents for general information on topics related to coastal tidal flooding and hurricanes. The appendices include the following:

APPENDIX A: STATE AND FEDERAL INFORMATION CONTACTS

(1) State Flood Insurance Contacts

(2) Corps of Engineers District and Field Offices

(3) U.S. Geological Survey Contacts

(4) Federal Emergency Management Agency Regional Offices

(5) State Coastal Zone Management Agencies

(6) State Officials Responsible for Disaster Operations and Emergency Planning

APPENDIX B: GENERAL SOURCES OF INFORMATION ON FLOODPLAIN MANAGEMENT, STORMWATER MANAGEMENT, AND COASTAL EROSION

APPENDIX A STATE AND FEDERAL INFORMATION CONTACTS

(1) STATE FLOOD INSURANCE CONTACTS

Alabama

State Planning and Federal
Program Division
State Capitol Bldg.
Montgomery, AL 36130
(205) 832-6400

Alaska

Department of Community
& Regional Affairs
Division of Community and
Regional Planning
225 Cordova, Bldg B
Anchorage, AK 99501
(907) 264-2206

Arizona

Department of Water Resources
Floor Control Branch
99 E. Virginia 2nd Floor
Phoenix, AZ 85004
(602) 255-1566

Arkansas

Division of Soil & Water Resources
State Department of Commerce
1818 W. Capitol Building A
Little Rock, AR
(501) 371-1611

California

Department of Water Resources
P.O. Box 388
Sacramento, CA 95802
(916) 445-2985

Colorado

Colorado Water Conservation Board
State Centennial Building, Room 823
1313 Sherman Street
Denver, CO 80202
(303) 866-3441

Connecticut

State Dept. of Environmental
Protection
State Office Bldg.
Hartford, CT 06115
(203) 566-3540

Delaware

Office of Management, Budget,
and Planning
Townsend Building, 3rd Floor
Dover, Delaware 19901
(302) 736-4271

District of Columbia

Department of Environmental
Services
5000 Overlook Ave., SW
Washington, D.C. 20032
(202) 767-8170

Florida

Department of Community Affairs
2571 Executive Ctr. Circle East
Howard Building
Tallahassee, FL 32301
(904) 488-9210

Georgia

Georgia Department of Natural
Resources Environmental Protection
Division
270 Washington Street, S.W.
Atlanta, GA 30334
(404) 656-4713

Guam

Office of Civil Defense
Post Office Box 2877
Agana, Guam 96910
477-9841

Hawaii

Hawaii Board of Land and Natural Resources
P.O. Box 373
Honolulu, HI 96809
(808) 548-7619

Idaho

Department of Water Resources
State House
Boise, ID 83720
(208) 334-4440

Illinois

Local Flood Plain Office
Illinois Dept. of Transportation
Division of Water Resources
Local Flood Plain Programs
300 North State Street, Room 1010
Chicago, IL 60610
(312) 793-3864

Indiana

Department of Natural Resources
608 State Office Building
Indianapolis, IN 46204
(317) 633-5267

Iowa

Iowa Natural Resources Council
Wallace State Office Building
Des Moines, IA 50319
(515) 281-5029

Kansas

Chief Engineer & Director
Division of Water Resources
Kansas State Board of Agriculture
901 Kansas Avenue
Topeka, KS 66612
(913) 296-3717

Kentucky

Division of Water Resources
Kentucky Department of Natural Resources
950 Leestown Road
Frankfort, KY 40601
(502) 564-3980

Louisiana

Louisiana Department of Urban & Community Affairs
P.O. Box 44455
Baton Rouge, LA 70804
(504) 925-3706

Maine

Bureau of Civil Emergency Preparedness
State House
Augusta, ME 04330
(207) 622-6201

Maryland

Maryland Water Resources Administration
Flood Control Section
Tawee State Office Building D-2
Annapolis, MD 269-3826

Massachusetts

Massachusetts Water Resources Commission
State Office Building
100 Cambridge Street
Boston, MA 02202
(617) 727-3267

Michigan

Water Management Division
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909
(517) 373-3930

Minnesota

Land Use Management Section
Minnesota Department of Natural Resources
Division of Waters
444 LaFayette Road
St. Paul, MN 55101
(612) 296-9226

Mississippi

Mississippi Research & Development Center
Post Office Drawer 2470
Jackson, MS 39205
(601) 982-6376

Missouri

Disaster Planning & Operations Office
P.O. Box 116
Jefferson City, MO 65102
(304) 751-2321

Montana

Montana Department of Natural Resources & Conservation
32 South Ewing Street
Helena, MT 59601
(406) 449-2864

Nebraska

Nebraska Natural Resources Commission
P.O. Box 94876
Lincoln, NB 68509
(402) 471-2081

Nevada

Division of Water Resources
Dept. of Conservation & Natural Resources
201 South Falls St.
Carson City, NV 89700
(702) 885-4380

New Hampshire

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

New Jersey

Division of Water Resources
New Jersey Department of Environmental Protection
P.O. Box CN 029
Trenton, NJ 08625
(609) 292-1840

New Mexico

State Engineer
Bataan Memorial Bldg.
Sante Fe, NM 97501
(505) 827-2135

New York

Bureau of Flood Protection
New York Dept. of Environmental Conservation
50 Wolf Road - Room 618
Albany, NY 12233
(518) 457-3157

North Carolina

North Carolina Department of Natural Resources & Community Development
Archdale Building
Raleigh, NC 27611
(919) 733-4918

North Dakota

North Dakota Water Commission
State Office Building
900 Boulevard
Bismark, ND 58505
(701) 224-2750

Ohio

Ohio Department of Natural Resources
Flood Plain Management Unit
Ohio Department Building
Fountain Square
Columbus, OH 43224
(614) 466-6020

Oklahoma

Oklahoma Water Resources Board
12th Floor Northeast
10th & Stonewall
Oklahoma City, OK 73105
(405) 271-2555

Oregon

Oregon Water Resources Dept.
Milcreek Office Park
Salem, OR 97310
(503) 378-3671

Pennsylvania

Department of Community Affairs
551 Forum Building
Harrisburg, PA 17120
(717) 787-7400

Puerto Rico

Puerto Rico Planning Board
P.O. Box 41119
Minillas Station
Santurce, PR 00940
(809) 726-7110

Rhode Island

Statewide Planning Program
Rhode Island Office of State Planning
265 Melrose Street
Providence, RI 02907
(401) 277-2656

South Carolina

South Carolina Water Resources Commission
P.O. Box 4515
3830 Forest Drive
Columbia, SC 29240
(803) 758-2514

South Dakota

South Dakota Planning Bureau
State Capitol
Pierre, SD 57501
(605) 224-3661

Tennessee

Local Planning
Tennessee State Planning Office
660 Capitol Hill Building
Nashville, TN 37219
(615) 741-2211

Texas

Texas Dept. of Water Resources
1700 North Congress Avenue
Austin, TX 78701
(512) 475-2171

Utah

Utah Department of Public Safety
317 State Office Building
Salt Lake City, UT 84114
(801) 533-4900

Vermont

Division of Water Resources
Agency of Environmental Conservation
State Office Building
Montpelier, VT 05602
(802) 828-2761

Virgin Islands

Disaster Preparedness Office
Box 839
Charlotte Amalie
St. Thomas, VI 00801
(809) 744-6555

Virginia

Virginia State Water Control Board
P.O. Box 11143
Richmond, VA 23230
(804) 257-0056

Washington

Department of Ecology
Olympia, Washington 98504
(206) 753-0577

West Virginia

Disaster Recovery Office
1262 1/2 Greenbrier St.
Charleston, WV 25305
(304) 348-0416

Wisconsin

Department of Natural Resources
Flood Plain-Shoreline
P.O. Box 7921
Madison, WI 53707
(608) 266-2121

Wyoming

Wyoming Disaster & Civil Defense
Agency
P.O. Box 1709
5500 Bishop Boulevard
Cheyenne, WY 82001
(307) 777-7566

(2) CORPS OF ENGINEERS DISTRICT AND FIELD OFFICES

Alabama

Mobile District
P.O. Box 2288
Mobile, AL 36628
(205) 690-2511

Alaska

Alaska District
P.O. Box 7002
Anchorage, AK 99510
(907) 752-2605 or 279-1132

California

South Pacific Division, Room 1216
630 Sansome Street
San Francisco, CA 94111
(415) 556-0914

Los Angeles District
P.O. Box 2711
Los Angeles, CA 90053
(213) 688-5300

Sacramento District
650 Capitol Mall
Sacramento, CA 95814
(916) 448-2232

San Francisco District
100 McAllister Street
San Francisco, CA 94102
(415) 556-3660

Connecticut

New England Division
424 Trapelo Road
Waltham, MA 02154
(617) 894-2400, Ext. 200

Delaware

Baltimore District
P.O. Box 1715
Baltimore, MD 21203
(301) 962-4545

Philadelphia District
U.S. Custom House
2nd and Chestnut Streets
Philadelphia, PA 19106
(215) 597-4848

Florida

Jacksonville District
P.O. Box 4970
Jacksonville, FL 32201
(904) 791-2241

Georgia

South Atlantic Division
510 Title Building
30 Pryor Street, S.W.
Atlanta, GA 30303
(404) 526-6711

Savannah District
P.O. Box 889
Savannah, GA 31402
(912) 233-8822, Ext. 224

Hawaii

Pacific Ocean Division
APO, San Francisco, 96558
(808) 438-1500

Illinois

North Central Division
536 South Clark Street
Chicago, IL 60605
(312) 353-6310

Chicago District
219 South Dearborn Street
Chicago, IL 60605
(312) 353-6400

Rock Island District
Clock Tower Building
Rock Island, IL 61201
(309) 788-6361

Louisiana

New Orleans District
P.O. Box 60267
New Orleans, LA 70160
(504) 865-1121

Maine

New England Division
424 Trapelo Road
Waltham, MA 02154
(617) 894-2400, Ext. 200

Maryland

Baltimore District
P.O. Box 1715
Baltimore, MD 21203
(301) 962-4545

Massachusetts

New England Division
424 Trapelo Road
Waltham, MA 02154
(617) 894-2400, Ext. 200

Michigan

Detroit Division
P.O. Box 1027
Detroit, MI 48231
(313) 226-6762

Minnesota

St. Paul District
1135 USPO and Customhouse
St. Paul, MN 55101
(612) 725-7501

Mississippi

Lower Mississippi Valley Division
P.O. Box 80
Vicksburg, MS 39180
(601) 636-1311

Vicksburg District
P.O. Box 60
Vicksburg, MS 39180
(601) 636-1311, Ext. 401

New Hampshire

New England Division
424 Trapelo Road
Waltham, MA 02154
(617) 894-2400, Ext. 200

New Jersey

New York District
26 Federal Plaza
New York, NY 10007
(212) 264-0100

Philadelphia District

U.S. Custom House
2nd and Chestnut Streets
Philadelphia, PA 19106
(215) 597-4848

New York

North Atlantic Division
90 Church Street
New York, NY 10007
(212) 264-7101

Buffalo District
1776 Niagara Street
Buffalo, NY 14207
(716) 876-5454, Ext. 200

New York District
26 Federal Plaza
New York, NY 10007
(212) 264-0100

New York Harbor, Supervisor of
26 Federal Plaza
New York, NY 10007
(212) 264-0100

North Carolina

Wilmington District
P.O. Box 1890
Wilmington, NC 28401
(919) 763-9971, Ext. 466

Oregon

North Pacific Division
310 Custom House
220 N.W. 8th Avenue
Portland, OR 97209
(503) 221-3700

Portland District
P.O. Box 2946
Portland, OR 97208
(503) 777-4441, Ext. 200

Pennsylvania

Philadelphia District
U.S. Custom House
2nd and Chestnut Streets
Philadelphia, PA 19106
(215) 597-4848

Pittsburgh District
Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222
(412) 644-6800

Rhose Island

New England Division
424 Trapelo Road
Waltham, MA 02154
(617) 894-2400, Ext. 200

South Carolina

Charleston District
P.O. Box 919
Charleston, SC 29402
(803) 577-4171, Ext. 229

Texas

Southwestern Division
Main Tower Building
1200 Main Street
Dallas, TX 75702
(214) 749-3336

Fort Worth District
P.O. Box 17300
Fort Worth, TX 76102
(817) 334-2300

Galveston District
P.O. Box 1229
Galveston, TX 77550
(713) 527-6301

Virginia

Norfolk District
803 Front Street
Norfolk, VA 23510
(703) 625-8201, Ext. 231

Washington

Seattle District
P.O. Box C-3755
Seattle, WA 98124
(206) 764-3690

Walla Walla District
Building 602, City-County Airport
Walla Walla, WA 99362
(509) 525-5500, Ext. 100

(3) U.S. GEOLOGICAL SURVEY CONTACTS

Alaska

Water Resources Division, USGS
218 "E" St.
Anchorage, AK 99501

California

Water Resources Division, USGS
855 Oak Grove Ave.
Menlo Park, CA 94025

Connecticut

Water Resources Division, USGS
Room 235, Post Office Bldg.
135 High St., P.O. Box 715
Hartford, CT 06101

Georgia

Water Resources Division
Southeastern Region, USGS
1459 Peachtree St., NE
Suite 200
Atlanta, GA 30309

Illinois

Water Resources Division, USGS
605 N. Neil St., P.O. Box 1026
Champaign, IL 61820

Indiana

Water Resources Division, USGS
1819 North Meridian St.
Indianapolis, IN 46202

Louisiana

Water Resources Division, USGS
P.O. Box 66495
6554 Florida Blvd.
Baton Rouge, LA 70806

Massachusetts

Water Resources Division, USGS
150 Causeway St., Suite 1001
Boston, MA 02114

Maryland

Water Resources Division, USGS
8809 Satyr Hill Rd.
Parkville, MD 21234

Michigan

Water Resources Division, USGS
2400 Science Parkway
Okemos, MI 48864

Mississippi

Water Resources Division, USGS
430 Bounds St.
Jackson, MS 39206

New Jersey

Water Resources Division, USGS
P.O. Box 1238
Room 420, Federal Bldg.
402 East State St.
Trenton, NJ 08607

New York

Water Resources Division, USGS
P.O. Box 1350
Room 343, Post Office & Court House
Albany, NY 12201

North Carolina

Water Resources Division, USGS
P.O. Box 2857
Room 440, Century Sta.
Post Office Bldg.
Raleigh, NC 27602

Oregon

Water Resources Division, USGS
P.O. Box 3202
830 NE Holladay St.
Portland, OR 97208

Pennsylvania

Water Resources Division, USGS
P.O. Box 1107
4th Floor, Federal Bldg.
228 Walnut St.
Harrisburg, PA 17108

South Carolina

Water Resources Division, USGS
2001 Assembly St., Suite 200
Columbia, SC 29201

Texas

Water Resources Division, USGS
630 Federal Bldg.
300 East 8th St.
Austin, TX 78701

Virginia

Water Resources Division, USGS
200 West Grace St., Room 304
Richmond, VA 23220

(4) FEDERAL EMERGENCY MANAGEMENT AGENCY REGIONAL OFFICES

Region I (Boston)

Federal Emergency Management Agency
422 J.W. McCormack Post Office & U.S.
Courthouse, Boston, MA 02109
Director (617) 223-4741
DR&R (617) 223-4741

Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

Region II (New York)

Federal Emergency Management Agency
1349 J. K. Javits Federal Building
New York, NY 10278
Director (212) 264-8395
DR&R (212) 264-8980

New Jersey
New York
Puerto Rico
Virgin Islands

Region III (Philadelphia)

Federal Emergency Management Agency
Curtis Bldg. 7th Floor
Sixth and Walnut Sts.
Philadelphia, PA 19106
Director (215) 597-9416
DR&R (215) 597-9416

Delaware
District of Columbia
Maryland
Pennsylvania
Virginia
West Virginia

Region IV (Atlanta)

Federal Emergency Management Agency
1375 Peachtree St., N.E., Room 664
Atlanta, GA 30309
Director (919) 226-1761 (Thomasville)
DR&R (404) 881-2400

Alabama
Florida
Georgia
Kentucky
Mississippi
North Carolina
South Carolina
Tennessee

Region V (Chicago)

Federal Emergency Management Agency
300 S. Wacker Drive 24th Floor
Chicago, IL 60606
Director (312) 353-1500
DR&R (312) 353-1500

Illinois
Indiana
Michigan
Minnesota
Ohio
Wisconsin

Region VI (Dallas)

Federal Emergency Management Agency
206 Federal Regional Center
Denton, TX 76201
Director (817) 387-5811
DR&R (817) 387-5811

Arkansas
Louisiana
New Mexico
Oklahoma
Texas

Region VII (Kansas City)

Federal Emergency Management Agency
300 Old Federal Office Building, Room 405
911 Walnut St.
Kansas City, MO 64106
Director (816) 374-5912
DR&R (816) 374-5912

Iowa
Kansas
Missouri
Nebraska

Region VIII (Denver)

Federal Emergency Management Agency
Federal Regional Center
Denver, CO 80225
Director (303) 234-2553
DR&R (303) 234-6542

Colorado
Montana
North Dakota
South Dakota
Utah
Wyoming

Region IX (San Francisco)

Federal Emergency Management Agency
211 Main St. Room 220
San Francisco, CA 94105
Director (415) 556-8795
DR&R (415) 556-8795

American Samoa
Arizona
California
Guam
Hawaii
Nevada
Trust Territories of the Pacific Islands

Region X (Seattle)

Federal Emergency Management Agency
Federal Regional Center
Bothell, WA 98011
Director (206) 486-8800
DR&R (206) 486-8800

Alaska
Idaho
Oregon
Washington

(5) STATE COASTAL ZONE MANAGEMENT AGENCIES

Alabama

Coastal Area Board
P.O. Box 755
Daphne, AL 36526
(205) 626-1880

Alaska

Policy Development and Planning Div.
Office of the Governor
Pouch AP
Juneau, AK 99801
(907) 465-3541

American Samoa

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

California

California Coastal Commission
631 Howard St., Fourth Floor
San Francisco, CA 94105
(415) 543-8555

Connecticut

Coastal Area Management Program
Dept. of Environmental Protection
71 Capitol Ave.
Hartford, CT 06115
(203) 566-7404

Delaware

Coastal Management Program
Office of Management, Budget & Planning
James Townsend Bldg.
Dover, DE 19901
(302) 736-4271

Florida

Office of Coastal Zone Management
Dept. of Environmental Regulation
Twin Towers Office Bldg.
2600 Blair Stone Rd.
Tallahassee, FL 32301
(904) 488-8614

Georgia

Coastal Resources Division
Dept. of Natural Resources
1200 Glynn Ave.
Brunswick GA 31520
(912) 264-4771

Guam

Bureau of Planning
Government of Guam
P.O. Box 2950
Agana, Guam 96910
(via Overseas Operator) 477-9502

Hawaii

Dept. of Planning and Economic Development
P.O. Box 2359
Honolulu, HI 96804
(808) 548-4609

Illinois

Illinois Coastal Zone Management Program
300 N. State St., Room 1010
Chicago, IL 60610
(312) 793-3126

Indiana

State Planning Services Agency
143 West Market St., Harrison Bldg.
Indianapolis, IN 46204
(317) 232-1482

Louisiana

Coastal Management Section
Dept. of Natural Resources
P.O. Box 44396
Baton Rouge, LA 70804
(504) 342-7898

Maine

State Planning Office
Resource Planning Div.
189 State St.
Augusta, ME 04333
(207) 289-3155

Maryland

Dept. of Natural Resources
Tidewater Administration
Tawes State Office Bldg.
Annapolis, MD 21401
(301) 269-2784

Massachusetts

Executive Office of Environmental Affairs
100 Cambridge St.
Boston, MA 02202
(617) 727-9530

Michigan

Dept. of Natural Resources
Div. of Land Use Programs
Stephens T. Mason Bldg.
Lansing, MI 48926
(517) 373-1950

Minnesota

State Planning Agency
Capitol Square Bldg.
550 Cedar St., Room 100
St. Paul, MN 55155
(612) 296-2633

Mississippi

Mississippi Bureau of Marine Resources
Dept. of Wildlife Conservation
P.O. Box Drawer 959
Long Beach, MS 39560
(601) 864-4602

New Hampshire

Office of State Planning
2½ Beacon St.
Concord, NH 03301
(603) 271-2155

New Jersey

Bureau of Coastal Planning and Development
Dept. of Environmental Protection
P.O. Box 1889
Trenton, NJ 08625
(609) 292-9762

New York

Coastal Management Unit
Dept. of State
162 Washington St.
Albany, NY 12231
(518) 474-8834

North Carolina

Dept. of Natural Resources and Community Development
Box 27687
Raleigh, NC 27611
(919) 733-2293

Northern Mariana Islands

Coastal Resources Management Office
Office of the Governor
Saipan, Mariana Islands 96950
(via Overseas Operator) 6623

Ohio

Dept. of Natural Resources
Division of Water
1930 Belcher Dr., Fountain Square
Columbus, OH 43225
(614) 466-6557

Oregon

Land Conservation and Development Commission
1175 Court St., N.E.
Salem, OR 97310
(503) 378-4097

Pennsylvania

Dept. of Environmental Resources
Third and Reily Sts.
P.O. Box 1467
Harrisburg, PA 17120
(717) 783-9500

Puerto Rico

Coastal Management Office
Dept. of Natural Resources
P.O. Box 5887
Puerta de Tierra, Puerto Rico 00906
(809) 725-2769

Rhode Island

Coastal Resources Management Program
Washington County Government Center
Tower Hill Rd.
South Kingstown, RI 02879
(401) 789-3048

South Carolina

South Carolina Coastal Council
Wildlife and Marine Resources Dept.
1116 Bankers Trust Tower
Columbia, SC 29201
(803) 758-8442

Texas

Natural Resources Div.
Texas Energy & Natural Resource Advisory Council
E.R.S. Bldg.
200 E. 18th St.
Austin, TX 78701
(512) 475-0773

Virgin Islands

Virgin Islands Dept. of Conservation and Cultural Affairs
P.O. Box 4340
Charlotte Amalie, St. Thomas
U.S. Virgin Islands 00801
(809) 774-3320

Virginia

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

Washington

Dept. of Ecology
PV-11
State of Washington
Olympia, WA 98504
(206) 753-4348

Wisconsin

Office of Coastal Management
Dept. of Administration
General Executive Facility 2
101 S. Webster St.
Madison, WI 53702
(608) 266-3687

(6) STATE OFFICIALS RESPONSIBLE FOR DISASTER OPERATIONS AND EMERGENCY PLANNING

Alabama

Director, Civil Defense Dept.
State Administrative Building
64 North Union Street
Montgomery, AL 36130
(205) 832-5700

Alaska

Director, Division of
Emergency Services
P.O. Box 2267
Palmer, AK 96645
Dial 9 (907) 248-0055

American Samoa

Commissioner of Public Safety
Department of Public Safety
Office of the Governor
Pago Pago, Tutuila
American Samoa 96799
Overseas Operator
(160+684) 633-4127

Arizona

Director, Arizona Division
of Emergency Services
5636 East McDowell Road
Phoenix, AZ 85008
(602) 273-9880

Arkansas

Director, Officer of Emergency
Services
Dept. of Public Safety
P.O. Box 758
Conway, AR 72032
(501) 329-5601 (in Conway)
(501) 374-1201 (in Little Rock)

California

Director, Office of Emergency
Services
P.O. Box 9577
Sacramento, CA 95823
(916) 421-4990 Ext. 201

Colorado

The Adjutant General
300 Logan Street
Denver, CO 80203
(303) 733-2431 Ext. 41

Director, Disaster Emergency
Services
DOC, Camp George West
Golden, CO 80401
(303) 279-7555

Connecticut

State Director
Connecticut Office of Civil
Preparedness
State Armory, 360 Broad Street
Hartford, CT 06115
(203) 566-3180

Delaware

Director, Division of Emergency
Planning and Operations
Department of Public Safety
P.O. Box C
Delaware City, DE 19706
(302) 834-4531

District of Columbia

Acting Director, Office of
Emergency Preparedness
Room 5009, Municipal Center
300 Indiana Avenue, N.W.
Washington, D.C. 20001
(202) 727-6161

Florida

Chief, Bureau of Disaster Preparedness
1720 S. Gadsden Street
Tallahassee, FL 32301
(904) 488-1320

Georgia

Deputy Director of Civil Defense
Georgia Emergency Management Agency
P.O. Box 18055
Atlanta, GA 30316
(404) 656-5500

Guam

Director, Civil Defense
Territory of Guam
P.O. Box 2877
Agana, Guam 96910

Hawaii

The Adjutant General and
Director of Civil Defense
3949 Diamond Head Road
Honolulu, HI 96816
Dial 9 (808) 734-2195

Idaho

State Coordinator
Bureau of Disaster Services
650 West State Street
Boise, ID 83720
(208) 334-3460

Illinois

Director, Illinois Emergency
Services and Disaster Agency
110 East Adams Street
Springfield, IL 62706
(217) 782-2700

Indiana

Director, Indiana Department of Civil
Defense and Emergency Management
90 State Office Building
100 North Senate Avenue
Indianapolis, IN 46204
(317) 232-3830

Iowa

The Adjutant General & Executive Director
Department of Public Defense
Camp Dodge, R.R. #1
Grimes, IA 50111
(515) 278-9211

Director, Office of Disaster Services
Hoover State Office Building
Level A
Des Moines, IA 50319
(515) 281-3231

Kansas

Deputy Director, Division of
Emergency Preparedness
P.O. Box C-300
Topeka, KS 66601
(913) 233-9253 or 333-7560 Ext. 300

Kentucky

Adjutant General and State Director
of Disaster & Emergency Services
EOC Building
Boone National Guard Center
Frankfort, KY 40601
(502) 564-8558

Louisiana

Assistant Secretary
Department of Public Safety
Office of Emergency Preparedness
P.O. Box 66536
State Land and Resource Building
Baton Rouge, LA 70896
(504) 342-5470

Maine

Director, Bureau of Civil Emergency
Preparedness
State Office Building
Augusta, ME 04333
(207) 622-6201

Maryland

Director, Maryland Civil Defense &
Disaster Preparedness Agency
Reisterstown Road and Sudbrook Lane
Pikesville, MD 21208
(301) 486-4422

Massachusetts

Director, Massachusetts Civil
Defense Agency & Office of
Emergency Preparedness
400 Worcester Road
Framingham, MA 01701
(617) 237-0200

Michigan

Deputy State Director of
Emergency Services
111 South Capitol Avenue, 2nd Floor
Lansing, MI 48913
(517) 373-0617

Minnesota

Director, Division of Emergency
Services
B-5, State Capitol
St. Paul, MN 55155
(612) 296-2233

Mississippi

Director, Mississippi Emergency
Management Agency
P.O. Box 4501, Fondren Street
Jackson, MS 39216
(601) 354-7200

Missouri

Director, Disaster Planning
and Operations Office
P.O. Box 116
Jefferson City, MO 65102
(314) 751-2321 Ext. 173

Montana

State Disaster Coordinator
Disaster & Emergency Services Div.
P.O. Box 4789
Helena, MN 59604
(406) 449-3034

Nebraska

Adjutant General and Director,
Nebraska Civil Defense Agency
National Guard Center
Lincoln, NB 68508
(402) 473-1100

Nevada

Director, Civil Defense and
Disaster Agency
2525 South Carson Street
Capitol Complex
Carson City, NV 89710
(702) 883-7111

New Hampshire

Director, New Hampshire Disaster
Planning Office
Room 3 - Building 257
NHANG, PAFB
Portsmouth, NH 03801
(603) 436-2450

New Jersey

New Jersey State Police
State Police Headquarters
P.O. Box 7068
West Trenton, NJ 08625
(609) 882-2000 Ext. 201

New Mexico

Director, State Planning Division
Department of Finance and Administration
505 Don Gaspar, Greer Building
Santa Fe, NM 87501
(505) 827-2073

New York

Disaster Preparedness Program
Division of Military and Naval Affairs
Public Security Building
State Campus
Albany, NY 12226
(518) 457-2222

North Carolina

Assistant Secretary of Public Safety
Department of Crime Control and
Public Safety
116 West Jones Street
Raleigh, NC 27611
(919) 733-3867

North Dakota

Director, Disaster Emergency Services
P.O. Box 1817
Bismark, ND 58505
(701) 224-2111

Northern Mariana Islands

Disaster Control Officer
Commonwealth of the Northern
Mariana Islands
Saipan, Mariana Islands 96950
Overseas Operator (160+671) 6407

Ohio

The Adjutant General and
Director of Disaster Services
2825 W. Granville Road
Worthington, OH 43085
(614) 889-7070

Oklahoma

Director, Oklahoma Civil
Defense Agency
P.O. Box 53365
Oklahoma City, OK 73152
(405) 521-2481

Oregon

Administrator, Emergency
Services Division
Oregon State Exective Department
43 Capitol Building
Salem, OR 97310
(503) 378-4124

Pennsylvania

Director, Pennsylvania Emergency
Management Agency (PEMA)
Room B151, Transportation and
Safety Building
Harrisburg, PA 17120
(717) 783-8150

Puerto Rico

Director, State Civil Defense Agency
P.O. Box 5127
San Juan, PR 00906
Dial 9 (809) 724-0124

Rhode Island

Director, Defense Civil Preparedness
Agency
State House
Providence, RI 02903
(401) 421-7333

South Carolina

Director, South Carolina Emergency
Preparedness Division
Rutledge Building
1429 Senate Street
Columbia, SC 29201
(803) 758-2826

South Dakota

The Adjutant General and State
Director of Civil Defense
Camp Rapid
P.O. Box 2150
Rapid City, SD 57709
(605) 394-2211

Administrative Services Officer
Division of Emergency and
Disaster Services
EOC State Capitol
Pierre, SD 57501
(605) 773-3231

Tennessee

Director, Division of Civil Defense
and Emergency Preparedness
Emergency Operations Center
National Guard Armory
Sidco Drive
Nashville, TN 37204
(615) 741-5181

Texas

Chief, Division of Disaster
Emergency Services
Texas Department of Public Safety
Box 4087, North Austin Station
Austin, TX 78773
(512) 465-2000 Ext. 2434

Trust Territory of the Pacific Islands

Disaster Control Officer
Office of the High Commissioner
Trust Territory of the Pacific Islands
Saipan, Mariana Islands 96950
Overseas Operator (160+671) 9367, 9306

Utah

Utah Division of Comprehensive
Emergency Management
Department of Public Safety
1543 Sunnyside Avenue
Salt Lake City, UT 84108
(801) 533-5271

Vermont

Deputy Director
Civil Defense Division
132 State Street
Montpelier, VT 05602
(802) 828-2163

Virginia

State Coordinator, Office of
Emergency and Energy Services
310 Turner Road
Richmond, VA 23235
(804) 745-3305

Virgin Islands

Lt. Governor
P.O. Box 450
Charlotte Amalie
St. Thomas, VI 00801
Dial 9 (809) 774-2991

Washington

Director
Department of Emergency Services
4220 East Martin Way
Olympia, WA 98504
(206) 753-5255

West Virginia

Director, Office of Emergency Services
State Capitol Building, Room EB-80
Charleston, WV 25305
(304) 348-5380

Wisconsin

Deputy Administrator
Office of Emergency Government
Hill Farms State Office Building
4802 Sheboygan Avenue #99A
Madison, WI 53702
(608) 266-2983

Wyoming

Coordinator, Wyoming Disaster and
Civil Defense Agency
P.O. Box 1709
Cheyenne, WY 82001
(307) 777-7566

APPENDIX B GENERAL SOURCES OF INFORMATION ON FLOODPLAIN MANAGEMENT, STORMWATER MANAGEMENT, AND COASTAL EROSION

FLOODPLAIN MANAGEMENT

- Lehman Powell Associates, Inc. A Process for Community Flood Plain Management. U.S. Department of Interior, Office of Water Research and Technology. November 1979. 121 pages.

  A planning manual that presents guidelines for the process of preparing and implementing plans for the reduction and avoidance of flood damages. The manual emphasis a discussion of planning process. It includes as well a review of the full variety of tools available for flood plain management. The legal framework of flood plain management is discussed, along with technical and financial assistance available. References are included. The manual also contains a selected list of federal programs offering flood plain management assistance.

- Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Natural Hazard Management in Coastal Areas. Washington, D.C. November 1976. 250 pages.

  This handbook provides easy access to information on a wide range of natural hazards affecting coastal areas including hurricanes, floods, coastal erosion, landslides, earthquakes, tsunamis, volcanoes, avalanches, and land subsidence. The information is organized by coastal hazard and by category of management recommendations. It is not intended to provide in-depth scientific analyses but instead focuses on an overview of hazard area delineation, kinds of adjustments, federal policy and programs, and community examples. It includes an annotated bibliography as well as a directory of selected federal, state, and voluntary agencies concerned with natural hazards in the coastal zone.

- U.S. Army Corps of Engineers, Hydrologic Engineering Center; by William D. Carson. Estimating Costs and Benefits for Nonstructural Flood Control Measures. October 1975. 100 pages.

  This research paper reports the findings of William D. Carson, Research Economist at the University of California, Davis, on procedures for estimating costs and benefits of three nonstructural measures: flood-proofing, evacuation/relocation, and land use regulation. Cost data from a number of Corps of Engineers reports are summarized for flood-proofing and evacuation. The report concludes with some observations on criteria for an adequate analytic tool to screen nonstructural measures.

- U.S. Army Corps of Engineers, Hydrologic Engineering Center and Institute for Water Resources; by William K. Johnson. Physical and Economic Feasibility of Nonstructural Flood Plain Management Measures. March 1978. 225 pages.

  This report presents the findings of an investigation into the physical and economic feasibility of 11 nonstructural flood plain management measures -- temporary and permanent closures for openings in existing structures; raising existing structures; small walls or levees around new or existing structures; rearranging or protecting damageable property within an existing structure; removal of existing structures and/or contents from a flood hazard area; flood forecasting, warning, and evacuation; elevating new structures; construction materials and practices for new or existing structures; zoning ordinances, subdivision regulations, and building and housing codes; public acquisition of flood plain land, and flood insurance. Appendices contain the detailed damage analyses used in establishing economic feasibility, a summary of the engineer's cost estimates for selected measures, and a bibliography of literature collected during this study.

• U.S. Water Resources Council. A Unified National Program for Flood Plain Management. Washington, D.C. September 1979. 90 pages.

An update of the 1976 Unified National Program this report: (1) sets forth a conceptual framework for floodplain management; (2) identifies available management strategies and tools for reducing the risk of flood loss, minimizing the impacts of floods on human safety, health, and welfare, and restoring and preserving natural and beneficial floodplain values; (3) assesses the implementation capability of existing federal and state agencies and programs; and (4) makes recommendations for achieving a unified national program for floodplain management.

• Waananen, A.O., Limerinos, J.T., Kockelman, W.J., U.S. Geological Survey and Spangle, Blair, Spangles & Associates. Flood-Prone Areas and Land Use Planning -- Selected Examples from the San Francisco Bay Region, California. Geological Survey Professional Paper 942, Washington: U.S. Government Printing Office. 1977. 75 pages.

This report focuses on the relationships between land use planning and floodplain management through an examination of the problem of flooding in the San Francisco Bay region. It describes the preparation and use of various types of flood maps and flood information reports, lists sources of information on flooding and floodplains, discusses flood loss prevention and reduction measures, and addresses the role of comprehensive planning in floodplain management.

STORMWATER MANAGEMENT

- American Society of Civil Engineers. Urban Stormwater Management in Coastal Areas. 1980. 435 pages.

  A collection of papers presented during the June 1980 National Symposium on Urban Stormwater Management in Coastal Areas. This report includes reports covering the following aspects of coastal stormwater management: frequency analysis, management approaches, runoff simulation, estuaries and canals, planning models, stormwater quality control models, lake and detention basins and inlets and channels. References are included for each section.

- American Society of Civil Engineers, National Association of Home Builders, and Urban Land Institute. Residential Storm Water Management: Objectives, Principles and Design Considerations. Second Printing, March 1977. 64 pages.

  This report emphasizes the desirability of detaining or storing rainfall where it falls, on-site, thereby attentuating both peak runoff and total short-term runoff. Its discussion of objectives, principles and design considerations attempts to articulate a creative approach to managing stormwater that moves beyond historic urban drainage practices. Considerations in analyzing stormwater runoff and storage are presented along with design considerations for streets and curbs, natural drainage, underground pipe systems, and stormwater inlets.

COASTAL EROSION

- Mitchell, James K. Community Response to Coastal Erosion; Individual and Collective Adjustments to Hazard on The Atlantic Shore. University of Chicago, Department of Geography Research Paper No. 156, Chicago: 1974. 209 pages.

  The problem of coastal erosion is reviewed and individual and community adjustments to erosion are examined. Case studies of five east coast communities are described in an attempt to understand how communities reach erosion control decisions.

- Sorenson, John H. with J. Kenneth Mitchell. Coastal Erosion Hazard in the United States: A Research Assessment. Institute of Behavorial Science, University of Colorado, Boulder, Colorado: 1975. 63 pages.

  Though directed towards identifying research needs and opportunities, this assessment discusses the dimensions of the coastal erosion problem in the U.S., the range of possible adjustments, and the findings of current research.

- U.S. Army Corps of Engineers, North Central Division. Help Yourself: A Discussion of Erosion Problems on the Great Lakes and Alternative Methods of Shore Protection. Revised September 1978. 25 pages.

  This pamphlet provides private property owners with technical assistance for the protection of the Great Lakes shoreline from damage due to erosion. An explanation of shore erosion is provided along with planning considerations for erosion control. A number of general shore protection designs and costs are presented, with discussions of construction and maintenance guidelines, standard designs, and sample specifications in order to help the property owner select a type of shore protection. The discussion may be of interest to non-Great Lakes communities as well as those in the Great Lakes region. It also contains a glossary of shoreline erosion terms.

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