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WISCONSIN'S SHORE EROSION PLAN: AN APPRAISAL OF OPTIONS AND
STRATEGIES

by

Roger Springman

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AN APPRAISAL OF
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by

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Roger Springman
Steve Born

June 1979

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PREFACE

The effective management of erosion hazard areas along Wisconsin's Great Lakes shoreline requires a combination of state and local actions. Studies of erosion management alternatives by the Wisconsin Coastal Management Program have shown that erosion problems can be handled in a large number of ways by state and local governments. In this regard, this document was prepared to serve as the basis for public policy formulation and action in Wisconsin. It was not intended to prescribe single, community-specific solutions for the Great Lakes shoreline. By providing the factual basis for tailoring structural and nonstructural approaches to fit specific problems, individual communities and state agencies can select appropriate responses, consistent with their style and management needs.

The Wisconsin Coastal Management Council, the policy-making body for the Coastal Management Program consisting of twenty-nine state and local government representatives, discussed alternative erosion policies through the winter of 1979. On March 21, 1979 the Council adopted a twelve-point action strategy largely based on Erosion Plan findings. Simultaneously, the Council began to implement a number of these actions, particularly those that relate to regulatory process improvement, shoreland zoning, and hazard disclosure. A complete listing of these actions is provided on the following page. This twelve-point strategy provides an initial state and local government response to the policy questions raised in Chapter VI of this report.

Listing of Actions Taking by the Wisconsin Coastal
Management Council (3/21/79)

1. Adopt the "guidelines for damage reduction programs" as a set of policies for state agency actions and a framework for local government action. Publicize and encourage incorporation in state and local policies.
2. Recommend to DNR that they specify the criteria used in making decisions or applications for shore structure permits (environmental impact, downdrift effect, design considerations, etc.)
3. Clarify the permitting process, streamlining it where possible, seeking to simplify forms and procedures.
4. Have DNR establish systematic coordination and review sessions for professionals at the local, state, and federal levels to exchange information on existing problems and alternative solutions.
5. Up-grade DNR staff expertise on coastal and bluff engineering for the development of improved procedures and criteria.
6. Conduct training seminars for private engineers, public works offices, and others on coastal and bluff engineering.
7. Conduct public information workshops on erosion hazards for lending institutions, realtors, civic groups, etc.
8. Locate high risk erosion areas and provide map(s) to the Real Estate Examining and Licensing Board for publication, alerting realtors and their clientele to the location of hazards.
9. Establish a technical assistance capacity to answer local property owners' questions; assist local governments in developing erosion programs; and to help in training programs.
10. Encourage local governments to undertake erosion planning using incentives, information, and technical assistance provided by the state.
11. Initiate a study of beach nourishment, its feasibility and impact on reducing erosion damage as well as its impact on the environment.
12. Seek demonstration projects of innovative solutions to erosion damage mitigation.

ACKNOWLEDGEMENTS

Numerous individuals, some over a four-year period, have contributed to the Coastal Management Program's Shore Erosion Study Plan. Some have been involved in data gathering, others in analysis, and yet others in review and comment on the many working papers which underpin this document. We wish to especially note the contributions of Tuncer Edil, Department of Civil and Environmental Engineering, University of Wisconsin-Madison; Charles Hess, Department of Health and Social Services (formerly with the Department of Natural Resources); Ted Lauf, Department of Natural Resources; Dave Mickelson, Department of Geology and Geophysics, University of Wisconsin-Madison; Al Miller, Wisconsin Coastal Management Program, Department of Administration; and Douglas Yanggen, Environmental Resources Unit, University of Wisconsin-Extension.

In addition, we would like to gratefully acknowledge the following for their contributory roles: Onno Brouwer, UW-Madison (formerly with DNR); Ed Brick, DNR; Kent Butler, University of Texas-Austin (formerly with UW-Madison); Rich Cohen, UW-Madison (formerly with the Office of State Planning and Energy); Robert DeGroot, Owen Ayres and Associates (formerly with GNHS); Doris Fischer, Department of Revenue (formerly with GNHS); Mark Greenwood, University of Michigan-Ann Arbor (formerly with Office of State Planning and Energy); Dave Hadley (formerly with GNHS); Serge Hanson, U.S. Forest Service (formerly with Owen Ayres and Associates); Gregory Hedden, Sea Grant College Program, University of Wisconsin; Norman Lasca, UW-Milwaukee; Richard Lehmann, UW-Extension; M.E. Ostrom, GNHS; David Owens, North Carolina Coastal Management Program (formerly with Office of State Planning and Energy); Gordon Pirie, UW-Milwaukee, Michelle Rothenburg (formerly with Office of State Planning and Energy); Al Schneider, UW-Parkside, and Paul Tychsen, UW-Superior.

Finally, we wish to especially thank the Wisconsin Geological and Natural History Survey, and in particular Mike Czechanski and Valarie Wulf, for providing the necessary supportive services for this document, and serving as the coordination point for a large part of Study Plan activities.

Chapter I

INTRODUCTION

In mid-1974, Wisconsin began its formal participation in coastal management planning under provisions of the national Coastal Zone Management Act of 1972. That Act offered coastal states, including the Great Lakes states, the opportunity to receive federal financial assistance while developing a program to improve the management of their coastal shorelands and waters. For those state programs approved by the federal Office of Coastal Zone Management, U.S. Department of Commerce, additional assistance was provided to implement the management plan. Executive Order 49 of 1977 officially created the Wisconsin Coastal Management Council, the policy-making body for the coastal program. The Wisconsin Coastal Program was approved by the federal government on June 8, 1978--the first Great Lake state to receive program approval.

From its inception, the principal goal of the Wisconsin Coastal Management Program was to preserve, protect, develop, and, where possible, restore the resources of Lakes Michigan and Superior. Through the extensive involvement of state and local officials and citizens, a number of major coastal problems and issues were identified for Program attention and action. Shore erosion was consistently ranked as a high priority concern of riparian property owners and local government officials. Interest and concern in shore erosion was high because Lakes Michigan and Superior were at record high levels during this period (1972-1976), and coastal property owners, businesses, and governments were suffering millions of dollars in damages as a result of extensive erosion. In response to this concern, the Coastal Management Program initiated a shore erosion planning study in late 1974.

Wisconsin's Shore Erosion Study Plan was directed towards coordinating all related erosion activities, developing a more complete coastal data base, identifying erosion hazard areas, analyzing various structural and nonstructural damage reduction options, and "packaging" necessary information for state policy decision-making, primarily through the Wisconsin Coastal Management Council. In addition, several special studies on subjects such as lake level regulation, ordinary high water mark definition

and delineation, and erosion damage compensation were also conducted. A diagram of the Erosion Study Plan is found on Figure 1. Appendix A contains a complete listing of all erosion-related reports and working papers of the Coastal Management Program. Information from this entire work effort has been incorporated into this summary report--Wisconsin's Erosion Plan: An Appraisal of Options and Strategies.

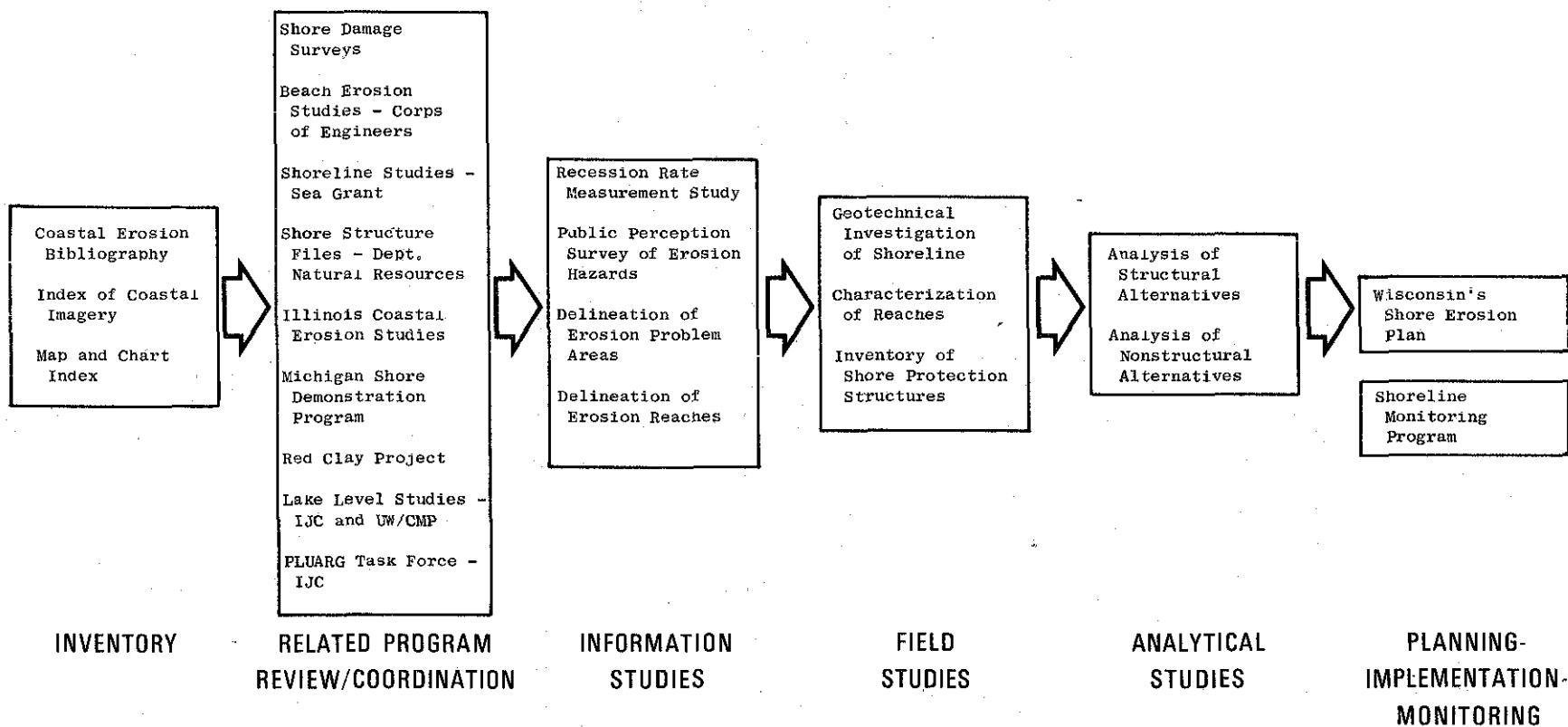
During this four-year study effort, a great wealth of supportive information was generated by the Coastal Management Program. Vertical and oblique aerial photography, shoreline recession rates, geologic and geotechnical data, and inventories of shore protection structures represent a few of the "tools" which were required to underpin the Study Plan. Much of this information was immediately made available to, and used by, state agencies, local governments, and regional and county planning agencies in their coastal planning and management activities.

Role of this Report

Coastal erosion is not a new problem or hazard along the Great Lakes shoreline. Erosion of Wisconsin's shorelines began at least ten thousand years ago after the retreat of glacial ice sheets, the establishment of the present outlet conditions, and the stabilization of post-glacial lake levels. Depending upon the rate of shoreline recession (retreat) and the effectiveness of any structural actions taken to reduce these rates, all buildings and economic activities in close proximity to the Great Lakes can become endangered along erodible beaches, dunes, and bluffs. At present, about 150 miles of Wisconsin's Great Lakes shoreline have serious erosion hazard problems. The U.S. Army Corps of Engineers recently estimated damage losses at \$16 million along Wisconsin's shorelines between 1972 and 1976.

Coastal erosion directly affects several thousand coastal property owners and a greater number of Wisconsinites through impacts upon public facilities and beach and bluff use, e.g. public facility protection, higher park and beach maintenance costs, limitations for marina and boat launching development. Hence it is appropriate that the state take a close look at the impacts of, and damage reduction options for, coastal erosion along Lakes Michigan and Superior. But, it should be noted that erosion is only

Figure 1: Wisconsin's Shore Erosion Study Plan



facet of a far larger hazard area management problem in Wisconsin, as indicated by comparing the above damage figures with statewide flood damages in excess of \$50 million during 1978 alone. At some point, the state may wish to consider a more comprehensive approach to resolving common hazard area management problems.

This report, Wisconsin's Erosion Plan: An Appraisal of Options and Strategies, assesses state-level policy options to reduce shore erosion damages along the Great Lakes shoreline. The report describes and evaluates policy alternatives for mitigating erosion damages through both structural and nonstructural measures on developed and undeveloped lands. Although the Erosion Plan does not provide a series of specific recommendations for immediate policy-level action, the focus is on before-the-fact strategies rather than after-the-fact emergency measures. Erosion control or structural strategies have generally not proved cost-effective over the short and long term. However, given the continuing amount of riparian and local government interest in structural approaches, particular attention has been given to the possible role of state government in providing further financial and technical assistance. Also, it should be pointed out that the Shore Erosion Study Plan produced a geotechnical data base that can be utilized in follow-up, site-specific engineering feasibility studies.

Chapters IV and V are the "heart" of Wisconsin's Erosion Plan. Chapter IV, Remedial Approaches to Damage Reduction: Structural Alternatives, reviews basic structural options and their limitations, then analyzes three types of possible state-level responses: regulatory framework modification, financial assistance, and technical assistance. Chapter V, Preventive Approaches to Damage Reduction: Nonstructural Alternatives, highlights four major preventive options: land use regulation, acquisition, relocation, and hazard disclosure, then assesses some alternative implementation strategies. The final chapter, Setting the Course: Some Final Considerations, provides a brief overview of research, monitoring, and interstate coordination needs for the effective reduction of damages in Wisconsin. A wide range of management-related information is contained in the Appendix. Those topics of special interest include a listing of financial/technical assistance sources, several laws and programs from other coastal states, and cost-data for structural solutions.

From the outset, the intent of this Study Plan summary report has been to provide the factual basis for making decisions and choosing among alternative courses of action. Consequently no recommended, or "best", courses of action are found within the Erosion Plan. The process of selecting the "best" option(s) is often, in the case of policy decision-making, a value judgement. For example, is it "best" to reduce future erosion damages by preventing further development of erosion-prone lands by regulation? Or, is it "best" to achieve this objective by providing relevant information about the potential hazards to prospective developers, land purchasers, realtors, lending institutions, local government officials, etc.? To a great extent, the answer to this question depends upon one's point of view. Yet another illustration--if land use regulation is to be the focus of damage reduction actions, is it "best" to regulate at the local or state levels? "Best", as regards public policy, is a subjective determination--a point all too often overlooked by technical specialists. Such questions are resolved by a political process. In laying out the various alternatives for the Wisconsin Coastal Management Council, state agencies, and local governments, we hope that the Erosion Plan will serve as a sound foundation for the policy-making process.

One final note. This report is a policy plan, not an area-specific action plan. As such, it does not provide a detailed blueprint for each foot of shoreline--as traditional land use plans and maps do. Regardless of what actions, if any, the state may choose to take over the next few years to reduce damages, local government officials and coastal riparians should find this report helpful in determining what actions can be taken independent of state activities.

In summary, the possible actions growing out of the Coastal Management Program's erosion planning effort have the potential to shift Wisconsin's response from a reactive, remedial posture to a preventive, anticipatory one. The policy decisions made by the Wisconsin Coastal Management Council, state agencies, and local governments, along with the extent of public support for these decisions, will largely determine whether this effort has been "one more study" or an important ingredient in improving coastal management in Wisconsin.

Chapter II

OVERVIEW OF SHORE EROSION IN WISCONSIN

A. Shoreline Setting and Conditions

Nearly one-half of Wisconsin's Great Lakes shoreline is vulnerable to shore erosion. The 1971 National Shoreline Study¹ identified 290 miles of Wisconsin's 620 mile mainland shoreline as having significant erosion potential. Wisconsin's shoreline is highly vulnerable to shore erosion largely because of the presence of unconsolidated glacial materials such as gravels, lake-deposited clays, and tills* in coastal landforms. These materials have little ability to withstand the persistent attack of shore erosion agents, particularly storm-driven waves during high water periods. The susceptibility of coastal landforms to shore erosion has been further increased by land use activities and management practices along the shoreline. Once coastal landforms such as bluffs, beaches, and dunes become unstable or subject to wave attack, recession* generally continues until an equilibrium is reached between lake levels, gravity, and ground water conditions. Except where wetlands (marshes), bedrock outcrops, and durable, long-term structural devices adjoin the shoreline, shore erosion remains a real or potential threat from Carol Beach in Kenosha County to Superior Harbor in Douglas County.

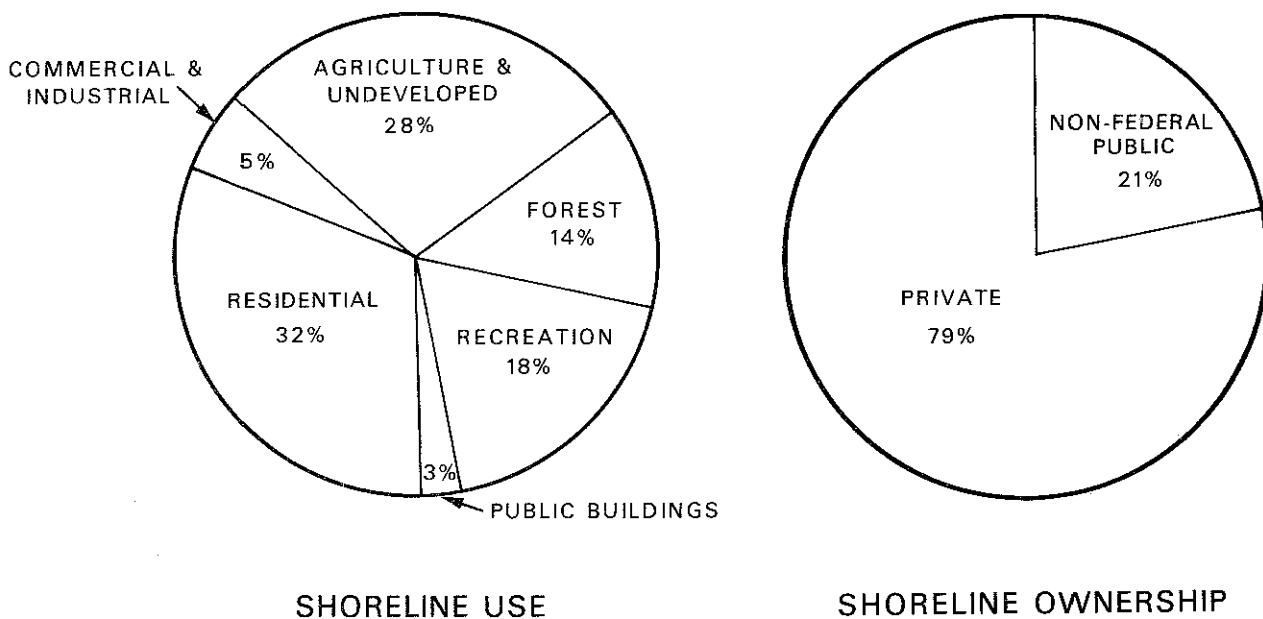
Wisconsin's Lake Michigan shoreline is generally vulnerable to shore erosion from the Illinois state line to the Sturgeon Bay Canal--a distance of 185 miles. From the Sturgeon Bay Canal around the northern tip of Door County to Green Bay, shore erosion is largely limited to bays and clay bank areas. Coastal flooding replaces shore erosion as the most serious natural hazard from Green Bay to the Michigan state line. Erosion rates are particularly high along sandplains and high bluffs composed of till. Short term recession rate measurements² of 3-15 feet per year have been recorded along sandplains and 2-6 feet per year along high blufflines. Bluff height increases from less than five feet in southern Kenosha County to 80-100 feet near Whitefish Bay. From southern Ozaukee County to the

* Refer to glossary on page 119 for definition or explanation

Sturgeon Bay Canal, the bluff crest generally remains 40-80 feet above the lake. Near Virmond Park in southern Ozaukee County, the bluff reaches its highest elevation of 140 feet. Water movement or seepage in coastal bluffs is common along the entire Lake Michigan shoreline. Much of the Lake Michigan bluffline remains in a relatively unstable condition because of toe erosion* during the 1972-1976 high water period. Exposed or unvegetated slopes are common along a significant portion of the shoreline. Beach widths presently vary between 10-20 feet along high bluffs to 50-100 feet along sandplains and dunes.

Shore erosion presents a widespread and serious hazard along many of Lake Michigan's coastal reaches*. Twenty-four percent (24%) of Wisconsin's entire population lives in incorporated communities having erosion-prone reaches along Lake Michigan (see Appendix K, Selected Land Use Information on Incorporated and Unincorporated Coastal Areas). These communities include Milwaukee, South Milwaukee, Racine, Kenosha, Sheboygan, Kewaunee and Manitowoc-Two Rivers. Urban-related land uses (residential, commercial, and industrial) account for 36% of total shoreline use from Kenosha County to northern Door County. Table I provides an overview of land use and ownership along this section of coast.

Table I: Shoreline Use and Ownership-Lake Michigan (Illinois State Line to Northern End of Door County)



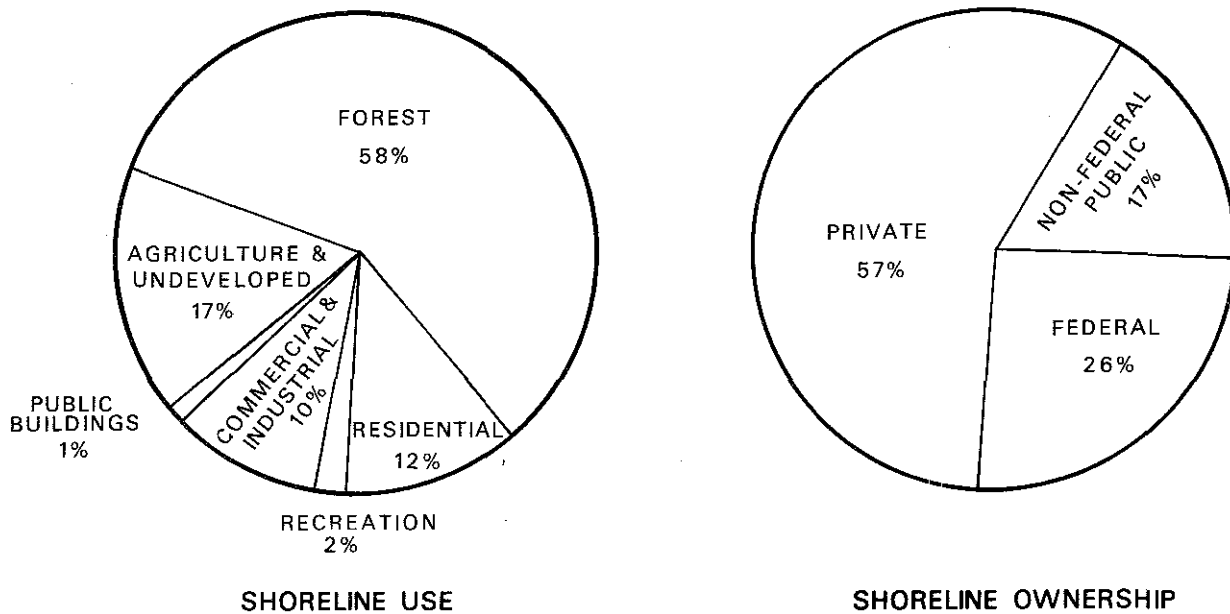
Source: National Shoreline Study. Army Corps of Engineers. 1971

A large number of public and semi-public facilities such as power plants, water intakes, sewage treatment plants, marinas, state parks, and county/local parks adjoin the shoreline. Approximately 80% of the shoreline is held under private ownership and 20% by state, county and local governments. Shore protection structures are concentrated around public facilities, recreational facilities, urban centers, and residential developments. Over 800 structural devices were recently inventoried between the Illinois state line and Manitowoc.³

Except for several bedrock and wetland areas in Ashland and Bayfield Counties, Wisconsin's Lake Superior mainland shoreline is generally vulnerable across its entire length--a distance of 212 miles. Although sandstone bluffs and rocky beaches are found along many of the Apostle Islands, locally, erosion continues to pose significant problems along the Madeline Island shoreline. Nearly one-half of the Lake Superior shoreline consists of high clay bluffs. These clay bluffs are largely confined to two major stretches of shoreline: from Iron County to the White River in Ashland County and from Bark Point in Bayfield County to the base of Wisconsin Point in Douglas County. The highest bluffs, some near 200 feet, are found near Port Wing in Bayfield County. Because the silts and clays which comprise coastal landforms are subject to flows* as well as slumps* and slides*, bluff erosion is a continual problem along many reaches. Recession rates of 2-5 feet per year are common along blufflines and rates in excess of 10 feet per year have been recorded around bays, e.g. Port Wing. Much of the bluffline remains in an unstable and unvegetated condition. Beach widths presently vary from 10-20 feet along high bluff areas to 50-100 feet near sand bays, sand points, and river mouths.

Shore erosion problems and hazards are more localized along the Lake Superior shoreline than they are along Lake Michigan. Only 1% of the state's entire population lives in the four incorporated communities of Lake Superior--Ashland, Bayfield, Washburn, and Superior. Over 75% of the shoreline is devoted to agricultural, recreational, or forest land uses. Table II provides an overview of land use and ownership along the shoreline. Forty-three percent (43%) of the shoreline is under public ownership, federal and non-federal. Two Indian reservations, Bad River in Iron and

Table II: Shoreline Use and Ownership-Lake Superior



Source: National Shoreline Study. Army Corps of Engineers. 1971

Ashland Counties and Red Cliff in Bayfield County, and the Apostle Islands National Lakeshore account for virtually all federal ownership. Excluding boat ramps and harbors, only a small number of public and semi-public facilities are located along the shoreline. The relatively few shore protection structures of the Lake Superior shoreline are concentrated around recreational facilities and residential areas, both permanent and seasonal.

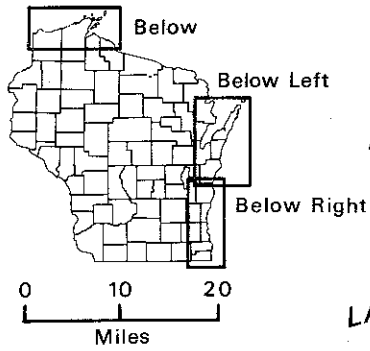
Erosion hazards are critical, either continually or cyclically, along a significant portion of Wisconsin's Great Lakes shoreline. Coastal Management Program investigations of recession rates, slope stability conditions, development patterns, and shore damages have revealed that between 125 and 150 miles of shoreline can be classified as critical at the present time. Those areas of particular concern to coastal residents, local government officials, and state agencies along the Lake Michigan shoreline include the Carol Beach area; the shorelines between Kenosha and Racine, Windpoint and the Oak Creek Power Plant, South Milwaukee and Cudahy, Shorewood and Grafton; the shorelines adjoining Port Washington, Sheboygan, Manitowoc,

Kewaunee; and areas where highways run close to coastal bluffs, e.g. Sheboygan County LS, State Highway 42 Manitowoc/Kewaunee County. Although the Lake Superior shoreline has a smaller number of critical hazard reaches, damage potential is still significant in several areas. Those areas of particular concern include the Superior Harbor region; the shoreline between Washburn and Bayfield; the southern and eastern sides of Madeline Island; the shorelines adjoining Ashland, Saxon Harbor, Cornucopia, Herbster, Port Wing; and Highway 13 near Port Wing. Figure 2 on page 11 provides a map of actively eroding areas along Wisconsin's Great Lakes shoreline.

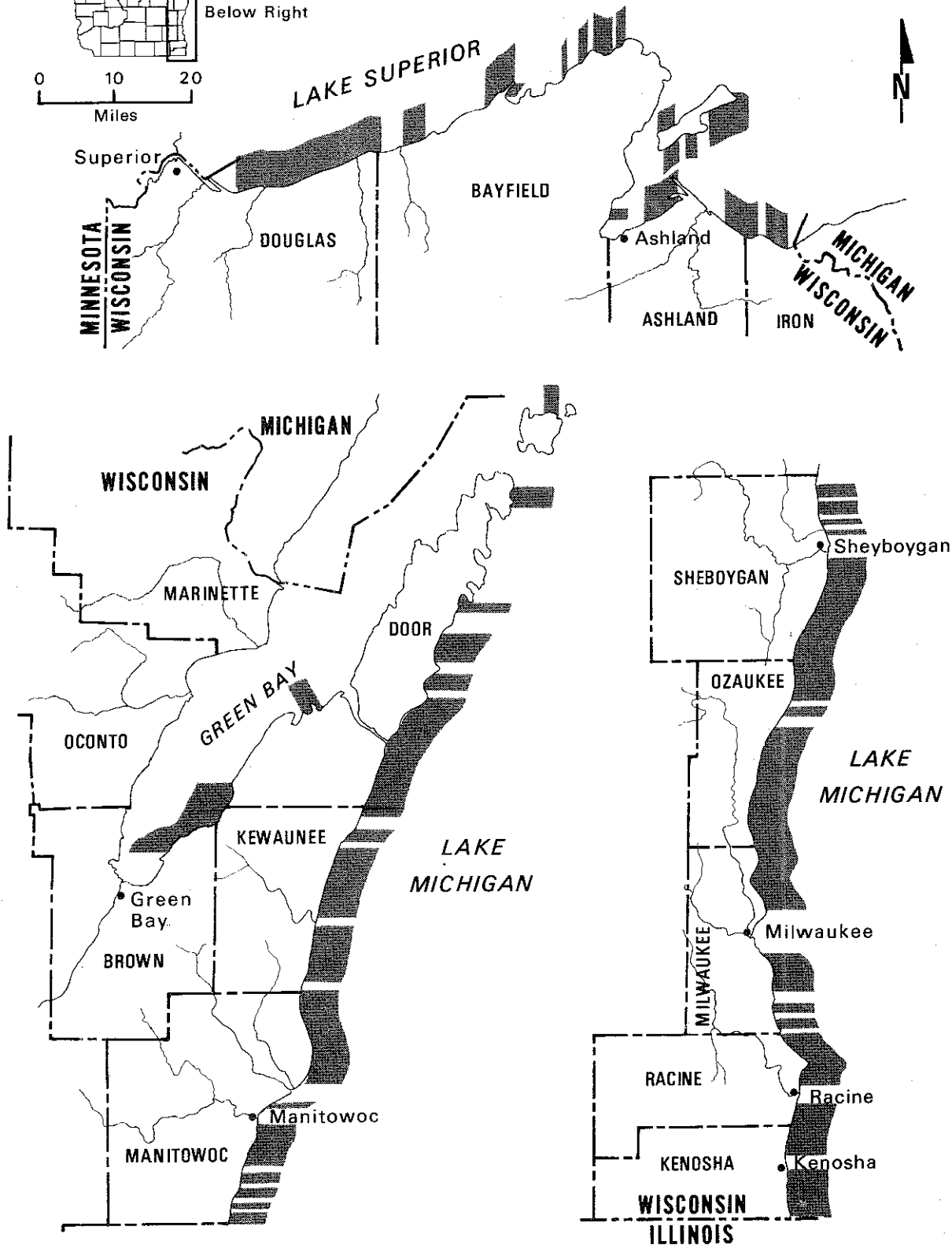
Shore erosion rates and problems have generally been decreasing since 1976. This reduction can largely be attributed to the natural decline of the Great Lakes water levels from their 1974 record highs.⁴ However, coastal riparians, local government officials, and state agencies should not be lulled into a false sense of security during the present lower water period. Erosion will continue to "gnaw away" at the second and third tiers of development along many reaches thereby endangering once distant homes, businesses, and public facilities. Then during the next high water period--perhaps some twenty years from now--erosion damages may dramatically increase, Effective and long-term damage reduction can only come about when erosion hazard areas are managed on a sustained basis.

B. Causes and Processes

Traditionally, shore erosion has been viewed as a natural hazard only caused by the action of storm-driven waves during high water periods. This has led many coastal residents and public officials to assume that shore erosion is only associated with high water periods. While the largest amount of bluff and beach recession generally occurs during or immediately after high water periods, many erosive forces and agents are at work on a year-round basis. These agents and forces include gravity, water seepage, wind action, and ice (frost) action. Wave action during high water periods serves as a "trigger" to destabilize coastal landforms--sometimes for a decade or more. Increasingly, man's coastal land use activities, upland management practices, and shore protection devices are also being seen as erosion agents. This complex, natural weathering process cannot, and should not, be generalized for on-site planning or engineering. Before



ACTIVELY ERODING AREAS



WISCONSIN
G&NS 1978

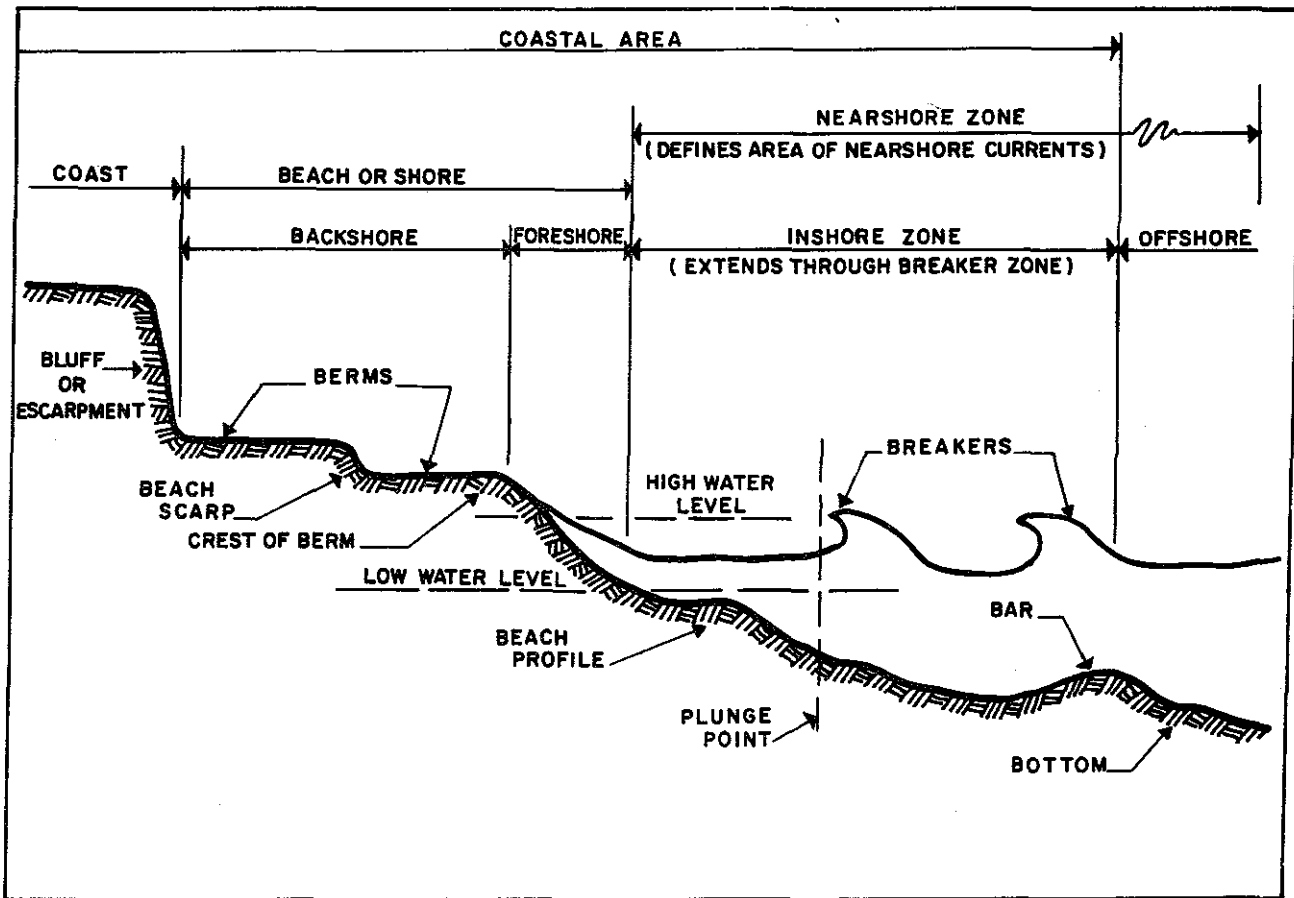
initiating actions to reduce shore erosion hazards and damages, care must be taken to insure that all causes and process have been accurately identified.

A complete discussion of all forces, processes, and agents associated with erosion of Wisconsin's Great Lakes shoreline can be found in two previous reports of the Wisconsin Coastal Management Program: Great Lakes Shore Erosion Protection - A General Review with Case Studies and Shore Erosion Study Technical Report. For this abbreviated summary, the shoreline has been divided into three zones: the beach and bluff toe area, bluff area, and upland management area. Each of these zones or areas will be briefly discussed below. The final paragraphs provide an overview of two man-related factors: artificial lake regulation and shore protection structures.

Beach and Bluff Toe Zone

The beach and toe zone provides the primary contact between the Great Lakes and its coastal landforms. Two agents, waves and currents, are constantly at work in this area. Beaches provide a natural cushion or buffer for coastal bluffs by absorbing wave energy over their sand or gravel surfaces. A generalized profile of wave-approach conditions along coastal bluffs and beaches is found on Figure 3. Where beaches are absent or too steep, waves can directly erode any unconsolidated materials in bluff toes thereby destabilizing the entire bluff face. Generally speaking, the gentler and wider the beach, the more effective it will be at absorbing wave energy. In 1970, 48% of the Lake Superior and 68% of the Lake Michigan shoreline had beach zones along Wisconsin's major erosion-prone reaches.⁵ Currents result from the net movement of wave energy along the nearshore and offshore zones. Because they can transport soil and fine rock particles along the shoreline (littoral drift*), longshore currents can be particularly helpful in the build-up or accretion of beaches. But, they can also remove particles (scouring) around shore protection structures, rock outcrops, and any other fixed points thereby narrowing beaches or damaging structures.

Figure 3: Beach Profile and Related Terms



Source: National Shoreline Study: Shore Protection Guidelines. Army Corps of Engineers, August 1971.

The ability of waves and currents to cause erosion around the beach and toe zones is largely dependent upon lake levels, storm direction and intensity, wind strength and duration, nearshore and offshore bottom configuration, and ice pack depth and duration. Few factors are as critical as lake level conditions. An increase in water levels generally decreases beach width, increases nearshore erosion by currents, and permits waves to expend their energy directly against unconsolidated glacial materials. A great majority of all beach recession or retreat occurs during high water periods.

The cyclic fluctuations in Great Lakes water levels are largely due to the confined outlet conditions of the Great Lakes combined with variations in precipitation. Table III provides a summary of high water level conditions from 1860 to 1976. Lake Michigan water levels have been above 579 feet (generally recognized as the threshold level for significant damages) for nearly 60 years--one half of this period. Lake Superior water levels have shown greater stability, partially due to artificial lake regulation.

Table III: High Water Periods and Episodes Along Lakes Michigan and Superior: 1860-1976

Lake Michigan	Lake Superior
Year(s) Above 579 Feet Elevation (2.2 feet above low water datum)	Year(s) Above 601.5 Feet Elevation (1.5 feet above low water datum)
1972-1976++	1970-1973
1969-1971	1968
1951-1955++	1952-1950++
1943-1948	1947
1929-1930	1943-1944
1916-1920	1938-1939
1890-1909	1928
1873-1889++	1916
1872	1899-1900
1869-1871++	1876
1866-1868	
1860-1865++	

+ Except where indicated by ++, threshold damage levels were only reached on a seasonal basis, typically between May and September.

++ Periods of near constant levels above 579 feet and 601.5 feet.

Source: Monthly Bulletins of Great Lakes Water Levels and
Cumulative Records, National Oceanic and Atmospheric
Administration

Regardless of water level conditions, a critical consideration in the delivery and transfer of wave energy is wind direction and intensity. Wind speed and direction largely determine the size of waves reaching the beach zone. Storm-setup (the local rise in lake levels due to wind-driven waves) often ranges between 10 and 18 inches along the Great Lakes shoreline.

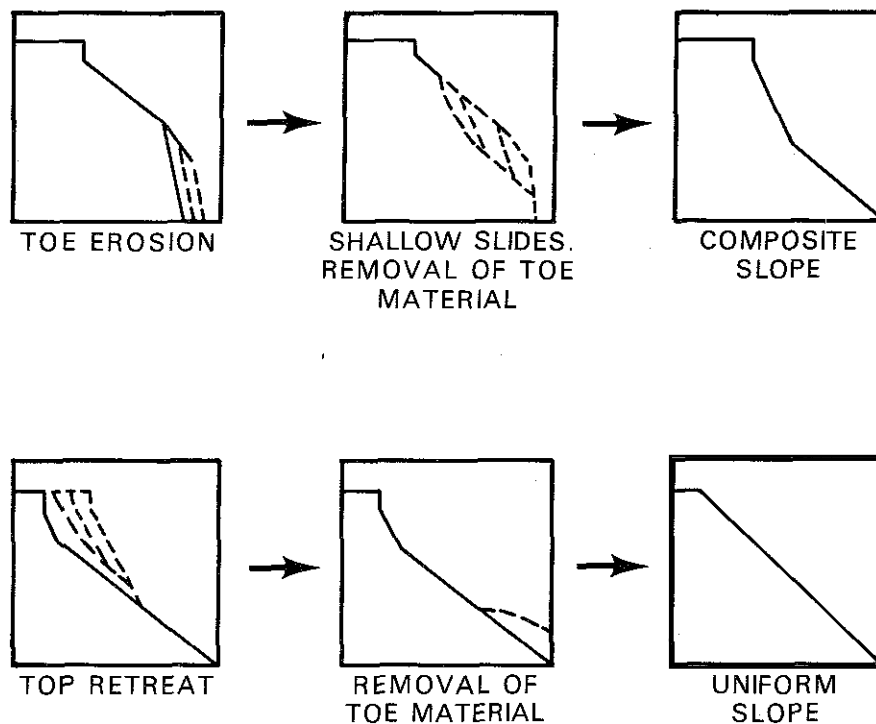
Because extreme wind and wave attack conditions are directly associated with major storm events, storm records and predictions are important tools for coastal planners and engineers.

Bluff Zone

Nearly 80% of Wisconsin's erodible Great Lakes shoreline suffers from bluff erosion and recession problems. Excluding the destabilizing action of waves at the toe, a number of additional agents are at work in the bluff zone. They include gravity, water seepage, ice (frost), and all too often, man. Reducing the threat of wave attack by constructing shore protection devices only serves as a partial solution. Regardless of the cause(s), once a bluff becomes unstable, it will undergo profile change through slope failures until a new stable slope angle is reached. The most common forms of slope failure are slumps, slides, and flows. Figure 4 illustrates two bluff profile changes near Port Washington. Bluff volume losses associated with slope failures along the Great Lakes shoreline have been enormous. For example, south of the Oak Creek Power Plant in Racine County, over 38 million cubic feet of material eroded into Lake Michigan between 1968 and 1974 alone.⁶ However, it should be pointed out that all wave-induced bluff recession does not occur during high water periods. A three to four year time lag between high water periods and interim bluff stabilization has been observed on the Great Lakes.⁷ In general, Lake Michigan and Superior bluffs appear more stable when their angles are less than 25°. Where slope modifications are planned, a 2:1 to 3:1 (horizontal to vertical) grade is often recommended.⁸

Geologically, most coastal bluffs contain layers of unconsolidated glacial materials, e.g. till-clay-till, sand-gravel-till. When acted upon by erosive agents and forces, each layer tends to respond differently. Any agents or forces which increase bluff weight, reduce internal soil strength, or remove soil particles will tend to decrease slope stability. Water is, perhaps, the most critical agent acting upon bluffs. Both ground and surface water can greatly increase shore erosion hazards. Regardless of the source, water entering the ground water system adds weight to the bluff, removes soil particles upon discharge, and reduces internal soil strength. Excessive surface water runoff can create gullies and destabilize bluff

Figure 4: Bluff Profile Changes Near Port Washington



SOURCE: Shoreline Erosion and Landslides in the Great Lakes Edil and Vallejo;
University of Wisconsin-Civil and Environmental Engineering Department

faces by removing soil and vegetation. In some places, the amount of material removed by surface erosion may exceed that amount removed by slumps and slides.

Frost and ice action over the winter months (solifaction*) contribute to a large amount of annual bluff erosion. Between one and two feet of erosion has been attributed to this agent annually along the Kewaunee County shoreline.⁹ Gravity is the universal and constant force acting upon all coastal landforms. Once other agents have sufficiently destabilized a bluff, gravity will pull all loosened materials down through slides, slumps, and

flows. Deep-seated failure planes* and large slump blocks*, such as the types occurring in northern Milwaukee County, pose a special problem and danger. They can cause sudden and large-scale damage over a long shoreline expanse.

Upland Management Zone

A great number of land use activities and management practices adjacent to the shoreline increase the susceptibility of bluffs to erosion. The primary agent at work in this area is man. Generally, any land use or management practice that adds weight to the bluff, increases or alters ground and surface water movements, alters the shoreline geometry (slopes) and removes or alters the existing vegetation regime should be avoided along coastal bluffs--or only be undertaken after a comprehensive site analysis. Along high risk reaches, public officials and coastal riparians should be particularly sensitive to the impacts of development upon erosion processes.

Waste water and surface water management is critical along the entire Great Lakes shoreline. Septic tank drainage fields, leaky storm sewers and water mains, and highway drainage culverts have contributed to many failures over the years. For example, near Bark Point in Bayfield County, a highway culvert extended a gully back over 100 feet from the edge of the Lake Superior shoreline.¹⁰ Leaky storm sewers in several Lake Michigan communities have served to lubricate soil materials and increase ground water pressures thereby increasing erosion potential. Land management practices such as vegetation removal and earth grading can dramatically increase rates of erosion. Plants, particularly trees and shrubs, reduce the amount of water entering the soil, provide protection against surface erosion, strengthen the soil mass through root penetration, and provide some protection against excessive frost penetration. Building codes, zoning ordinances, and special management ordinances, e.g., tree removal, sediment control, can all assist in reducing man's impact within the upland management area.

Shore erosion rates are affected by many man-related factors. Two factors which warrant consideration are artificial lake regulation and shore protection devices. Considerable public debate has centered around the further regulation of Great Lakes water levels to reduce erosion hazards and damages over the past decade. While it is true that Great Lakes water levels are affected by the operation of locks and dams, diversions, and power gates, the net impact of these devices remains difficult to accurately measure. In a 1976 report¹¹ prepared for the Wisconsin Coastal Management Program, a University of Wisconsin research team concluded:

All the regulation plans ... can exercise only limited control over fluctuations of water levels on the Great Lakes. Natural factors such as climate and the configuration of connecting channels exert, by far, the major influence.

Further, because the volumes of water are so enormous and the outlet conditions so confined on the Great Lakes, a substantial time lag (measured in months or years) exists between an action and any measurable change in water levels. Even though artificial lake regulation does not generally offer a viable alternative for reducing erosion damages, the State has gone on record as wanting to participate in all matters affecting lake level modification. In a 1975 letter¹² to the International Joint Commission and Great Lakes Basin Commission, Governor Patrick Lucey noted that "any management scheme must take into account the possibility of damage along the Lake Michigan shoreline" and the "unique qualities of Lake Superior and its environs".

Shore protection structures can have some localized and significant impacts on erosion processes and rates. Three types of structures are widely recognized: shore perpendicular structures, shore parallel structures, and offshore breakwaters. Each type, depending upon its design, materials, and placement, can cause problems, both updrift and downdrift. Their adverse impacts are more observable along reaches with intermittent protection. Generally, shore perpendicular structures such as groins and jetties tend to accelerate erosion through sand entrapment and downdrift beach starvation. Shore parallel structures tend to accelerate erosion rates through the deflection of wave energy. A more complete discussion of adverse impacts is contained in Chapter IV.

C. Damages and Impacts

Over the past 100 years shore erosion has caused millions of dollars in damages to residential lands and buildings, recreational lands and facilities, agricultural lands, public facilities, and shore protection structures. Comprehensive estimates of damage losses have only been taken during high water periods. The 1952 Great Lakes Shoreline Damage Survey, coordinated by the Army Corps of Engineers, remains the most complete inventory of erosion-related losses. Between the springs of 1951 and 1952, damage totaled \$745,000 and \$3,582,000 along the Lake Superior and Lake Michigan shorelines, respectively.¹³ Up-dated to 1970 dollar values, the costs are \$1,482,000 and \$7,793,000 for Lakes Superior and Michigan, respectively.¹⁴ Presently, the Army Corps of Engineers is in the process of completing a damage survey for the 1972 to 1976 high water period. Preliminary findings have revealed that damages in excess of \$16 million occurred during this four-year period.¹⁵ Even after adjustments for inflation, losses may be nearly double that of the previous period along some reaches. Table IV provides a listing of recent losses by category and lake.

Extensive erosion damages are not limited to high water periods alone. Under favorable conditions, storm events during "normal" water level periods can cause significant damage. For example, the Lake Superior shoreline suffered an unusual amount of erosion during 1968 because of storms and high seasonal water levels. Damage losses totaled \$156,200.¹⁶ The year-round action of gravity, ice, wind, and water also contributes to damage losses along the Great Lakes. Any attempts to generate comprehensive annual damage figures should account for all possible erosion processes and events.

**Table IV: Preliminary Summary of Erosion-Related Damages: 1972-1976
(by category)**

	LAKE MICHIGAN SHORELINE	LAKE SUPERIOR SHORELINE
Residential	\$ 9,732,000	\$619,000
Commercial/ Industrial	971,000	45,000
Transportation	10,000	110,000
Agriculture/ Utilities	3,296,000	---
Other	<u>1,124,000</u>	<u>30,000</u>
Total	\$15,133,000	\$804,500

Source: Great Lakes Damage Survey: Labor Day 1972-Labor Day 1976
(preliminary), North Central Division, Army Corps of Engineers,
September 1978.

Damage losses attributable to shore erosion will, in all probability, substantially increase in the future. The International Great Lakes Levels Board, in conjunction with the Army Corps of Engineers, has estimated that annual damages between Milwaukee and Manitowoc alone could increase from \$4.3 million in 1980 to \$16.4 million in 2020.¹⁷ Steadily increasing property values (largely due to inflation) will account for much of this jump. But, two additional factors, increasingly acute hazard conditions and structural failures, could push projected losses even higher.

Along many reaches of Wisconsin's shoreline, the second and third tiers of development are increasingly being exposed to erosion hazards. Since building density and public facility investment are often higher along this zone, damage losses may be significantly greater during future high water periods. Evidence of this phenomena has recently been seen by the number of highways requiring emergency protection/relocation. Even though building losses have been minimal in recent years (estimated at under 50 since 1950), more can be anticipated in the future. To alleviate hazard conditions, many property owners and local governments have turned to shore protection structures. Ironically, in spite of their costs and design, many will fail during high water periods as a result of improper maintenance, inadequate engineering, or conditions exceeding design capabilities.

Damages resulting from the failure of structural devices will be quite high in the future--both for the structure (replacement) and the land it is protecting.

Aside from its devastating effects upon property and structures, shore erosion has had other impacts upon the coastal region over the past 100 years. As a result of bluff and beach recession, the State of Wisconsin has lost between three and six square miles of land since 1900. Between January 1973 and April 1974 alone, Bender Park in southern Milwaukee County lost 8.68 acres.¹⁸ During the same high water period, Douglas, Brown, and Racine Counties lost 9.5 million square feet of beach (one-third of a square mile).¹⁹ Such losses have economic and land use implications beyond the affected property owners. Local and county governments lose a valuable portion of their tax base, either outright or through changes in land use because of hazard conditions. For example, the City of Oak Creek has estimated that erosion in Bender Park cost taxpayers \$34,666 (park land was valued at \$5,000 per acre)²⁰ in 1974.

To reduce damages and losses, many communities have encouraged low density and open space shoreline land uses. Nearly 40% of Milwaukee County's shoreline is in park/recreational uses. Thus both public and private investment opportunities have been affected by shore erosion. Public access to, and use of, the Great Lakes shoreline has also been seriously affected by shore erosion. Along many reaches, high bluffs combined with unstable slopes have virtually eliminated beach access. Finally, because shoreline protection is essential around all key public facilities, e.g., power plants, sewage treatment plants, the costs and risks associated with shore erosion are shared by all residents of coastal regions.

Shore erosion has played, and is playing, an important role in modifying Wisconsin's natural environment as well. The enormous volumes of sand, silt, and clay moving out into deeper water alter fresh water ecosystems, either temporarily or permanently. Conclusive evidence on the impacts of coastal erosion within the offshore environment is not available at this time. Many indications suggest that erosion may be playing an important role in warming the nearshore zone, adding nutrients to the lake

system, providing more productive aquatic habitats, and in facilitating species diversification. Shore erosion has significantly modified the shape and configuration of Wisconsin's shoreline. These effects are particularly noticeable near non-erodible headlands such as bedrock and shore protection structures. Commonly, erosion-resistant areas maintain their shoreline position while erodible areas around them retreat thereby creating bays with peninsulas or points on either end. The shorelines of Door and western Bayfield Counties offer excellent examples of this phenomena. Before taking actions to stop or control erosion, the beneficial aspects of shore erosion should be thoroughly understood. Some erosion may, in fact, be necessary to insure the presence of sufficient quantities of sand in the littoral drift for the natural accretion of beaches and protection of coastal properties.

D. Traditional Approaches to Damage Reduction

A variety of structural and nonstructural techniques have been utilized to reduce shore erosion damages along Wisconsin's Great Lakes shorelines over the years. Generally, structural solutions such as groins, revetments, breakwaters, and bulkheads have been intensively used around residential and commercial properties, public facilities, harbors, and recreational developments. Most structural devices either attempt to reduce wave attack along beaches and bluffs or hold-back earthen materials at the base of bluffs. Average cost ranges for intermediate to long-term forms of shore protection vary between \$150 to \$350 per linear foot. Nearly two-thirds (563) of the 800 inventoried structures located between the Illinois state line and Manitowoc are found in Kenosha, Racine and Milwaukee Counties. Another 300 structures have been inventoried in Brown and Douglas Counties by the Corps of Engineers.²¹

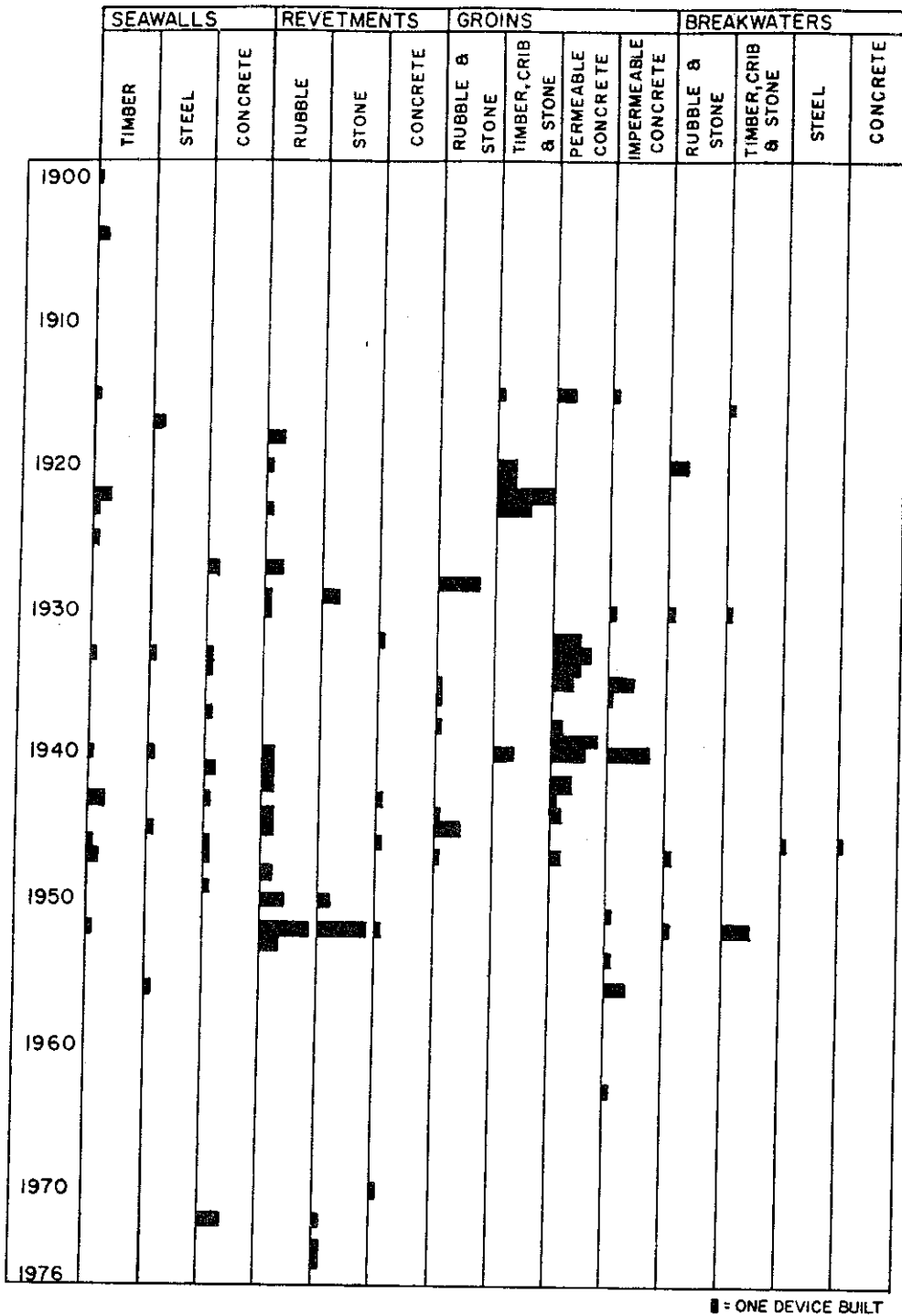
Nonstructural options such as building setbacks and hazard area zoning have generally been seen as more viable options in developing and rural areas. Rather than attempting to out-design or engineer erosion processes, these options anticipate continual erosion thereby promoting the safer siting of certain land uses. One nonstructural option, relocation, is starting to receive greater consideration for developed areas. Increasingly, land and water management practices are also being incorporated into preventive

approaches. In particular, bluff dewatering and vegetative stabilization techniques have been used more frequently in recent years.

Historically, prior to the 1920's, shore property owners were somewhat cautious in their encroachments upon the shoreline, particularly near high bluffs and beaches. Because shore protection structures were generally constructed of wood, stone, or sheet pile, long-lasting solutions could not be ensured. Stone-filled cribs, timber seawalls, and stone riprap revetments were common forms of protection. Some property owners sought to further protect themselves by providing deeper building setbacks. Beginning in the 1930's, concrete came into popular use for groins and seawalls. With the availability of more permanent types of protection, the shoreline could be more intensively used near urban areas. Throughout the 1940's and 1950's, the Beach Erosion Control Board and Corps of Engineers provided the public with information on coastal processes and structural solutions. A large percentage of Wisconsin's existing concrete structures were built between 1930 and 1950. Table V provides an overview of structural devices in Milwaukee, Racine, and Manitowoc Counties between 1900 and 1976.

During the 1951-1952 high water period, a large number of structures were either damaged or destroyed. With this destruction came a greater realization of the costs and difficulty associated with erosion control strategies. Interest in shore erosion generally declined with lake levels during the 1950's and 1960's. In 1965, the Wisconsin Legislature passed a Water Resources Act encouraging coastal counties and communities to initiate comprehensive nonstructural approaches through shoreland and floodplain zoning. Although the administration and enforcement of the resultant Shoreland Management Programs has varied over the years, all coastal counties now have zoning ordinances in-place. The 1972-1976 high water period brought a resurgence of interest in temporary and low-cost structural protection. But, the subsequent decrease in water levels has once again brought about widespread public indifference. In spite of the many structural devices which have been developed over the past decade and the many nonstructural options available to state and local governments, few communities and riparians have experimented with new approaches for damage reduction. Today, Wisconsin's shoreline has nearly the same amount of protection and safeguards which it had in the late 1960's.

Table V: Historical Use of Shore Protection Devices in Milwaukee, Racine, and Manitowoc Counties



Source: Great Lakes Shore Erosion Protection: A General Review with Case Studies. Wisconsin Coastal Management Program, 1977.

The availability of sufficient lead-time and money for the planning and implementation of damage reduction solutions has been a major problem over the years. Typically, coastal residents, communities, and state agencies have only begun to seriously consider hazard mitigation alternatives as Great Lakes water levels rise. Few long-term solutions can be planned and implemented during a six to eighteen-month period. To provide some additional protection, low-cost and emergency structural solutions have been heavily relied upon, e.g. concrete rubble revetments, stone riprap revetments. Unfortunately these measures only temporarily postpone damage. Where time and money have run too short, relocation, selling, or abandonment have often become the solutions of last resort in Wisconsin. As bluff and beach retreat continue to place more buildings in peril, these options may be used more frequently in the future.

Given the amount of damage which has occurred along Wisconsin's Great Lakes shoreline over the past 25 years, it is clear that many traditional approaches, particularly structurally-oriented ones, have not proved effective. Along many reaches, if shore protection devices last more than fifteen years or through one high water period, they are considered a success. Generally, there appears to have been an over dependence upon structural solutions combined with a lack of understanding of erosion processes. Shore erosion is not a hazard which is simply eliminated with the expenditure of large sums of money on shore protection. Careful site analysis and design must precede the placement of all structural devices-- and even then "success" is measured in terms of a few decades. Without proper engineering and maintenance, structural failure can be expected at an even earlier point. Virtually all emergency structures and many low-cost structures (those under \$100 per linear foot) do not last beyond ten years.

Existing nonstructural solutions have not proved any more effective. While all coastal counties and many coastal communities have adopted minimum setback standards (75 feet from the ordinary high water mark), this single measure does not insure adequate protection. Recession rates and slope failure hazards are simply too great along many reaches. Also, since erosion hazard disclosure is not officially required in Wisconsin, decisions

on coastal lands continue to be made without adequate advance information. If traditional structural and nonstructural methods continue to be employed on an individual-needs basis in Wisconsin, damage losses can be expected to rise in the future.

Chapter III
ESTABLISHING A FRAMEWORK FOR ACTION

Introduction

Traditionally, the mitigation of erosion damages has been the responsibility of directly affected parties in Wisconsin--primarily coastal riparians and local governments. Direct state-level involvement has been limited and highly localized over the years. Factors contributing to this state-level position include the cyclic nature of serious erosion problems, the relatively small number of affected riparians, the relatively small amount of damages caused by coastal erosion compared to other natural hazards (especially riverine flooding) and the high costs of protection versus the low benefits. In short, in spite of historic damage losses, shore erosion has not been perceived as a high priority statewide issue. Thus, private property owners have been left with very limited public aid and assistance. Public entities are in a much better position to cope with erosion problems in that some financial and technical assistance is available through several federal and state agencies, e.g., Army Corps of Engineers, Soil Conservation Service, Wisconsin Department of Transportation, Wisconsin Department of Natural Resources.

Over the past four years there has been a growing awareness that the present framework does not adequately provide for long-term damage reduction. Simply stated, it appears that Wisconsin's individualistic and piecemeal approach toward erosion damage reduction has created a series of problems and conflicts. First, shore protection devices have often accelerated erosion rates on adjacent properties and, in many cases, have provided only minimal levels of protection. Second, because many land use regulations are not sufficiently erosion sensitive, damage potential is actually increasing along many coastal reaches in Wisconsin. Finally, within the present institutional framework, coordinated and comprehensive reach planning has been difficult to achieve. Consequently, those state and local agencies with coastal management responsibilities are finding it more difficult to meet broader environmental goals and objectives. In recognizing these and other problems through Wisconsin Coastal Management Program discussions, considerable attention has been focused on the possible roles

of state agencies. State agencies such as the Department of Natural Resources, Department of Transportation, Department of Local Affairs and Development, Board of Soil and Water Conservation Districts, University of Wisconsin-Extension and University of Wisconsin-Sea Grant Program all affect coastal decision-making in a number of ways; from regulatory requirements to financial assistance and technical assistance/education. Thus, the real dilemma facing state agencies is to determine what, if any, additional actions can be taken to facilitate the wise and environmentally sensitive reduction of shore erosion damages over the long term.

With the lowering of Great Lakes water levels from their recent record highs, Wisconsin is once again in a position to systematically address coastal erosion. Instead of dealing with erosion on a piecemeal, emergency protection basis, consideration can now be given to the full range of structural and nonstructural alternatives. Accordingly, in the present decision-making environment, damage reduction activities can be more objectively "tailor fit" to the long-term coastal management objectives of local governments and state agencies. In order to ensure the presence of sufficient lead-time to permanently reduce damages, actions should be initiated over the next few years. The memories and events of the last high water period are still on the minds of many local government officials and the several thousand riparians presently living along the next zone of endangerment. This opportunity for action should not be missed if Wisconsin's response to coastal erosion is to be based on foresight and not hindsight.

A. Principles and Guidelines for Reducing Erosion Damages

Regardless of what specific options state agencies may consider over the coming months and years, it has become increasingly evident that erosion damages cannot be efficiently and effectively reduced without some comprehensive policy-level guidance. Given the physical variability of Wisconsin's Great Lakes shoreline, the wide ranging erosion concerns of local governments and coastal riparians, and the number of structural and nonstructural shoreline management options available to reduce damages, the opportunity for conflicting, inappropriate, and/or inconsistent action remains high. The present state policy framework provides minimal guidance since state laws,

statutes, and administrative rules contain few direct references to shore erosion hazards or management options. For example, in protecting the state's interest in navigable waters, Chapter 30, Wisconsin Statutes, no firm rules have been adopted by the Department of Natural Resources for shore protection devices.²² Also, permit coordination/issuance has been further complicated by the presence of legislatively-approved lake bed grants (Chapter 30.05, Wisconsin Statutes) which cede state authority to local governments for selected public purposes. One of the most notable exceptions to the general lack of erosion policy specificity in Wisconsin is the Shoreland and Floodplain Management Program. Pursuant to Chapter 59.97, Wisconsin Statutes, a comprehensive land use management-oriented framework was developed for unincorporated lands within 1000 feet of the Great Lakes shoreline over the past decade. But, on erosion-related matters such as hazard disclosure, acquisition of hazard areas, relocation of endangered buildings/facilities, encouraging/discouraging specific types of structural solutions, and emergency assistance, the existing policy framework remains largely silent.

The lack of comprehensive policy statements on shore erosion has complicated the task of finding more enduring solutions to erosion hazards. Of special significance is the implicit encouragement of structural approaches to damage reduction. A careful historical review and analysis of protective devices reveals an important fact. Except for those large, durable devices, e.g., armor stone revetments, concrete seawalls, and groins, constructed by federal public works agencies (principally the Works Progress Administration and Army Corps of Engineers), public utilities, and industries, most structural devices have failed within two decades of their initial placement. Thus, coastal riparians have virtually "dumped" millions of dollars into protective measures with only a limited return. The historic tendency to view erosion hazard area management in terms of either structural or nonstructural options has obscured the real choice: erosion control versus damage reduction. As has been pointed out, erosion control through the application of structural techniques has been heavily relied upon over the years. However, this strategy is expensive, has had limited success, and in many cases has even increased erosion hazards. Damage reduction, on the other hand, implies a much broader approach to shoreline

and resource management. While structural techniques could be employed, the emphasis is placed upon nonstructural or preventive approaches. This general strategy recognizes the inevitability of shore erosion and the resultant need to make man's coastal land use activities more erosion sensitive; not erosion-proof. Damage reduction is attainable along the Great Lakes shoreline; permanent erosion control is not.

Through their police, general public welfare, and taxation powers, state agencies and local governments are in an excellent position to promote and implement damage reduction concepts. But, what of the several thousand individual coastal riparians who may face imminent hazards sometime within the next two decades? If individual structural actions are not seen as widely desirable, what options are available to riparians seeking to mitigate damages under the "common enemy" doctrine?²³ Briefly, such options as building relocation, land acquisition/exchanges, and "trading off" public access for shore protection all seem to hold promise under many circumstances. These options and others will be discussed in subsequent chapters. To summarize, with a sustained commitment to preventive-oriented approaches, damage reduction remains attainable along Wisconsin's entire Great Lakes shoreline.

In order to provide a comprehensive framework around which to build damage reduction programs, a set of guidelines has been prepared for state-level consideration. These guidelines are found on page 31. They cover a wide range of erosion-related concerns, from reach planning to hazard disclosure to structural implementation. These guidelines do not provide specific answers to every conceivable problem. Rather, they provide a common basis for decision-making, which can help ensure some decision-making consistently and compatibility over time. State agencies along with other public entities such as local governments, regional and county planning agencies, and park commissions could consider endorsing these guidelines, or making some appropriate modifications, as a first-step toward the implementation of damage reduction programs. Where several communities and/or agencies join forces to reduce erosion damages, a commonly accepted set of guidelines may greatly expedite program planning, design, and implementation.

Table VI: Guidelines for the Development of Shore Erosion Damage Reduction Programs in Wisconsin

1. Shore erosion is a complex natural process which is difficult, if not impossible, to totally arrest.
2. Even though Wisconsin's erodible coastal reaches possess many development limitations, they also provide resource opportunities in the form of natural areas, sand generation areas, aquatic/terrestrial habitats, recreational settings, and aesthetics for coastal communities and regions. These natural resource opportunities should be respected and, where possible, incorporated into damage reduction projects.
3. The planning and implementation of long-term damage reduction solutions must begin prior to the presence of high water and emergency periods.
4. Shore erosion problems can be more effectively reduced with cooperative and comprehensive planning between coastal property owners, local governments, and state agencies.
5. Land use management and other nonstructural approaches offer a viable and effective means for reducing damages and hazards over a long period of time. Priority must be given to these approaches in Wisconsin.
6. In some situations, structures can help mitigate damages. However, structures must be cautiously promoted and sited since many are costly and short-lived, and may create adverse impacts upon adjacent properties and the environment.
7. Sound technical information is essential for erosion management. Before initiating structural actions along the Great Lakes shoreline, the causes of erosion must be accurately identified in the beach, bluff toe, bluff, and upland management area zones. Erosion rates and slope stability information should be used to guide the development and implementation of nonstructural approaches.
8. In high hazard (risk) areas, new coastal development should be precluded or limited only to those land uses for which there is no feasible alternative location.
9. All individuals, agencies, and governments acquiring an interest in land along the shoreline should be informed of erosion hazards and of any special siting requirements in advance of final transactions.
10. Where public funds are used to reduce damages or preserve coastal resources on private property, the benefits to the public should be commensurate with the costs.
11. The multiple-use potentials of structural and nonstructural solutions should be utilized in the design and implementation of damage reduction programs wherever possible. Shore damage reduction can be compatible with public access, recreational opportunities, conservation, preservation, and aesthetics.

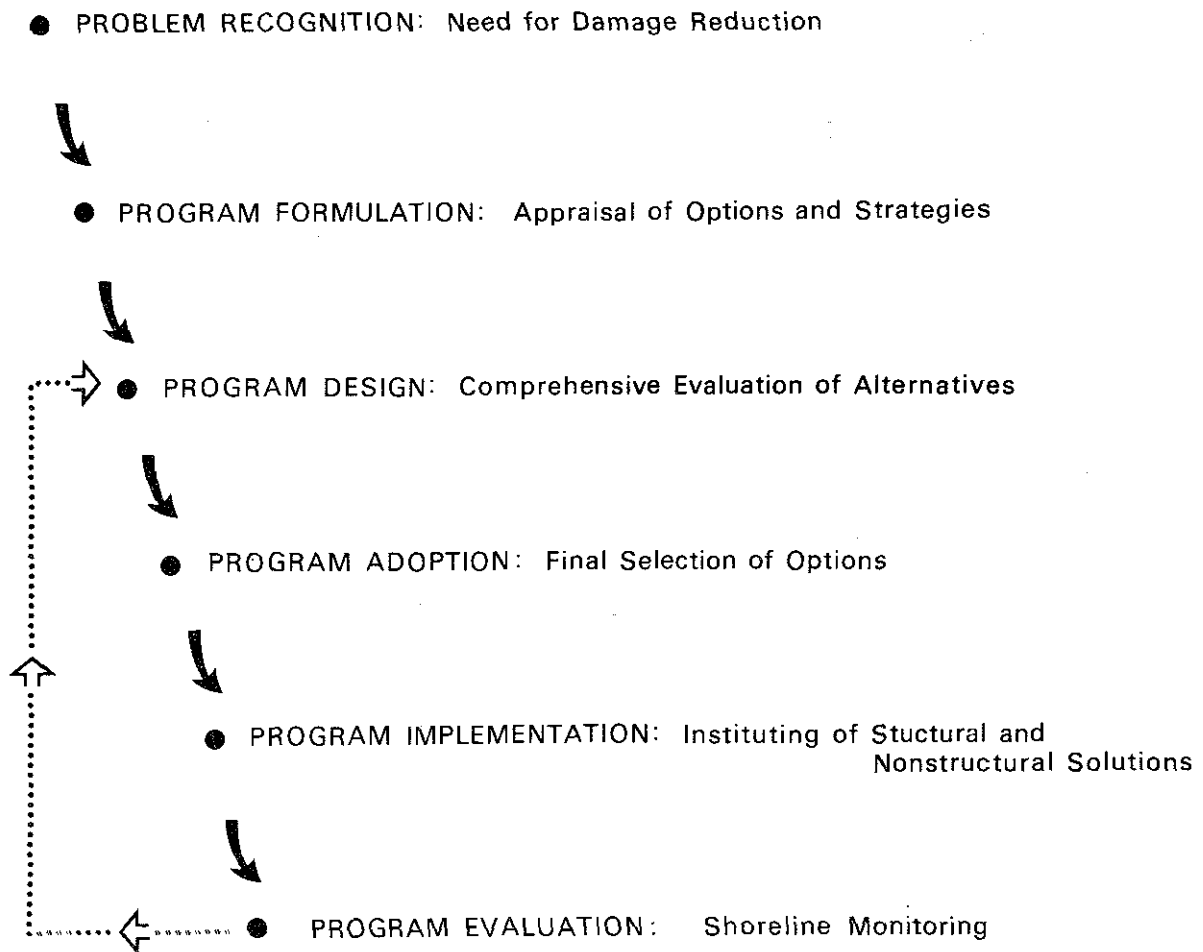
B. Planning Process for Damage Reduction Programs

Shore erosion damage mitigation should not be seen as a unique and individual problem of state agencies, local governments, and coastal riparians to be resolved in the absence of concern for other coastal management issues. Virtually all structural and nonstructural options have impacts upon public access, recreation, aesthetics, navigation, land use, transportation, or environmental quality. For example, stone revetments and riprap commonly hinder public access to beaches, limit recreational uses of the beach zone, and adversely impact coastal aesthetics. These options may be more feasible for privately-owned, high bluff shorelines where public access and recreational opportunities are typically more restricted than along publically-owned beach/sand dune environments. Likewise, in considering many nonstructural alternatives, special attention must often be given to existing/future land use controls, future recreational and public facility needs, transportation access, and wildlife/vegetational communities. Public acquisition of a small, isolated parcel of land along a high, erodible bluffline may not make for the most efficient use of public resources--if done for damage reduction purposes alone. For maximum effectiveness and impact, a close relationship must be cultivated between damage reduction programs and all on-going coastal planning/management activities. The multiple-use potentials of both structural and nonstructural options can, and should, be taken advantage of by state agencies, local governments, and coastal riparians.

Given the ever-expanding range of coastal issues, community/regional needs, erosion protection concerns, and federal/state requirements which public officials must consider, the development and implementation of long-range damage reduction programs has often proved difficult and controversial. While shorter term, erosion control projects have been seen as more expedient and feasible, the record has shown that this strategy should not be heavily depended upon. But, the step between limited-purpose, single riparian/community approaches and multi-faceted, reach approaches is long. To narrow this gap, and assist in the planning and implementation of long-term damage reduction programs in Wisconsin, a planning process has been developed for state and local government consideration. Figure 5 on page 34 contains a flow diagram of this process.

In short, the process recognizes the need to "package" damage reduction options through close coordination with existing coastal planning/management activities. It is not anticipated that the output of this process should be an identifiable plan or program in all cases. Rather, that for many public entities, the output might simply be an updating of existing recreational, water quality, land use, and/or public access plans to reflect greater erosion hazard sensitivity and a series of long-term damage reduction goals and objectives. Special damage reduction projects may be identified and funded, as needed, through available federal/state assistance programs. The recently completed Lake Michigan Estuary and Direct Drainage Area Subwatersheds Planning Program Prospectus²⁴ of the Southeastern Wisconsin Regional Planning Commission provides an excellent example of the type of product which could emanate from this process. State agencies, local governments, regional and county planning agencies, park commissions, and other public entities should consider using this process for evaluating, up-dating, and preparing damage reduction programs. When combined with the guidelines for damage reduction programs, a solid framework exists for managing erosion hazard areas in Wisconsin.

Figure 5: Generalized Planning Process for Damage Reduction Programs



Chapter IV

REMEDIAL APPROACHES TO DAMAGE REDUCTION; STRUCTURAL ALTERNATIVES

Introduction

Not all conditions and circumstances along Wisconsin's Great Lakes shoreline favor the increased use of preventive or land management-oriented approaches. Most notably, where resources or facilities of special public concern such as parks, historic sites, power plants, and marinas adjoin the shoreline, erosion control strategies may prove to be the only practical solutions. For coastal riparians, erosion control has historically been seen as an option of first, not last, resort. Given present rates of erosion and coastal development patterns, many privately-owned coastal buildings (primarily permanent and seasonal homes) could be endangered during, and immediately after, the next high water period. Thus, the several thousand coastal residents presently living within 75 feet of the bluff/beach edge will, in all probability, give erosion control high priority over the next two decades. Also, it can be expected that the number of erosion-related problems will continue to increase as erosion gets farther into the second and third tiers of coastal development. Evidence of this phenomenon is seen by the number of recent highway endangerments, e.g., Town of Port Wing, Bayfield County. And, even in those areas presently protected by intermediate to long-term devices, there is no assurance that effective levels of protection will remain beyond the next two decades. Thus, given the continuing amount of interest in, and need for, structural approaches to damage reduction, what additional role, if any, can the state government play?

Over the past several years a number of questions have been raised by coastal residents and local government officials about the costs and feasibility of structurally protecting Wisconsin's entire erodible shoreline. In theory, such an undertaking might lead to an immediate, and long term, reduction of erosion damages. Through a number of special studies, the Wisconsin Coastal Management Program has taken a close look at this strategy on a statewide and reach basis. Based on these investigations, it has been estimated that \$326 million would be needed to armor (long-term shore protection devices such as revetments, bulkheads, and seawalls) 200 miles of

erodible shoreline, \$170 million and \$63 million would be needed to bring the shoreline up to intermediate-life (devices capable of lasting from 5-25 years) and emergency protection (devices lasting from 2-5 years) levels, respectively. Table VII on page 37 provides a county-by-county breakdown of these figures. Appendix B summarizes the methodology used to generate these figures. Even on a more restricted basis, the costs of structurally protecting the shoreline remains quite high. For example, between \$9 and \$13 million would be required to structurally protect six miles of high bluffline in Ozaukee County (reach 12). Appendix C contains a listing of high/low long-term protection costs for thirty reaches along the Lake Michigan shoreline. Annual and post-storm maintenance costs were not included in the above analysis. Statewide, these costs could exceed \$10 to \$15 million per year.

Even if adequate financial resources could be generated for statewide or multi-reach erosion control strategies, a number of serious environmental, implementation, and policy concerns would have to be addressed. For example, the environmental impacts resulting from this strategy could adversely affect fish and wildlife habitats and alter coastal processes such that erosion rates would accelerate down the coast due to beach starvation, scouring, and nearshore profile changes. For these and other reasons, it could be expected that the Army Corps of Engineers and Wisconsin Department of Natural Resources would likely strongly oppose such extensive protection actions. However, this strategy raises an even more fundamental issue, that of public assistance to the private sector. Since the number of directly benefitting riparians would be relatively small, can substantial public expenditures be justified? In short, while a state-level erosion control program could be defended on several public interest principles, e.g. to protect public health/safety, protect public facilities, increase nearshore water quality, it does not appear that the net benefits of such a program would be commensurate with the costs--even if damage losses were considered.

Table VII: Structural Solutions Applied to Wisconsin's Erosion-Prone Shoreline: Initial Cost Estimate

Coastal County	Unprotected, Erosion-Prone Shoreline	Initial Cost of Structural Solution by Level of Protection		
		Temporary	Intermediate	Long-Term
Kenosha	26,750 linear feet	\$1,605,000	\$3,243,000	\$6,069,000
Racine	27,600	1,656,000	5,222,000	9,214,000
Milwaukee	65,000	3,900,000	11,515,000	21,845,000
Ozaukee	100,750	6,045,000	21,250,000	32,604,000
Sheboygan	55,250	3,315,000	9,938,000	14,262,000
Manitowoc	114,850	6,891,000	20,691,000	37,766,000
Kewaunee	114,750	6,885,000	25,651,000	40,941,000
-37- Door (to Sturgeon Bay)	25,000	1,500,000	3,741,000	7,452,000
Lake Michigan	529,950	31,797,000	101,251,000	170,153,000
Douglas	117,750	7,065,000	15,308,000	34,736,000
Bayfield	260,600	15,636,000	33,878,000	76,877,000
Ashland (with Madeline Island)	114,360	6,862,000	14,867,000	33,736,000
Iron	37,350	2,241,000	4,856,000	11,018,000
Lake Superior	530,060	31,804,000	68,909,000	156,367,000
Total	1,060,010 or 200.8 miles	\$63,601,000	\$170,160,000	\$326,520,000

Given that a state-funded, multi-reach erosion control strategy is not feasible or likely, other possible state-level responses need to be assessed. Three types of state responses appear to offer a possibility of further assisting in the management of erosion hazard areas along the Great Lakes shoreline. They are (1) regulatory framework modification, (2) expanded financial assistance programs, and (3) increased technical assistance. A wide range of sub-options and strategies are available under each one of the above responses. The remaining sections of this chapter will take a close look at all of the above options and strategies after reviewing the types and characteristics of structural devices.

A. Types and Characteristics

Shore erosion hazards and damages can be reduced through physical alterations of the shoreline and coastal processes. These alterations either promote beach accretion, armor the shoreline, intercept or attenuate waves, or stabilize the backshore and bluff zones. A wide variety of natural factors assist in determining which type(s) of solution is best for a given shoreline setting. They include bluff height, soil/subsoil conditions, onshore and offshore slopes, water level variations, wind and wave conditions (normal and during storms), shoreline orientation, and longshore current transport (littoral drift). Before entering the engineering design phase, such factors as financial resource availability, desired level of protection, future bluff/beach use and access, and lead-time assist in narrowing the range of site alternatives. Two commonly overlooked factors influencing decision-making are beach access and material availability. If trucks and heavy equipment cannot be brought to a site quickly and efficiently, project costs not only escalate dramatically, but many forms of more permanent protection are largely precluded. Where traditionally low-cost materials, e.g. sand, quarystone, large timbers, are not available or are too expensive to transport, more costly techniques and devices may be required.

Hundreds of protection devices and techniques have been devised over the years for different coastal settings and client needs. Each one affords a different level of protection, depending upon its material durability and design characteristics. Thus, structural devices and techniques can be

used as emergency or temporary solutions (less than five years), intermediate-life solutions (from five to twenty-five years), and long-term solutions (more than twenty-five years). Approximate cost ranges for these classifications per linear foot of protected shoreline are \$50 to \$100, \$100 to \$200, and above \$200, respectively. Generally, the more durable and permanent the structure, the higher the cost.

A complete discussion of the planning considerations and characteristics associated with all structural solutions is beyond the scope of this report. (see Great Lakes Shore Protection: A General Review with Case Studies and Great Lakes Shore Protection: Structural Design Examples--two previous reports of the Wisconsin Coastal Program--for more details.) To provide some added information for damage reduction planning purposes, representative types of structural solutions are discussed in Appendix D. Subjects addressed include definitions, general planning considerations, construction materials, and costs.

Even though a large number of structural devices (presently estimated at 1200) have been deployed along Wisconsin's shoreline, they reflect a relatively narrow range of types, designs, and materials. Riprapping, the loose-dumping of stone or large concrete blocks, has remained the most popular form of shore protection for individual riparians over the years. Often used in conjunction with filling, this technique is generally only suitable for short-term protection and it may create a number of additional problems, e.g. water pollution, aesthetics, public health/safety. The most commonly deployed engineered devices are stone groins and revetments, concrete rubble revetments, concrete groins, steel and timber bulkheads, and offshore breakwaters (near ports and harbors). Bluff regrading, vegetating, and dewatering have become more popular over the past decade. The Kewaunee County Soil and Water Conservation District has been particularly successful in demonstrating the value of these techniques.

One of the factors contributing to the narrow range of structural approaches in Wisconsin has been the lack of in-state expertise and experience with more innovative techniques. To reduce this knowledge and experience gap, a number of special demonstration and monitoring projects have been undertaken over the past few years. The Environmental Protection Agency, through the Red Clay Project, is exploring the use of Longard tubes near Madigan Beach,

Ashland County. Near Port Wing in Bayfield County, the Army Corps of Engineers installed a number of low to moderate-cost (\$116 to \$296 per linear foot) revetments and bulkheads during late 1978. Devices installed include concrete cobblestones, concrete control blocks, precast concrete sheet piles, H-piles with railroad ties, and scrap tires. Funds for the planning and construction of these devices were authorized under the federal Shoreline Erosion Control Demonstration Act of 1974 (P.L. 93-251). Also, for the past five years the State of Michigan has been examining and monitoring a wide range of low-cost alternatives under a special demonstration program. Table VIII lists those structures which were initially installed in 1974. Interim findings have revealed that many lower cost devices can provide adequate protection with proper siting and construction. This research should continue to be helpful in suggesting possible alternatives for similar coastal settings in Wisconsin.

Shore and bluff protection devices should not be constructed indiscriminately with little regard to adverse impacts upon adjacent property owners and the environment. To this end, the permitting requirements of federal, state, and local agencies need to be considered at an early date for structurally-oriented damage reduction programs. In the case of structures placed on or near the lake bed, the Wisconsin Department of Natural Resources and U.S. Army of Corps of Engineers will often need to formally review shore protection projects. To ensure the proper development and execution of shore protection projects, coastal property owners and managers are encouraged to seek the services of consulting and engineering firms specializing in coastal processes. General assistance and advice can often be solicited from universities, state and federal agencies, and regional and county planning agencies (see Appendix E for a listing of technical assistance sources).

B. Major Policy-Level Concerns

Structurally-oriented damage reduction programs need to be carefully considered by public officials. The three policy concerns discussed in this section, cost-effectiveness, adverse impacts, and shoreline management implications, can all affect the nature and scope of future damage reduction activities in Wisconsin.

Table VIII: Michigan Demonstration Project Summary: 1974

TYPE OF PROTECTION	SITE	TYPE OF STRUCTURE	COST PER FOOT OF STRUCTURE (1973 DOLLARS)			POSSIBILITY FOR DO IT YOURSELF CONSTRUCTION	CONCEPT HAS POTENTIAL FOR PERMANENT MEANS OF SHORE PROTECTION
			Actual (Test)	Large Job	Small Job		
Revetments and Seawalls	Michiana	Rock-Mastic	\$71	\$41	\$56	No	Yes
	Empire	Longard Tube	28	28	32	No	d
	Brevort	Longard Tube	57	42	47	No	d
		Sand Bags	60	55	40	Yes	No
	Whitefish Township	Rubble	45	43	48	a	a
	Tawas Point	Rock	52	c	c	No	a
	Manistique	Gabion	19	15	4	Yes	Yes
Groins	Lincoln Township	Timber Pile	133	120	150	No	Yes
		Longard Tube	57	25	28	No	d
	Charles Mears State Park	Rock Gabion	c	15	7	Yes	Yes
	Ludington State Park	Sheet Piling	b	128	150	No	Yes
	Sanilac	Rock-Mastic	154	110	115	No	Yes
		Sand Bags	109	80	45	Yes	No
		Longard Tube	55	42	46	No	d
Marquette	Sheet Piling	34	128	150	No	Yes	
Breakwaters	Pere Marquette Township	Pre-Cast Zig-Zag	66	c	c	No	d
	Lakeport State Park	Longard Tube	24	c	c	No	d
Nourishment	Tawas City	Sand	19	15	19	a	Yes
	East Tawas	Sand	16	15	16	a	Yes

- a) Depends on site conditions and area.
- b) Project cost includes seawall construction and cannot be accurately separated for tabulation.

- c) Not determined at this time
- d) Cautiously recommended.

Source: Michigan's Demonstration Erosion Control Program: Evaluation Report.
Michigan Department of Natural Resources, November 1974.

Cost-Effectiveness

Structural approaches require a significant commitment of resources, both over the short and long terms. Private property owner investments in excess of \$10,000 and local government investments in excess of \$100,000 are common along the Great Lakes shoreline. More extensive and complete protection schemes are often prohibitively expensive. For example, the Milwaukee County Park Commission estimated the cost of a complete shore and bluff protection plan for the south lakefront area at \$5 million in 1965.²⁵ However, the mere expenditure of large sums of money on structural solutions has not, and will not, necessarily guarantee a higher degree of protection. Most shore protection devices have relatively short life expectancies. Even the more durable devices fail--sometimes before their design lives are reached. Reasons for failure include improper placement, inadequate maintenance, adverse impacts of adjacent structures, and storm or wave conditions exceeding design capabilities. One often unrecognized factor is poor timing, particularly along high blufflines. Since coastal bluffs typically undergo several years of profile change upon destabilization, devices installed at the wrong time and place will have a greater probability of failure. To summarize, in spite of dollar investments, there will invariably be a natural event or series of human errors which can lead to the partial or complete failure of both shore and bluff structures.

In an attempt to solve the cost-effectiveness problem, many riparians have turned to emergency and/or low-cost protection strategies (do-it-yourself projects) over the past decade. While these strategies do not necessarily lead to expensive, one-time projects, over time, the total amount of money used to temporarily slow erosion rates may equal the costs of longer duration projects. Subsequently, when more permanent devices are installed, project costs frequently increase because of the presence of failed structures, e.g. submerged stone and steel, dilapidated groins, exposed piling. No single strategy can be identified to "save money" on shore or bluff protection. Strategies involving intermediate-life structures hold some promise of minimizing costs and maximizing protection in selected cases. But, when lower cost or shorter life structures are installed, the replacement cycle simply begins at an earlier date. Ultimately coastal riparians and local governments may simply have to decide how much risk they are willing to live with, and accept, as a part of living along an erodible shoreline.

For state-level decision-making, this issue clearly poses some major public policy investment questions. If structural devices are destined to fail or, at best, only provide adequate protection for a relatively short period of time, can, or should, significant public expenditures be risked along the shoreline? At the very least, the cost-effectiveness issue appears to suggest that state resources must be invested judiciously and cautiously. Both the short and long-term benefits and costs of structural strategies need careful assessment, particularly where nonstructural options exist. For example, in benefit/cost studies conducted by the Coastal Zone Laboratory, University of Michigan, building relocation has often compared favorably to, or better than, the costs of constructing durable shore protective structures.²⁶ Along light to moderately-developed coastal reaches, nonstructural options may, in fact, be able to reduce damages more effectively and permanently. But, there will continue to remain conditions and circumstances which will favor the implementation of structural approaches. The erosion control needs and priorities of these areas will require close attention over the coming years.

Adverse Impacts

Any actions taken to structurally reduce erosion damages will create some physical and environmental impacts. All too often, the adverse impacts of structural devices have led to the acceleration of erosion rates down-drift, or adjacent to, the protected area through beach starvation (sand capture) and wave energy transfer/deflection. In a recent recession rate analysis of the Illinois shoreline, high erosion rates were consistently, and directly, linked to nearby protected areas.²⁷ Depending upon their placement, configuration, and materials, structural devices can affect nearshore navigation, fish populations, aquatic habitat, and public safety/access. In a number of cases, water quality problems have also resulted from the use, or placement of, contaminated materials along the shoreline, e.g. solid waste used as riprap/fill, eroding fly ash spoil piles. While the state-of-the-art is not such that all negative impacts can be accurately predicted, most potential problems can be substantially minimized by properly selecting and designing devices in concert with comprehensive evaluations of site and reach geologic/coastal processes. Even common coastal construction projects, e.g. jetties, coal unloading facilities,

marinas, can create some severe impacts when natural processes have not been fully considered. For example, over time, many armored coastal facilities have in effect become large groins as the shoreline recedes around them. Ironically, the more effective and durable the device, the more it may tend to generate adverse impacts.

Since structurally-oriented strategies will continue to be integral components of many state and local damage reduction programs, what role can, or should, the state play in further reducing the adverse impacts of structural devices? In protecting the public interest along navigable waterways, both state and local governments have been authorized to take many regulatory actions, i.e. Chapters 30 and 31, Wisconsin Statutes; Chapter 59.97, Wisconsin Statutes (unincorporated areas via shoreland zoning ordinances, where required²⁸). The administration and enforcement of these statutes and ordinances has direct implications for reducing the adverse impacts of structural devices. In granting/denying permits, local governments and the Department of Natural Resources can consider the impacts of structural devices upon navigation, public safety, aquatic communities, and adjacent riparians. But, a number of historic problems have tended to limit the effectiveness of public oversight. For example, where local authority supercedes state authority, i.e. along lake bed grant areas, broader reach and environmental concerns tend to be looked at superficially--if at all. Most structures placed above the ordinary high water mark (the demarcation line for state authority) for shore protection/filling purposes receive minimal review at the present time even though adverse impacts can occur upon sliding or failure. Section C of this chapter will review some possible refinements and improvements of Wisconsin's regulatory framework.

Shoreline Management Implications

Structural devices alter the character and use-potential of the shoreline hence they can have impacts which go beyond their immediate shore protection goals. In the past, the shoreline management aspects of structural devices have not always been considered due to emergency conditions, limited time/money, the piecemeal implementation of plans, etc. One of the side-effects of this approach has been the limiting or "locking-out" of

future management options. For example, once an armor stone revetment is constructed, the shoreline may lose much of its recreational value through erosion of the fronting beach and public access impairment. Since public use of, and access to, Wisconsin's Great Lakes shoreline is already limited by high bluffs and land ownership patterns, every opportunity should be taken by local and state governments to comprehensively manage coastal environments.

Alternatively, there is yet another side to the shoreline management problem. Shore erosion has traditionally been viewed as a natural hazard which needs to be controlled. However, a certain amount of erosion may, in fact, be necessary for the lake system and downdrift, shore protection devices. The indiscriminate placement of devices along sand generation areas, e.g. southern Kenosha County, south central Sheboygan County, could have serious sediment starvation repercussions.

Even though direct state-level management authority is largely limited to publically-owned lands, e.g. state parks/forests, highway corridors, the state influences many kinds of local/regional shoreline decisions through financial and technical assistance programs and regulatory activities. Thus, the state could play an important role in facilitating an even closer linkage between shore/bluff protection and comprehensive, multi-faceted shoreline management. At the very least, it appears that the multiple-use potentials of structural devices can be more widely acknowledged and taken advantage of in damage reduction planning efforts. For example, with proper planning and coordination, shore protection devices can be used for bank/pier fishing purposes, building-up recreational beaches, and/or increasing shoreline access. Public Access: A Policy Study²⁹, a previous report of the Wisconsin Coastal Management Program, provided a significant step in this direction by discussing several strategies available to state agencies and local governments and the means to implement them. The preparation of long-term shoreline management plans on a reach-by-reach basis in combination with increased state-level technical assistance appears to offer a viable means of helping to ensure the proper use and siting of protective devices.

C. Options and Strategies

State-Level Regulatory Responses

In Wisconsin, state and local governments are responsible for administering and enforcing a wide range of laws, statutes, and ordinances designed to protect the public interest along navigable waterways within 1000 feet from the Great Lakes shoreline. Both shoreline and bluffline erosion control projects may require some combination of state and local permits. In addition, the U.S. Army Corps of Engineers issues permits for shore protection activities below the high water mark along navigable waterways. Taken in total, the regulatory requirements and actions of federal, state, and local governments have a significant impact upon encouraging/discouraging various structural approaches, minimizing the adverse impacts of structural devices, ensuring early and continuous reach coordination, and, in general, reducing erosion damages along the Great Lakes shoreline. Of particular concern to this discussion is the role of the state government in the regulatory framework. For this policy plan, the question arises, is the existing policy framework and review process governing the use of erosion control structures adequate, or should it be modified legislatively or administratively? To answer this question, it is necessary to review and analyze the process and substance of the existing framework in some depth.

Existing Framework

Pursuant to Chapter 30, Wisconsin Statutes (Navigable Waters, Harbors, and Navigation), the Wisconsin Department of Natural Resources (DNR) has developed an extensive review/permitting program for a wide range of coastal activities. Table IX lists those Chapter 30 activities directly related to shore protection/erosion control. Direct state-level regulatory authority along the Great Lakes shoreline has been limited to submerged lands held in trust by the state and activities initiated at, or below, the ordinary high water mark (OHWM). With regard to submerged lands, where the Legislature has ceded a portion of the lake bed to municipalities for designated public purposes (Chapter 30.05 Wisconsin Statutes), Chapter 30 authorities are generally exempt. Most cities along the Lake Michigan shoreline and Milwaukee County have been granted partial, or complete, authority over their

**Table IX: Shore Protection-Related Statutes Administered by the Bureau
of Water Regulation and Zoning, Wisconsin Department
of Natural Resources**

Chapter	Regulation
30.11	Establishment of Bulkhead Lines
30.12	Structures and Deposits in Navigable Waters Prohibited; Exceptions; Penalty
30.13	Regulation of Wharves and Piers; Establishment of Pierhead Lines
30.19	Enlargement and Protection of Waterways
30.20	Removal of Material from Beds of Navigable Waters
30.205	Zoning for Certain Lake Bed Removals

adjacent submerged lands (a comprehensive listing of lake bed grants is found in Lake Bed Grants: Great Lakes; a Coastal Management Program publication). However, where the shoreline has receded away from the officially demarcated lake bed grant area, the state has retained its direct regulatory authority. Whether the lake bed is state or locally owned, permits may be required from the U.S. Army Corps of Engineers for any Great Lakes project pursuant to Federal Rivers and Harbors Acts and Section 404 of the Federal Clean Water Act (P.L. 92-500).

Since 1914, Wisconsin has defined the boundary separating lands held in trust by the state from private lands as the ordinary high water mark (OHWM). The ordinary high water mark, determined on a case-by-case basis by DNR field staff, is

the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily recognized characteristic....³⁰

Most shore protection/erosion control projects initiated above the OHWM do not require state permits (see endnote 37). However, since many riprap/filling projects begin above the OHWM but invariably end-up in the Great Lakes upon failure, the DNR is presently determining what authority exists for the regulation of riprap materials (vis-a-vis solid waste provisions of NR 151) and/or prohibiting certain riprap projects pursuant to Chapter 30.12.³¹

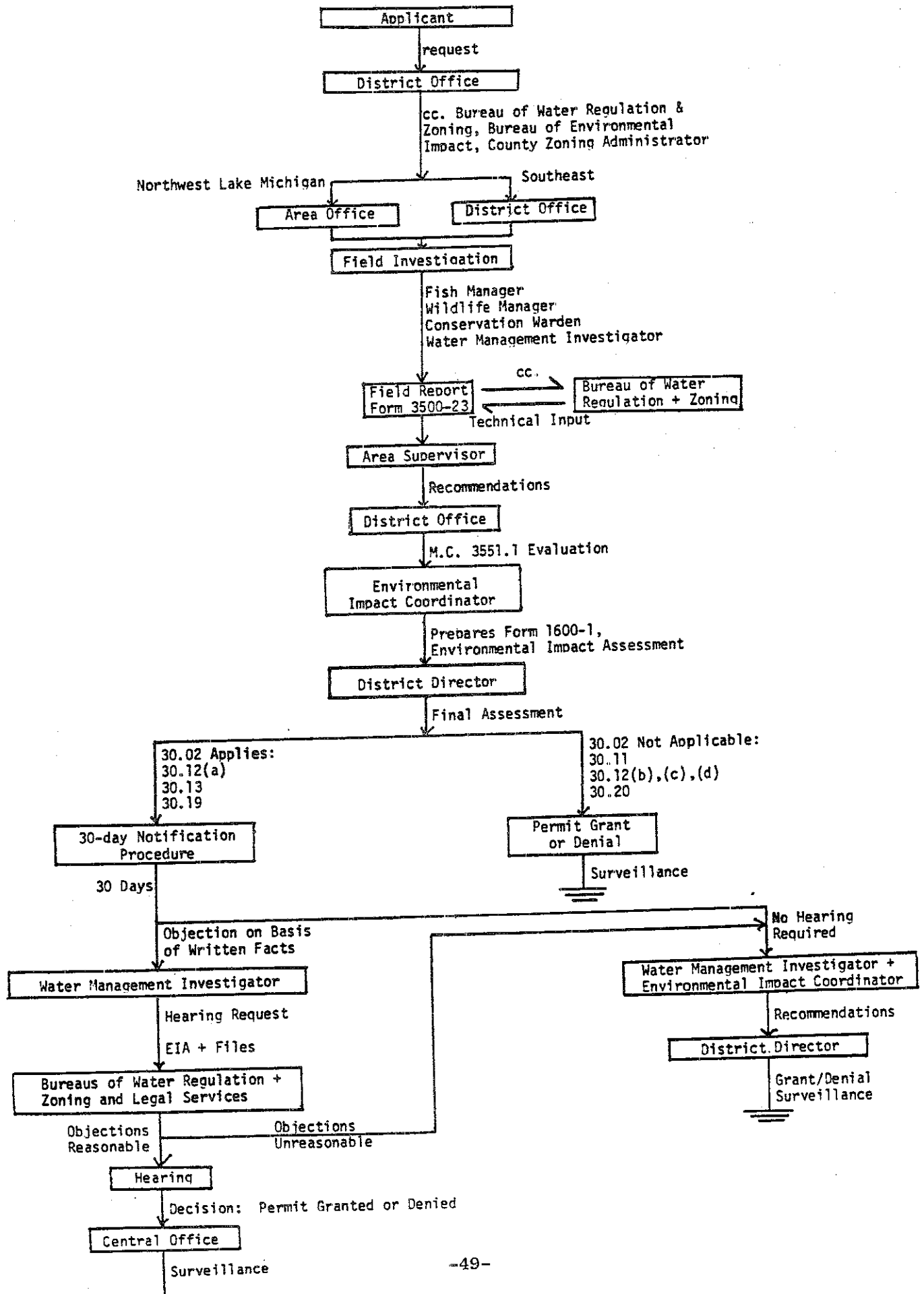
The Army Corps of Engineers has developed a system or using either biologic indicators, when present, or stage-duration curves (water level elevations) to identify the ordinary high water mark for federal regulatory purposes.

In lake bed grant areas, local governments are responsible for conducting reviews of coastal projects and issuing any necessary permits-- frequently through the zoning administrator's office. But, even in non-lake bed grant areas, counties can require special exception permits for coastal projects so long as their shoreland zoning ordinances are in compliance with Chapters 144.25 (Navigable Waters Protection Law) and 59.971 (Zoning of Shorelands on Navigable Waters), Wisconsin Statutes.³² The granting of a local permit does not, however, preclude the possible denial of a state permit pursuant to Chapter 30 or the parallel federal permit. In short, a federal, state, and local permit may be required to install shore protection/erosion control devices along many reaches of the Great Lakes shoreline. Owing to the number of public entities with regulatory authority and the special conditions associated with jurisdiction, e.g. above/below OHWM, lake bed grant area, shoreland zoning authority, coastal riparians need to be aware of permit requirements before initiating shore or bluff protection projects.

A detailed discussion of the entire permit application/notification/review process for all public entities is beyond the scope of this report. Since Chapter 30 is the focal point of the state's regulatory activities, an overview of the present process is provided on Figure 6, page 49. Appendix F provides a step-by-step description of the process. Much of the following information is taken from "The Role of the Wisconsin Department of Natural Resources in the Protection of the Public Interest in Navigable Waters"; a working paper prepared for the Coastal Management Program.

Over the past several years the Department of Natural Resources, through the Bureau of Water Regulation and Zoning, has pursued a policy of decentralizing permit review activities. Hence the three coastal District Directors (Northwest, Lake Michigan, and Southeast) have been given more responsibility, and flexibility, in granting/denying Chapter 30 permits. The role of the central office (Madison) has been generally limited to the handling of controversial or unique projects along with maintaining a

Figure 6: Chapter 30 Permit Process



professional staff with expertise in certain subject areas. Along with District Directors, the role of Hearing Examiners has also substantially expanded over the past few years. Much of this increase can be attributed to the notification/hearing procedures used by the Department pursuant to Chapters 30.02 (General Provision for Notice and Hearing), 30.19 (Enlargement and Protection of Waterways), 31.06 (Hearing Requirements), and 165.07 (Assistant Attorney General - Public Intervenor), Wisconsin Statutes along with a heightening of public and agency interest in navigable waterway-related projects.

In brief, the Chapter 30 process operates as follows. Upon the receipt of a permit application, the District Director initiates a field investigation of the project area through an area office. Once a complete field report is on-file, the District Environmental Impact Coordinator prepares an environmental impact assessment screening worksheet (N.R. 150, Wisconsin Administrative Code). On the basis of the field report and environmental impact assessment, a final technical analysis of any probable impacts is made. Where the proposed project is not subject to notice and hearing (many small and/or noncontroversial projects are exempted), the District Director will make a final determination. For those projects requiring notice and hearing, i.e. Chapter 30.12 and 30.19 applications, a 30-day notification procedure is initiated. Copies of the notice are sent to all directly affected state agencies, the Attorney General's Office, Army Corps of Engineers, county and municipal clerks, local zoning administrators, environmental groups, adjacent property owners, and the applicant. If no objections are raised, the District Water Management Investigator and Environmental Impact Coordinator submit final recommendations to the District Director. Where reasonable objections (based upon fact) are received in writing, a formal hearing is set up through the central office. From this point on, the Hearing Examiner and central office assume responsibility for reaching, and implementing, the final decision.

A critical aspect of the Chapter 30 regulatory process are the standards used to grant/deny permits. At the present time, no administrative rules or regulations have been formally adopted by the Department for Chapter 30 activities. In their place, a flexible but comprehensive assessment procedure, largely defined in an internal Manual Code has been developed. Statutory language, relevant administrative code provisions, court decisions, normal operating procedures/administrative practices, and executive orders provide the basis for this code.³³ Only those criteria established by statute, administrative code, and the Supreme Court are deemed mandatory. Generally speaking, three statutory standards are recognized:³⁴ effect on navigation, impact on stream capacity, and the public interest test. The public interest test has been broadly interpreted to mean any detrimental impact upon the waters in question, the rights of other riparians, or the public trust. These parameters, in turn, have been further refined to include the biological, physical, and social aspects of coastal projects. Thus, the Department routinely assesses the possible impacts upon sport and commercial fisheries, aquatic/terrestrial habitat, lake currents, adjacent properties, scientific areas and historic sites, and the public health/safety. In addition, the Department may consider the effectiveness and life of a structure along with the financial capability of the applicant. Compliance with other federal, county, and/or municipal regulations and permits is also determined.

Analysis of Existing Framework

Chapter 30 provides the State of Wisconsin with the authority to directly manage erosion control activities along the Great Lakes shoreline, and, where necessary, provide the follow-up enforcement actions. But, during the course of Coastal Management Program investigations, a number of process and substantive problems were identified that could impair the effectiveness and comprehensiveness of the regulatory framework. Briefly, these concerns are related to the lack of officially adopted standards, adequate conflict resolution procedures, controls for measures above the ordinary high water mark, and intergovernmental/agency coordination. These problems have had the net effect of (1) making it more difficult for coastal riparians to understand the "ground rules" and receive timely, systematic reviews of permit applications and (2) making it more difficult

for those agencies and governments with regulatory responsibilities to collectively and consistently define and protect the public interest along navigable waterways. Since the regulatory policies and actions of the state are critical for the successful operation of the entire framework and reduction of erosion damages, the above problems may need to be addressed.

Even though the Department of Natural Resources has developed a flexible, comprehensive internal assessment procedure in the Manual Code, the lack of officially adopted rules and regulations tends to lead to the camouflaging of standards and the variable, perhaps subjective, enforcement of state policy. In making this statement, it should be pointed out that each DNR district has perspectives, and procedures, differing from other districts as well as the central office. All concerned and interested parties, from the applicant (coastal riparian) to local government officials to the Army Corps of Engineers, could benefit by knowing--to a reasonable degree--what physical, environmental, economic, and social parameters are being used to grant/deny permits. When known in advance, state-level criteria can be used to assist in the design and siting of erosion control devices. Moreover, those local governments issuing permits pursuant to lake bed grant authority or shoreland zoning could then, if they so desired, also use state-level criteria to grant/deny permits. According to the Public Intervenor, the present standardless approach runs the risk of violating due process and equal protection rights guaranteed an applicant for a Chapter 30 permit.³⁵

In view of the generally flexible and cooperative atmosphere which pervades the local/state/federal regulatory framework along navigable waters, conflict resolution has not been perceived as a high priority issue. But, because this framework remains fraught with many substantive (permit criteria), jurisdictional, and overlapping administrative problems, adequate provision for conflict resolution appears essential to its efficient operation. For example, the lack of officially adopted state rules and regulations may, in the case of conflict resolution, have an important side-effect. Namely, that the state can be left in a tenuous position with regard to the defense of final permit actions, be they grants or denials. In 1976, out of a total of 63 permit applications, only one was denied (four were pending further action).³⁶ Without the formalization of conflict resolution procedures, it

would appear that coastal riparians could be "caught in the middle" of interagency/government disputes over new technologies, technical questions, or divergent permit disposition (one agency grants, the other denies). To summarize, as concern over projects along navigable waterways increases in Wisconsin, a much greater opportunity will exist for conflicts which will need immediate resolution.

Riprapping and earthen-fill projects account for more than half of all shore protection activities along Wisconsin's Great Lakes shoreline every year. Even though these projects are typically initiated above the ordinary high water mark (OHWM), quite often they enter the lake bed upon failure or continuous bluff slumping. Since the state has limited regulatory jurisdiction above the OHWM for shore protection projects³⁷, these activities, in theory, are covered under the provisions of county and municipal shoreland zoning ordinances. However, few local governments have demonstrated a willingness to regulate activities which are seen as "rights" of coastal riparians. Unfortunately, the lack of adequate controls above the OHWM has created many environmental, aesthetic, public access/use, and damage reduction problems along the shoreline. For example, unsorted debris and construction materials are commonly seen along the southern Lake Michigan shoreline. While the solid waste provisions of N.R. 151 may provide the state with a "handle" on this problem, a more direct state/local response appears desirable.

The public trust interests of local/state/federal regulatory agencies are generally quite similar along navigable waterways, e.g. protect adjacent riparians, minimize adverse impacts, protect the public health/safety. Hence the opportunity for uncoordinated, overlapping public responses remains high. Through informal agreements and arrangements, the Department of Natural Resources and Corps of Engineers have been able to cooperatively resolve most jurisdictional and permit disposition problems over the years. These efforts led to a largely unsuccessful attempt to officially streamline permitting activities during the mid-1970's. The relationship between the state and local regulatory bodies has remained far more confusing and uncertain, State/local coordination, except on a community-by-community basis, has been difficult to achieve. Even though a reasonable amount of coordination does occur in the present framework, it appears that a more formalized and

centralized system is needed to ensure consistent administration and protection of the public interest. With sufficient regulatory process coordination, most delays or problems involving interagency/government notification, due process, and permit disposition should be substantially alleviated. Both public and private sector interests can benefit by efforts designed to increase the efficiency of the regulatory process.

Although not a regulatory problem per se, the beach nourishment/dredge spoil issue deserves some consideration within the context of the discussion. One of the most effective, and natural, ways of protecting the shoreline is through the build-up and maintenance of protective beaches. Structural devices such as groins, inshore and offshore breakwaters, artificial headlands, and perched beaches can promote the build-up and maintenance of protective beaches. In addition, many of these devices enhance the flexibility of damage reduction programs by keeping the shoreline and nearshore zone open for recreational and beach uses, particularly swimming and surf fishing. Groins can also serve as fishing piers. But, to insure the presence of sufficient quantities of sand-sized materials in the beach system (including the littoral drift), beaches often need to be artificially nourished on a periodic basis.

In Wisconsin, the addition of any materials to lake beds held in trust by the state has been generally prohibited since the early 1970's. This prohibition has had a significant impact upon protective beach alternatives. Many potential sources of sand are found along the Great Lakes shoreline, e.g. harbors, river mouths, sandy bluffs/plains. These sources, while affording economically viable options in many cases, cannot be used for shore protection purposes. Further, the present state-level policy regarding the on-land disposal of dredge spoils³⁸ appears to be inconsistent with natural shoreline stabilization processes. In view of the success and experience of other states in artificially nourishing beaches, a reassessment of Wisconsin's policy on protective beach alternatives along the Great Lakes shoreline may be needed at this time. This reassessment should be completed in concert with other investigations related to dredge spoil disposal, harbor and port development, water quality, and shore protection issues.

Alternative Options and Strategies

In answering the policy question raised at the beginning of this section, it is clear that some modifications to Chapter 30 may be desirable. However, given the interrelationships between federal/state/local regulatory activities along the Great Lakes shoreline, there remains a potential that any "fine-tuning" or streamlining of Chapter 30 activities could generate many new problems. Consequently, any modifications of Chapter 30, whether legislatively or administratively pursued, should be made on the basis of comprehensive assessments of the entire regulatory framework. Direct participation by the Corps of Engineers and local governments in future policy-level discussions will help ensure a higher degree of coordination and regulatory program efficiency. The following goals or targets can be used to help establish priorities for Chapter 30 modifications over the coming years. Wisconsin's regulatory policies and procedures along the Great Lakes shoreline should provide for the:

- dissemination of permit process/substance information to coastal riparians in a timely, useable manner,
- non-duplication of permitting procedures between federal/state/local governments,
- early and immediate notification of all concerned public and private sector interests,
- consistent protection of the public interest along navigable waterways, over time, vis-a-vis clearly identified standards and/or guidelines,
- efficient and equitable resolution of all conflicts between the various public and private sector interests.

Before undertaking any Chapter 30 regulatory reforms, a fundamental policy issue is whether to encourage or discourage structural approaches to damage reduction along the Great Lakes shoreline. In spite of the controversial nature of structural approaches, e.g. cost-effectiveness, adverse impacts, shoreline management implications, the present state policy framework does little to officially discourage structural approaches. Rather, existing policy is oriented toward protecting the public interest after coastal riparians have decided to install structural devices. The California Coastal Commission takes an entirely different approach. Structural approaches can only be considered after all other nonstructural

options have been examined, and there is evidence that structures will be able to successfully mitigate coastal erosion. Table X contains a listing of criteria used by the Commission to evaluate shore protection projects. Appendix G contains a complete layout of California's recently prepared shoreline erosion protection policy.

The question of whether to encourage or discourage structural approaches, and under what circumstances, is critical for the "fine-tuning" of Wisconsin's Chapter 30 regulatory framework. If, for example, the state would choose to deviate from its present open-ended policy, any subsequent revisions of Chapter 30 can, and should, be made more compatible and consistent with this position. Pursuit of a California-type approach to state shore protection policy would also have the added advantage of providing a more substantive basis for permit approvals/denials. Aside from its obvious regulatory framework benefits, a more clearly articulated state erosion protection policy could aid in the deployment of state financial/technical resources, ensure more consistent state and local government management, and assist in the preparation of new laws and programs. The guidelines for damage reduction programs contained in Chapter III of this report provide a possible starting point for a comprehensive state policy.

Either through legislative or administrative rule-making processes, the state can modify the Chapter 30 regulatory framework. The amount of legislative/public interest in Chapter 30 activities, the immediacy of modification needs, the perceived complexity/comprehensiveness of Chapter 30 reform needs, and the willingness of the Department of Natural Resources to initiate/implement modifications can assist in determining which strategy, if any, is to be taken. In evaluating these factors, it should be pointed out that the DNR has been internally modifying Chapter 30 procedures on an "as needed" basis over the past several years. Thus, a complete appraisal of in-force policies and procedures, along with the possible impacts of planned modifications, could provide a clearer assessment of required actions. For example, although in various stages of completion, the DNR has been putting together a handbook (to accompany the Manual Code) for use by district personnel in evaluating permits and for enforcement proceedings³⁹. Hence the administrative modification of Chapter 30 appears attainable since the Department has already demonstrated an interest in moving in this direction.

Table X: California Coastal Commission Shoreline Protection Project Policies

Shoreline protection projects are proposed by both private parties and public agencies. It is the policy of the Resources Agency that the following policies should be followed when evaluating project applications:

- A. Nourishment of beaches to protect against erosion shall be encouraged where the following conditions are met:
 - 1. This does not conflict with significant living marine resources;
 - 2. This will result in adverse effects elsewhere on the coast;
 - 3. Measures are included in the project to maintain the affected beaches in a nourished state.

 - B. Construction of seawalls, revetments, breakwaters, or other artificial structures for coastal erosion control shall be discouraged unless each of the following criteria is met;
 - 1. No other non-structural alternative is practical or preferable;
 - 2. The condition causing the problem is site specific and not attributable to a general erosion trend, or the project reduces the need for a number of individual projects and solves a regional erosion problem;
 - 3. It can be shown that a structure(s) will successfully mitigate the effects of shoreline erosion and will not adversely affect adjacent or other sections of the shoreline;
 - 4. There will be no reduction in public access, use, and enjoyment of the natural shoreline environment, and construction of a structure will preserve or provide access to related public recreational lands or facilities;
 - 5. Any project-caused impacts on fish and wildlife resources will be offset by adequate fish and wildlife preservation measures;
 - 6. The project is to protect existing development, public beaches or a coastal-dependent use.
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In considering possible state-level actions to up-date Chapter 30, a high priority could be given to the preparation of legally binding rules and regulations. If pursued legislatively, enabling laws and statutes could be simultaneously amended so as to clear-up any existing language/interpretation problems, and reflect any new state policy concerns with regard to the use of structural devices along the Great Lakes shoreline. This legislative effort might, in effect, allow the comprehensive recodification of all related Great Lakes shoreline structural activities. Michigan's Great Lakes Submerged Lands Act could provide a basis for this revision. Administratively, state efforts might initially focus in on a series of informal hearings to discuss and review the DNR Manual Code and its related documents.

On the question of state jurisdiction above the ordinary high water mark, even though the DNR is moving ahead administratively, some legislative action might be needed to clear-up the intent of Chapter 144 (Water, Ice, Sewage and Refuse), Wisconsin Statutes and shoreland zoning provisions with regard to riprap/filling projects for shore protection purposes. To address notification and conflict resolution problems, one important step appears to be the formal establishment of a "shared notification system" for all permit issuing agencies. This system might be implemented through the signing of "memos of understanding" which describe agency responsibilities and detail operating procedures and "turn-around" time requirements. Legislatively, these modifications could be undertaken pursuant to the hearing/permit review activities outlined in Chapters 30.02, 30.19, 31.06, and 165.07, Wisconsin Statutes. Since communities/counties with lake bed grants are generally exempt from state administrative rule requirements, special legislative attention may be required to ensure complete state/local regulatory cooperation and coordination along the Great Lakes shoreline.

Although this section has focused on possible legislative and administrative adjustments to Chapter 30, the state has several other "tools" at its disposal. Most notably, technical assistance delivery, educational programs and activities, and direct program enhancement, e.g. additional staff, resources. Of particular concern is the need to increase the

regulatory capabilities of local governments. State-sponsored workshops/training sessions appear to offer a viable means of up-grading local permitting activities while facilitating better state/local coordination. Similarly, educational materials prepared for coastal riparians and zoning administrators on such topics as structural design/siting problems, the substance of federal and state permit reviews, and legal issues have the potential of improving the overall efficiency of the regulatory process. One 1974 leaflet, "Permits for Construction of Shore Protection Works on Lake Michigan" (a UW-Sea Grant College Program report) provides an example of the type of product which could be generated in a renewed informational effort. Regulatory program improvement has been given a high priority by the Coastal Management Program over the past two years. Additional staff capacity has been built-up at both the central and district office levels within the DNR.

State-Level Financial Assistance Responses

Erosion control will, in all probability, continue to be the focal point of many local government and coastal riparian responses to erosion along Wisconsin's Great Lakes shoreline. Most of the several thousand riparians living within 75 feet of the bluff/beach edge can be expected to give structural approaches a high priority over the coming decade. Thus, in addition to regulation, what role, if any, should state government play where structural devices are sought to reduce erosion damages? The most frequently heard demands relate to increased state-level financial assistance for the construction of structural devices on an individual, if not on a statewide or reach, basis. At present, local governments are eligible for some federal or state aid under special circumstances, e.g. emergency protection of public facilities. But, all too often, the amount of money available is either insufficient or not targeted for "lower priority" purposes, e.g. protection of parks, scientific areas, historical sites. Coastal riparians are in a much more difficult position. Except for business properties, virtually no direct or indirect (tax-related subsidies) assistance is available on a widespread basis. In Wisconsin, coastal riparians normally bear the full costs for installing and maintaining structural devices. Before examining some possible state-level options and strategies, it is necessary to take a closer

look at the existing framework.

Existing Framework

Only a handful of federal and state financial assistance programs have been exclusively designed for coastal hazards over the years. Except for some programs sponsored by the Army Corps of Engineers, Soil Conservation Service, Wisconsin Department of Transportation, and Wisconsin Coastal Management Program, the presence of erosion hazards generally does little to release monies for shore/bluff protection projects per se. In the case of local governments, other reasons must often be identified for funding, e.g. improved public access, recreational enhancement, increased economic development potential. Historically, even the presence of emergency conditions along the Great Lakes has done little to free-up additional financial assistance for erosion hazards. For example, during the 1972-1976 high water period, a special joint federal/state assistance program, Operation Foresight, was established for coastal flooding/inundation. Erosion damage mitigation activities were not covered. Recent efforts to seek direct and indirect financial assistance for coastal riparians at the federal level on the Great Lakes have met with no more success. In 1977, a bill introduced by Congressman Phillip Ruppe of Michigan to amend the Coastal Zone Management Act of 1972 so as to provide construction monies "died" due to insufficient support. Likewise, after lengthy study, the Flood Insurance Administration appears to have abandoned efforts to have Great Lakes shore erosion damages covered under the National Flood Insurance Act. In summary, unlike riverine flooding, erosion damages typically occur on a continuing basis hence public interest in extensive assistance has remained limited over the years.

Appendix E provides a comprehensive listing and summary of all principal federal and state financial assistance programs. By way of review, three Army Corps of Engineers programs serve as the "backbone" of shore erosion assistance activities: Section 14 projects (Emergency Protection of Public Facilities, Section 103 projects (Small Beach Erosion Control Projects), and Section 111 projects (Correction of Damages Attributable to Federal Navigation Structures). Except where damages accrue to private lands from navigational structures, all Corps of

Engineers programs are designed exclusively for public entities. The Soil Conservation Service, U. S. Department of Agriculture can offer some highly limited financial assistance to local district cooperators for reducing bluff erosion hazards under two programs: P.L. 566 Watershed projects and Resource Conservation and Development projects. Pursuant to the state Highway Disaster Fund (Chapter 86.34, Wisconsin Statutes), the Department of Transportation can assist in the restoration and improvement of non-state trunk highways damaged by flood-related erosion. Through Section 306, Coastal Zone Management Act implementation activities, the Wisconsin Coastal Management Program can offer planning and design assistance for structural devices to public entities. Along portions of the Great Lakes shoreline where Section 208, Federal Water Pollution Control Act water quality plans have been completed and approved, the newly enacted Wisconsin Fund may provide some limited monies for erosion abatement near the mouth of navigable streams.

In passing, it should be pointed out that several other assistance programs for the construction of structural devices or protection of coastal buildings may be available on a highly restricted basis. For example, where public entities are seeking to expand or improve recreational opportunities along the Great Lakes shoreline, state ORAP-200 (Outdoor Recreation Assistance Program) or federal LAWCON (Land and Water Conservation Fund) funds can be sought. One additional form of federal assistance, low-cost loans, can be made available to coastal businesses and riparians on a limited basis through the Small Business Administration and Farmers Home Administration. No low-cost loan programs are sponsored by the state for erosion damage mitigation purposes.

Indirect financial assistance through the offering of tax-related incentives or subsidies provides another state-level option for mitigating the economic impacts of constructing protective devices or encouraging structural approaches. In Wisconsin, only business property interests are eligible for special property/income tax benefits. Utilities, corporations, and businesses can receive full property tax exemptions pursuant to Chapters 70.11 (Property Exempted from Taxation) and 144 (Water, Ice, Sewage, and Refuse), Wisconsin Statutes, provided an "industrial

waste" is being confined along the Great Lakes shoreline. Additionally, two accelerated depreciation write-off options (deductions) are available to businesses and corporations where devices are constructed for pollution abatement purposes (Chapter 71.04-.05, Wisconsin Statutes). Since the siltation/sedimentation of nearshore Great Lakes waters has not been held to be "pollution" in Wisconsin, no tax relief is generally offered where water quality improvement is not the intended purpose. Devices constructed elsewhere along the shoreline can be considered "improvements" and be subject to full property tax levies. Through the casualty loss provisions of the Internal Revenue Service Code, both business and nonbusiness property interests can also claim some income tax deductions for structural device losses and repairs attributable to storm events. Losses associated with gradual erosion or inundation are not eligible for any federal tax benefits⁴⁰ (high water periods have been held to be "normal" events on the Great Lakes). Because federal and state income tax laws are not completely parallel, coastal riparians and business property interests need to carefully assess the applicability of all relevant provisions/codes.

Alternative Options and Strategies

In view of the limited amount of public assistance presently available for the implementation of structural measures in Wisconsin, many coastal riparians and local governments would welcome additional direct and/or indirect aid. Before determining what precise role the state might play, the broader implications of further state-level assistance should be kept in mind. First, statewide, coastal erosion generally remains a cyclic hazard which only directly affects a very small number of Wisconsin residents. Compared to other natural hazard events, e.g. riverine floods and tornadoes, the damage losses associated with coastal erosion appear relatively modest. There remains, then, a policy-level concern of how much attention should be directed to a natural problem only affecting a handful of Wisconsin citizens. Second, given the high costs of structural devices and their limited effectiveness, should the state encourage, either tacitly or explicitly, structural approaches even on a limited scale? The costs of structurally-oriented assistance programs will likely outweigh the benefits in most cases. And third, in

the absence of comprehensive state policy guidelines on damage reduction, including the role of nonstructural alternatives, financial aid programs for structural approaches could well have an adverse impact upon shoreline management. By facilitating the temporary, piecemeal reduction of damages, the task of finding cooperative, permanent solutions on a reach-by-reach basis will be made more difficult. To summarize, while there may well be a financial assistance role for the state, it can only be fully identified when the questions of "for whom" and "for what purpose" are answered.

The existing financial assistance framework, largely a collection of unrelated laws and programs, does not provide equal amounts of direct and indirect aid to all affected riparians and public entities. Residential property owners, urban residential properties in particular, are the groups most notably excluded at the present time. Virtually no direct aid is available for urban residences while rural residences and farms may be eligible for some limited aid, e.g. FmHA, SCS, ASCS. However, it should be noted that while residential structural devices can be taxed at full market value, there are indications that most appraisers ignore bluff/shore protection projects. Business properties, on the other hand, can receive a number of special indirect subsidies in Wisconsin where devices are installed for pollution abatement purposes, e.g. property tax exemptions, accelerated depreciation deductions. And, the casualty loss provisions of the Internal Revenue Code are generally more sensitive to business-related damages. Even though public entities are generally in a more favorable position than riparians, aid for non-emergency shoreline protection projects is limited and competitive. In summary, consideration might be given to making residential property owners and local governments the focus of any state-level financial assistance efforts.

Public financial assistance, whether direct or indirect, can help to offset the costs associated with the planning, design, construction, or emergency replacement/repair of structural devices. Factors which should be considered by the state in designing any new aid packages or modifying the existing framework include the financial needs of riparians and

local governments, the adequacy/impacts of existing assistance programs, the expected state financial commitment, the extent to which the existing tax system can (should) be modified, and the desired amount of state control over erosion control projects. Some possible targets or goals of new state aid programs include the protection of public facilities and development in high bluff areas, the improved maintenance of public protective devices, the ensuring of local participation in federal projects through state-sponsored matches, and the promoting of bluff erosion control projects in critical areas.

One special problem, erosion of park/open space lands in urban areas, may deserve some close attention by the state. Along much of the southern Lake Michigan shoreline, developed and undeveloped parklands serve as erosion buffers for adjacent homes and businesses. Because direct aid for erosion control projects is targeted toward the emergency protection of public facilities, local governments and adjacent property owners are often placed in the difficult position of waiting until erosion hazards have reached crisis proportions before aid is released. In some cases, the recreational value of these lands is lost by this time. Even when communities have been eligible for more extensive federally subsidized erosion control projects, match money difficulties have delayed project implementation. State-level assistance at an early date might serve to keep more erosion control options open while maintaining viable open space tracts along the Great Lakes shoreline.

The Wisconsin Supreme Court has held that a public purpose must be present before government actions can be legitimized (*Hopper vs. City of Madison*; *Wisconsin Development Authority vs. Dammon*, 1938). If the state seeks to provide further financial assistance for the implementation of structural devices, the question remains, what public benefits should (can) be received from, or guaranteed by, local governments and riparians? Although the state's financial interest in structural devices has been highly focused, i.e. public facilities, water quality, the use of incentive-type approaches may leave the state in a better position to seek broader public benefits. For example, as a condition of assistance, the state could require that additional public access be provided, that

multiple-use characteristics be incorporated into projects, or that a high priority be given to protective beach solutions. One coastal community, the City of Sheboygan, has already demonstrated how the public and private sectors can benefit by incentive programs. Over the past twenty years the city has acquired public access to virtually its entire shoreline through the less-than-fee simple technique of quit claiming (a land transfer technique in which property rights are assigned to another party). In return, the city has constructed a continuous stone riprap revetment along its entire waterfront.⁴¹ This same principle can be incorporated into state-sponsored assistance programs. To summarize, so long as state-level financial assistance efforts are targeted toward the resolution of recognized erosion hazard problems and openly seek broader public benefits, a strong legal basis exists for further financial action. Open-ended, grant-in-aid programs appear more questionable--and perhaps less desirable.

In responding to the financial assistance needs of coastal riparians and local governments, the state can take one of three basic actions. First, a "no-action" or status quo position can be held. Acceptance of this position would not necessarily signal a lack of state interest in structural devices or the needs of affected parties. Rather, that all significant problems are being adequately addressed. Hence any tampering or modification of the framework might only serve to complicate the task of effective shoreline management and burden the general public with largely unnecessary shore protection costs. Second, the state could serve as a facilitator of financial aid, not a provider. In this instance, the role and strategy of the state would be to modify the existing legal, institutional, and resource framework such that local governments and riparians could more efficiently resolve their own shore protection needs. This strategy has the added advantage of maintaining a closer relationship between those paying and those benefitting. And, third, the state could actually develop or modify financial aid programs. This strategy, while generally being the most resource intensive, could prove to be the most responsive and effective in addressing many of the problems described earlier in this section. The following paragraphs will provide an overview of selected direct and indirect financial assistance options associated

with the above strategies.

Direct assistance programs to local governments and/or coastal riparians could take several forms: full-funding, cost-sharing and low-interest loans. In view of the high costs of shore protection devices, often exceeding \$200 per linear foot, full-funding construction programs may not be economically and politically acceptable (a discussion of possible statewide and reach costs is found on page 36). No coastal state has enacted a full-funding program for general shore protection purposes. Full-funding programs may, however, be feasible for limited shore/bluff protection and demonstration projects. For example, where resources or facilities of unique regional/state interest are endangered, e.g. historical sites, scientific areas, and no federal monies are anticipated, a one-time, full-funding program could prove feasible. Similarly, this same technique could be used where the state desires to up-grade the level of protection around "lower priority" public facilities, e.g. parks, marinas. So as to stimulate bluff protection activities along the shoreline and/or experiment with innovative erosion control schemes, the state might consider the possibility of a one-time, full-funding program. The Michigan Demonstration Erosion Control Program provides an example of the kind of state-sponsored program potentially attainable in Wisconsin. Funding for one-time programs might be generated from bonds, special appropriations, or reallocations of existing financial assistance monies.

Cost-sharing and low-interest loan programs offer two distinct advantages over full-funding alternatives. First, and most importantly, the costs to the state can be significantly lessened hence program impact can be expanded. In the case of low-interest loan programs, an opportunity exists for the self-renewal of annual operating budgets. Second, the state tends to serve in more of a facilitative capacity. Hence a greater local commitment to erosion control and shoreline management is necessary. Generally, most cost-sharing programs have been oriented toward public entities while riparians are typically the target of low-interest loan programs. The State of Maryland has developed a nearly self-sustaining, interest-free Shore Erosion Control Revolving Loan Fund for both riparians and local governments. Since 1971, the state has lent nearly \$5 million

for the construction of 185 projects.⁴² Appendix H contains a brief overview of the Maryland program. North Carolina, on the other hand, has developed a cost-share program to ensure local participation in federal projects. Eighty percent (80%) of the non-federal match requirement is covered by the state. Appendix I contains North Carolina's Administrative Code program requirements. The cost-sharing approach has also been applied to emergency assistance situations. The Province of Ontario, for example, made extensive use of cost-share programs during the last high water period, principally for local municipalities,⁴³ e.g. Special Emergency Assistance Program, Ontario Disaster Relief Assistance Program.

To summarize, state-sponsored, cost-share and low-interest loan programs seem to hold an immediate possibility of resolving several problems in Wisconsin, e.g. match money shortages, lack of sufficient construction money, emergency responses to erosion, while not excessively utilizing state revenues. And, adequate state supervision and control of shore/bluff protection activities can be insured through the attaching of any desired funding conditions. But, it should be pointed out that where these types of programs have been developed, public interest in erosion control has been largely prompted by concern over coastal economic activities, e.g. fishing, tourism/recreation, and the potentially catastrophic impacts of continuing erosion.

The existing tax system could be modified to provide more financial relief to riparians and to increase local government participation in erosion control projects. However, tax system modification to provide further incentives and/or subsidies to private property interests through income tax credits, deductions, or accelerated depreciation write-offs remains both controversial and questionable. Over the past several years the state has developed or expanded tax benefits for such activities as agricultural lands preservation, solar energy stimulation, and water quality enhancement. It is not clear that legislative interest in further modifying an already complex income tax system for a very small number of riparians would be well received or justifiable. But, so as to provide a more equitable balance between that assistance offered to residential and business property interests, several modifications could be considered. First, the

value of shore/bluff protection projects along the Great Lakes shoreline could be officially exempted from local property tax assessments. Several states have made this property tax adjustment around the country. Appendix J contains a copy of Michigan's exemption act. Second, although a form of post-damage subsidy, the casualty loss provisions of state tax law could be amended for coastal hazards. To implement this modification, the state would have to develop criteria for the estimation of damage losses, presumably for non-catastrophic circumstances, and then determine what the deductible allowance would be, e.g. 100%, 50%, 25%. Except for some catastrophic events, property owners presently receive no form of direct or indirect public aid--and erosion hazard insurance, as such, is basically non-existent.

One final state-level action which could have significant financial impacts upon both residential and business properties is the clarification of state taxing policies on the water quality-related impacts and purposes of shore protection projects. Specifically, pursuant to Chapters 59, 70, 71 and 144, Wisconsin Statutes, there remains a number of questions as to whether property tax exemptions and state income tax deductions are available where a "natural resource is being developed", in areas of locally designated conservation areas, where significant siltation/sedimentation is being prevented, and when solid waste materials adjoin the shoreline. Opinions rendered by the Department of Revenue and/or Attorney General's Office would serve to clarify state policy and possibly suggest new reforms.

Local participation in, and funding of, erosion control projects in Wisconsin could be increased through a number of statutory changes. First, pursuant to Chapter 66.60 (Special Assessments and Charges), Wisconsin Statutes, local governments could be authorized to levy and collect special assessments for improvements to property attributable to publicly constructed shore/bluff protection devices. A copy of Michigan's act relating to public improvements for erosion control purposes is found in Appendix J. To facilitate the official public ownership, construction, and maintenance of protective devices, consideration could also be given to the creation of erosion control (coastal hazard) authorities or

districts in Wisconsin. The State of Maryland uses this concept in its Revolving Loan Fund. Wisconsin's Inland Lakes Protection Law would appear to provide a prototype for the creation of such districts along the Great Lakes shoreline. Since both of these approaches tend to encourage broader non-individualistic approaches to shoreline management, they may warrant some close attention and analysis. Finally, to increase local participation and interest in loan programs, special aid formulas could be developed. For example, the Province of Ontario developed a Shoreline Property Assistance Program several years ago which allowed local municipalities to recapture loans over a twenty-year period, at 8% interest, through property taxes.⁴⁴

In the role as a facilitator, the state could promote a number of other actions. For example, to encourage more collective or joint responses on shore/bluff protection projects, e.g. equipment, materials, maintenance, "resource pooling" could be given a higher priority pursuant to Chapter 66.30 (Intergovernmental Cooperation), Wisconsin Statutes. So as to increase the use of federal resources for erosion damage mitigation, particularly Army Corps of Engineers Section 111 and 103 projects, the state could more aggressively inform communities about their eligibility for federal aid pursuant to Chapter 66.45 (Federal Rivers and Harbors Resources Projects), Wisconsin Statutes. And, to follow-up on this effort, the state could serve in the capacity of a federal/local liaison until all reconnaissance studies are completed. Finally, where erosion control is a significant coastal management concern along publically-owned lands, the state might seek to reprioritize and reallocate available financial assistance resources for the Great Lakes shoreline, e.g. LAWCON, ORAP-200, Wisconsin Fund.

State-Level Technical Assistance Responses

A significant amount of technical information and expertise is necessary for the proper design, siting and construction of shore and bluff protection devices. Traditionally, the state's role in providing technical assistance to riparians and local governments has been largely limited to Shoreland Management Program activities and general planning/design information. Some special informational and educational materials

have also been prepared during high water periods. With the availability of Wisconsin Coastal Management Program technical documents and the increasing complexities of erosion hazard area decision-making, the state may now be in a position to consider a more substantive and continuous role. For this policy-level plan, the question is, should the state seek to expand its technical assistance activities and, if so, what should be the form and focus of this assistance? In initially assessing this question, it should be noted that close relationships exist between the regulatory, financial, and technical assistance frameworks. Hence state-level efforts designed to modify the regulatory and/or financial assistance frameworks may have significant impacts upon the accessibility, quality, and distribution of technical assistance in Wisconsin.

Existing Technical Assistance Framework

Federal, state, and regional/county agencies all participate in the delivery of technical assistance to local governments and riparians in Wisconsin. This information and assistance takes a wide variety of forms, from on-site inspections to generalized structural planning/design advice to educational materials for specific-user groups. However, the cyclic nature of acute erosion hazards, and the resulting cyclic needs of various user-groups, have had significant impacts upon technical assistance delivery and agency commitments to it. In spite of continuing coastal erosion along the Great Lakes shoreline, technical assistance activities have traditionally only received priority during high water periods, emergency protection situations, or when local governments and state agency field offices have been faced with unusual/controversial situations, i.e. sudden bluff failure endangering a highway, major problem installing a new protective device. The role of the public sector in erosion control projects has been further diminished by the greater use of geotechnical and coastal engineering consultants over the past decade. Also, it should be recalled that riprap/filling projects are the most frequently deployed forms of shore protection in Wisconsin. These devices have been perceived by many riparians and public officials as requiring little design or engineering assistance. In shore, public agencies with technical assistance capabilities and interests have generally not seen a need to sustain continual activities in view of cyclic demands and the availability of

private sector assistance.

Appendix E contains an overview of major federal and state technical assistance programs. In brief, two federal agencies play important roles in Wisconsin: the Army Corps of Engineers and the Soil Conservation Service. Through its erosion-related financial assistance programs, the Army Corps of Engineers provides technical assistance to public bodies for the planning, design, and construction of structural devices. In addition, both general and detailed technical assistance is available for a wide range of purposes through a separate program: Section 55. Even though most Corps of Engineers programs are designed for public entities, the Corps has shown an interest in the shore protection needs of riparians, i.e. "Help Yourself" brochure, consultation on projects. The Soil Conservation Service has provided engineering design information to public and private district cooperators for the installation of upland/bluff top erosion control devices along the Great Lakes shoreline. More detailed planning and technical assistance information has been made available to riparians and local governments through several county soil and water conservation districts. The technical assistance and educational activities in the Racine, Kewaunee, and Red Clay Project (Lake Superior) Soil and Water Conservation Districts have been particularly unique along the Great Lakes shoreline.

At the state-level, the Wisconsin Department of Natural Resources (DNR), University of Wisconsin - Sea Grant College Program, and Wisconsin Coastal Management Program (CMP) have played varied, but significant roles over the past several years. Although its technical assistance capabilities are limited, the DNR often provides advice and information to public officials and riparians through the Shorelands Management Program and, on a more limited basis, through Chapter 30 regulatory activities. In many cases, district field offices have served as referral points. Public information preparation and dissemination for structural approaches has not, however, received a high priority due, in part, to limited staff resources. Erosion hazard area research and general marine public education are two continuing objectives of the UW-Sea Grant Program. Although their direct technical assistance projects and activities for erosion

control have been somewhat limited to date, Sea Grant has served in a supportive capacity for other state agencies and their advisory services agents function as important local contact points. State-level technical assistance capabilities for erosion hazard area management have been substantially expanded by the Wisconsin Coastal Management Program over the past four years. Although the Geological and Natural History Survey (GNHS) is now serving as the lead assistance agency for the Program, many other agencies have contributed to, and have benefitted by, its coastal erosion projects and activities, e.g. DNR, Sea Grant, UW-Geology and Civil Engineering Departments. A wide variety of planning, economic, and engineering data is now available for structural approaches through the Program. This data base has provided Wisconsin with an excellent opportunity to prepare educational materials for specific target groups.

Several other public agencies are also frequently called upon to provide technical assistance for erosion control problems and projects in Wisconsin. They include the University of Wisconsin-Extension System (UWEX), regional county planning commissions, county planning offices, and University of Wisconsin System departments of geology and civil engineering. Quite commonly, county planning and Extension offices serve as a "first-stop" for public officials and riparians on general questions related to erosion control. Since internal expertise is generally limited, on-file publications are heavily relied upon along with information on other sources of assistance. Where permits for structures along navigable waterways are issued at the local level, additional technical expertise is sometimes available. Several UW-System departments in Superior, Green Bay, Parkside, Milwaukee, and Madison have been instrumental in conducting research on bluff erosion processes and in responding to technical questions raised by public officials and riparians over the past decade.

Alternative Options and Strategies

A wide variety of actions could be taken by the state to increase or redirect public technical assistance activities in Wisconsin. In view of the high costs, lead-time requirements, and controversial nature of many regulatory and financial assistance alternatives, technical assistance

options may be particularly appropriate and feasible. Moreover, because most technical assistance services/activities would presumably be available on a "no-charge" or limited-fee basis, riparians and public officials may welcome additional help, particularly for on-site work. But, in considering what options, if any, the state should pursue, the magnitude of erosion hazard problems, the extent to which the state should promote structural approaches, and the effectiveness/responsiveness of the existing framework must be kept in mind. Given the range of possible assistance forms, e.g. project-specific engineering, dissemination of existing data, workshops, and the number of possible target groups, e.g. zoning administrators, consultants, contractors, residential property owners, technical assistance options and strategies must be carefully selected if they are to efficiently respond to user-needs and problems. In summary, the state's goals and objectives in either resolving existing framework problems and/or increasing public participation in structural protection activities need to be articulated. The need for this assessment is heightened by the possibility of conflicts with the private sector on the public's responsibility in providing project-specific (on-site) assistance to riparians.

In addressing the questions of "for whom" and "for what purpose", an analysis of the existing technical assistance framework can provide some insights and direction. A number of problems have affected the quality, accessibility, and distribution of technical assistance in Wisconsin. First, there has generally been no sustained, state-level coordination of technical assistance activities and services. Consequently, public responses have often been scattered, incomplete, and, in some cases, duplicative. Complicating this problem, there appears to have been "breakdowns of communication" between the users and suppliers of technical assistance. Hence assistance has not always been delivered in the most desirable and understandable form. Second, several of the most influential decision-making groups, consultants, contractors, and zoning administrators, have been given minimal erosion control guidance in Wisconsin. In view of the fact that these groups directly, and daily (regardless of lake level condition), influence the quality and effectiveness of damage reduction efforts, this omission seems particularly crucial. Side-effects of this gap may include inadequate state and local permit reviews, excessive

dependence upon a small number of structural designs, and excessive dependence upon some public agencies for general/routine problems. Finally, largely due to institutional and program biases, assistance is not uniformly and consistently made available to all interested coastal groups. For example public entities are often eligible for federal engineering-level shore protection assistance (COE), but bluff erosion control assistance through the SCS is frequently more generalized. Riparians, on the other hand, typically receive generalized shore protection assistance and more detailed bluff protection assistance (primarily in rural areas). Problems like these have made it more difficult for single agencies or programs to resolve all user-needs.

If the state chooses to increase or redirect technical assistance activities in Wisconsin, a wide range of options are available. Possible options include the development of a state-sponsored, on-site assistance program; the accelerated funding of research on structural devices/erosion processes; initiating of a comprehensive training/educational series for selected user-groups; and/or the increasing of public sector technical expertise. In view of past technical assistance problems, a critical feature of any new effort would appear to be the amount of decentralization. That is, to what extent would technical assistance capabilities, resources, and expertise be focused at the local government and state agency field levels? The following guidelines could be used to provide some direction for state-level decision-making over the coming months. Wisconsin's technical assistance framework should, to the greatest possible extent, provide for:

- the development of capabilities, resources, and expertise, at the local level for all general and routine structural protection concerns, particularly where local shore protection regulations are in-force,
- the development of state-level capabilities, resources, and expertise on the more complex and technical aspects of structural protection concerns not covered or emphasized by federal agencies in Wisconsin,
- the continuing education of all parties affected by coastal erosion, and those potential user-groups making daily or routine decisions on erosion control devices, and
- the continual coordination of public technical assistance activities and programs through the designation or recognition of lead-agencies familiar with user-supplier problems and needs.

Pursuant to the above guidelines, some possible state-level assistance options under two alternative strategies will be outlined below. Depending upon resource availability and user-demands (needs), these options could be interchanged and "packaged" in a variety of ways.

Low-Level State Assistance Effort (minimal costs)

Coordination: Primarily through the UW-Extension System and the CMP

General Assistance: Largely handled by regional and county planning agencies and the field offices of state agencies. Existing CMP data and other relevant information transferred to local "clearinghouses". User's manuals and some limited training made available to local/field technical personnel. Erosion publications made available at local level.

On-Site (Detailed) Assistance: Done on an informal, "as resources available" basis by the GNHS, DNR, Sea Grant, and UW System departments. Continual reliance upon COE and SCS for engineering-level assistance.

Educational Activities: Existing CMP technical data base would be refined for several selected publications. Some occasional regional workshops/training sessions for local user-groups, possibly sponsored by UWEX, DNR, Sea Grant, and CMP.

Support Activities: Very limited research on structural devices/coastal erosion processes. COE, SCS, Sea Grant, and UW System departments heavily relied upon for further data acquisition. Limited monitoring of coastal environments and the effectiveness/impacts of structural devices.

High-Level State Assistance Effort (moderate to high costs)

Coordination: Primarily through UW-Extension System and the CMP, but a more formalized and permanent coordinating body would be convened.

General Assistance: Emphasis still placed at local and field office levels, but state participation in activities much higher. Technical personnel would receive more substantive and lengthy training. More area-specific information made available to "clearinghouses". And, "clearinghouses" would be provided with a modest budget to generate their own local publications.

On-Site (Detailed) Assistance: State-level technical assistance "teams" made available to solve local problems on an "as needed" basis. Additional coastal engineering and geotechnical expertise made available for on-site problem solving.

Educational Activities: A comprehensive publication series would be initiated for major user-groups. Annual workshops and

training sessions for specific target audiences on a regional and county basis. Existing CMP technical information would be turned into maps, bulletins, and manuals for specific audiences.

Support Activities: A modest budget made available for the further research and investigation of selected structural concerns, e.g. impacts, effectiveness, alternative techniques, benefits/costs. CMP data base expanded, where needed, to supplement federal data collection efforts. Some monitoring or demonstration sites established along shoreline.

Chapter V

PREVENTIVE APPROACHES TO DAMAGE REDUCTION: NONSTRUCTURAL ALTERNATIVES

Introduction

Erosion damages and hazards can be significantly reduced along the Great Lakes shoreline through the application of both regulatory and non-regulatory preventive measures. For undeveloped portions of the shoreline, the benefits can be substantial. Since development can be conditioned upon the taking of special precautions through ordinances and codes, e.g. setbacks, land development standards, damage potential may be eliminated for an indefinite period of time. Both regulatory and nonregulatory techniques can also serve to increase public access and recreational opportunities, and assist in protecting environmental attributes and open space areas along the Great Lakes shoreline. In developed areas, the opportunities for the use of preventive approaches are more limited--and often dependent upon the success of erosion control efforts. Building relocation, either on the same parcel or a more distant one, is often the only viable alternative available for riparians once hazards become imminent. By recognizing the inevitability of shore erosion hazards and the need to make coastal land use activities more sensitive to erosion hazards, damages can be greatly reduced along many reaches in Wisconsin.

At the national level, nonstructural approaches to damage reduction are receiving greater support and attention. The Office of Coastal Zone Management, Federal Insurance Administration, Army Corps of Engineers, Department of Housing and Urban Development, and Great Lakes Basin Commission have all taken actions to increase the use of preventive approaches in hazard areas. For example, in a recent report⁴⁵ prepared for the Federal Insurance Administration, the Erosion/Hazard Subcommittee of the Great Lakes Basin Commission recommended that a high priority should be given to nonstructural techniques within state erosion plans. In Wisconsin, two recent federal and state acquisition/relocation projects in flood-prone areas, Prairie du Chien and Soldiers Grove, are now serving to demonstrate the viability of preventive approaches in developed areas. The success and impact of Wisconsin's ten-year old Shoreland Management Program has also served to further illustrate the feasibility of preventive

approaches along the Great Lakes shoreline. In view of the general failure of past erosion control strategies and the "guaranteed nature" of nonstructural approaches, the principal question for this policy plan is, what role, if any, should the state play in further promoting and increasing the use of preventive strategies in Wisconsin?

State government is in a unique position to influence the development of nonstructurally-oriented damage reduction programs in Wisconsin. The legal basis for implementing many preventive measures is derived from state laws, statutes, and administrative codes. And, for a great number of resource/land use related concerns, the state works closely with local governments in Wisconsin, e.g. floodplains, building codes, on-site waste disposal. By increasing the erosion hazard sensitivity of the existing framework, the potential exists for the timely and efficient reduction of erosion damages. Where significant gaps and problems are found in this framework, the state could choose to promote the development of new statewide programs over the next few years. But, these possible reforms and adjustments are largely contingent upon the recognition of damage reduction as a coastal management problem which needs greater foresight and less hindsight. Failure to use foresight will not only encourage the repetition of past land use siting mistakes, but will also "lock" riparians and local governments into generally less efficient erosion control strategies.

A. Existing Nonstructural Framework

Background

A wide number of preventive options and strategies can assist in the reduction of erosion damages and hazards in Wisconsin. They range from zoning with conditional/prohibited use provisions to hazard disclosures through educational or regulatory activities to building relocation. In implementing these alternatives, state and local governments can call upon a number of other related techniques and powers. They include land acquisition in fee or less-than-fee simple e.g. easements, quit claiming, land donations, subdivision regulations, building code provisions, performance standards, and condemnation (power of eminent domain). Most of

these possible preventive actions have already been enabled through various planning, zoning, resource, and municipal government laws. Table XI on page 80 provides a listing of statutory citations for selected land use and resource laws in Wisconsin. The development status of coastal lands (developed/undeveloped), the "value" of endangered buildings and lands, the amount of lead-time, the effectiveness of existing damage reduction actions, and community/public official preferences toward preventive approaches will influence which preventive actions, if any, are to be pursued.

In considering further state-level actions, the characteristics of effective, nonstructurally-oriented damage reduction programs may provide some guidance and direction. First, the early recognition of coastal hazards and man's impact upon shore/bluff erosional processes is critical for program success. Zoning ordinances, building codes, hazard disclosures, etc. cannot provide emergency protection for riparians and local governments. They must be in-place during the months and years preceding the cyclic changes in Great Lakes water levels and erosion rates. Second, even though some preventive options can be implemented on a voluntary basis, e.g. emergency building relocation, voluntary setbacks and storm water management controls, some form of collective, public oversight is often necessary and desirable. Without coordination, conflicts between adjacent property owners and local governments could limit the effectiveness of preventive programs. Finally, nonstructurally-oriented damage reduction programs need continual monitoring and up-dating. Major changes in bluff/shore stability, judicial opinions, new development pressures, and shifts in public shoreline access/recreational needs could singly, or collectively, serve to reduce the effectiveness of preventive approaches.

Alternatives

Only four preventive techniques will be discussed in-depth: zoning and land use regulation, acquisition, relocation, and hazard disclosure. One alternative of continual interest to riparians is insurance, i.e. compensation. At the instigation of the Wisconsin and Michigan Coastal Management Programs, the Great Lakes Basin Commission undertook a major study of insurance as a vehicle to minimize erosion damages (Erosion

Table XI: Local Land Use Planning and Land Use Regulation Powers in Wisconsin

<u>Cities, Villages</u>	<u>Counties</u>	<u>Towns</u>	<u>Regional Planning Agencies</u>	<u>Special Districts</u>
A. <u>Broad land use planning powers</u> 62.23	A. <u>Broad land use planning powers</u> 59.97	A. <u>Broad planning powers</u> 62.23 (9) a	A. <u>Broad planning powers</u> 66.945	Soil Conservation District A. Plan for watershed protection 92.08
B. <u>Regulation</u>	B. <u>Regulation</u>	when acting with city powers 60.18 (12)		B. Adopt land management regulations 92.09
1. Zoning 61.35 62.23 (7)	1. Zoning 59.97	B. <u>Regulation</u>		
2. Flood plain zoning 87.30	2. Flood plain zoning 87.30	1. Zoning 60.74 59.57 62.231 (7)		<u>Flood Control Boards</u>
3. Shoreland zoning 144.26	3. Shoreland zoning 59.971	2. Subdivision regulations 236.45		A. Plan for drainage and flood control works Ch. 87
4. Subdivision ordinances 236.45	4. Subdivision ordinances 236.45	3. Building codes 62.23 (9) 66.058		
5. Building codes 61.35 62.23 (9)	5. Building codes 59.07 (51)	4. Official map 62.23 (6) with acting with city powers		
6. Official map 62.23 (6)	6. Sanitary codes 140.09, 59.07 (51)			
	7. Official map (weak) 80.64 236.46			

Source: Rural Land Resource Management
in Wisconsin Coastal Zone
Counties. Mueller and Van Berker,
Institute of Governmental Affairs,
January, 1976.

Insurance Study). The principal conclusion of this study (concurrent with by the Federal Flood Insurance Administration) was that insurance does not offer a viable mechanism⁴⁶ to reduce damages pursuant to the National Flood Insurance Act of 1968. Hence this nonregulatory technique has not been included for consideration within the Erosion Plan. Insurance and other compensatory options are discussed more fully in "Feasibility of Compensation for Man-Induced Erosion: Summary Report"; a working paper of the Wisconsin Coastal Management Program.

Each of the four alternatives will be discussed below. Two previous Coastal Management Program reports, Some Nonstructural Alternatives for the Reduction of Shore Damages and Nonregulatory Techniques for Urban Growth Management, provide the basis for much of the following information. Appendix P contains a listing of additional nonstructural references.

Regulatory Techniques

Zoning and Land Use Regulation

Wisconsin's planning and zoning laws have enabled counties, cities, villages, and towns to take many types of "police power" actions along the Great Lakes shoreline. Historically, while most communities have recognized the unique hazards associated with coastal development, efforts to systematically reduce damages were slow in coming until the late 1960's. Reasons for this inaction included the cyclic nature of erosion hazards, low land use planning priorities, inadequate data base, and fear of litigation. In 1966, the Legislature substantially changed this pattern with the passage of the Water Resources Act. This Act, and the resultant Shorelands Management Program prepared by the Department of Natural Resources and administered by counties, required counties to adopt⁴⁷ minimum zoning standards for all unincorporated areas lying within 1000 feet of the Great Lakes shoreline. Minimum standards were established for building setbacks (75 feet from the ordinary high water mark), lot sizes, tree removal, sanitary regulations, subdivision regulations, and land alteration activities within shoreland areas. By December 1971 all affected coastal counties had adopted ordinances which complied with the Act. A number of county ordinances now have standards which exceed the minimum standards

originally required to comply with the Act,⁴⁸ e.g. setbacks in Racine and Sheboygan Counties; lot sizes in Kewaunee, Door, Brown, Ashland, Bayfield, and Douglas Counties.

The Water Resources Act has provided a very limited test of zoning for the purpose of reducing erosion hazards and damages along the Great Lakes shoreline. Several limitations can be cited in this regard. First, only unincorporated areas are covered by the Act. Unincorporated areas account for only 20% of the state's population in coastal counties, but 77% of the land area. While incorporated communities have been encouraged to adopt similar standards and ordinances for shoreland zones, only a handful have done so to date. Appendix K contains some zoning, land ownership, and land use characteristics of incorporated and unincorporated areas. Second, the Water Resources Act does not specifically establish standards for relating erosion hazards to land use controls. Because erosion hazards vary dramatically along the shoreline, general minimum standards tend to create a "false sense of security" (Appendix L contains the administrative rules for the Shorelands Program, N.R. 115). Third, the Act and the Shorelands Management Program were initially viewed as "one-time" obligations or requirements. Changes in development patterns, erosion rates, and community priorities along with variable enforcement practices are serving to limit the effectiveness of many ordinances.

In spite of these limitations, Wisconsin's Shoreland Management Program has provided state and county governments with a solid and comprehensive framework around which to address coastal hazard problems in unincorporated areas. Incorporated areas (cities and villages), on the other hand, have found it necessary to respond in a more piecemeal fashion over the years. Although their interest in preventive techniques has remained somewhat low due to existing development patterns, many regulatory options remain available to cities and villages. Taken collectively, these options offer an equally comprehensive and solid framework for erosion hazard area management. For example, pursuant to Chapter 236 (Platting Lands and Recording and Vacating Plats), Wisconsin Statutes, erosion hazards can be officially acknowledged and identified during the subdividing of lands. Existing city and village zoning ordinances can also be legally modified

to reflect greater erosion hazard sensitivity.

Other regulatory devices which have the potential of being modified to reflect greater erosion hazard sensitivity are zoning maps, building codes, and land management ordinances (see Table XI for a listing of statutory references). One of the benefits of delineating hazard areas on zoning-related maps is the facilitating of hazard disclosure where such maps are publically-posted or widely distributed. Similarly, the official recognition of erosion hazards during land platting activities creates an opportunity for the recording of hazard conditions at the county level pursuant to Chapter 706.01 (Conveyances of Real Property; Recording; Titles), Wisconsin Statutes. With regard to building codes, communities can seek to reduce damages by increasing the moveability of buildings through local variances to Wisconsin's newly adopted Uniform State Dwelling Code. Ordinances for such purposes as storm water management, sediment control, and vegetation removal/land disturbance can readily be applied to erosion hazard areas. The City of Port Washington's sediment and erosion control ordinance demonstrates a regulatory action which can yield substantial environmental benefits along the Great Lakes shoreline.

Even though few state and local government regulatory activities have been aimed at damage reduction and hazard preventive per se, a strong legal basis for action has been established in Wisconsin. Specifically, Chapters 59.97 and 59.971 (counties), 62.23 (cities and villages), and 60.74 (towns), Wisconsin Statutes, give local governments the authority to relate zoning restrictions to conditions which could endanger the "health and well-being" of the public, i.e. natural hazard areas. In State vs. Deetz (66 Wisconsin 2d 1, 1974), a case involving surface erosion from a bluff top development along the Wisconsin River, the Wisconsin Supreme Court held that "erosion control should be exercised by zoning and subdivision and land use regulations." At the state level, the Water Resources Act has given state agencies the authority to directly participate in the management of shoreline lands which may contain both flood and erosion hazards. These powers were affirmed by the Wisconsin Supreme Court in the landmark case Just vs. Marinette County (201 NW 2d, 1972).

In addition, the Governor's Executive Order powers have already been used on hazard-related issues. Executive Order 67 of 1973 directed state agencies to consider the special needs of flood and erosion hazard areas in land use planning, public facility siting, and real estate licensing activities. Appendix M contains a copy of this 1973 directive.

Although zoning and land use controls can serve as the "anchor" of nonstructurally-oriented damage reduction programs, to be successful, many of the historic concerns associated with regulatory actions, e.g. due process, the "taking" issue, still need to be addressed. Specifically, a carefully prepared "intent" or "purpose" section in laws, ordinances, and codes will help alleviate interpretation problems. Wisconsin's Shoreland and Floodplain Management Program provides a comprehensive listing of possible public purposes. Second, in some cases, the "factual basis" for taking further regulatory actions may need to be well-documented. Data on recession rates, slope failure areas, past damages, and the possible impacts of improper development should prove particularly valuable for regulatory justification. Finally, given the variability of erosion hazard conditions and the technical aspects of zoning administration, special administrative procedures may have to be employed at the local and state levels, e.g. technical advisory committees, adjunct planning bodies. The uniform and sustained enforcement of state and local coastal regulations can play an important role in reducing future damage potential.

Nonregulatory

Acquisition

Several state agencies and virtually all local governmental units, including school districts, have been authorized by the Legislature to purchase lands for various public purposes, e.g. state forests, state and local parks, watershed protection areas, public facilities. Basic authority for land acquisition is contained within Chapters 60.18 (towns), 62.22 (cities), 61.34 (villages), 59.07 (counties), 23.09 (DNR), and 84.09 (DOT), Wisconsin Statutes. Public land transactions are subject to federal and state laws which protect the interests of the seller, often requiring basic relocation assistance, i.e. Federal Uniform Relocation and Real

Property Acquisition Act of 1970 (P.L. 91-646) and Wisconsin Relocation Law (Chapter 32.185, Wisconsin Statutes). Adjustments are made in local aid formulas once private land is removed from tax rolls. Eminent domain (condemnation) powers have also been granted to many governmental units to carry forth public projects under adverse circumstances. Land purchases, whether full fee simple or less-than-fee simple, are typically costly undertakings. Both the federal and state governments have developed a number of assistance programs over the past two decades. Two programs which have been instrumental in the acquisition of lands for coastal recreational purposes are LAWCON (Federal Land and Water Conservation Act) and ORAP 100/200 (Wisconsin's Outdoor Recreation Act Program). Several other sources of funding may also be available to local governments, e.g. Community Development Act, Rural Development Act, Farmers Home Administration. Most newly enacted programs require a 20-50% match from the applicant.

Public acquisition for the sole purpose of reducing erosion damages has not been used along Wisconsin's Great Lakes shoreline. Virtually all public acquisition projects have either been designed to increase public access/recreational opportunities or to facilitate the construction of public facilities. Even the Milwaukee County Park Commission's system of coastal parks were not designed with damage reduction as the primary goal. Simply stated, the costs (and benefits) of public acquisition along the shoreline combined with the perceived private sector nature of damage reduction activities have served to keep public interest low over the years. Often, land values on unimproved parcels near urbanizing areas will range between \$10,000 and \$20,000 per acre. Less-than-fee simple acquisition, e.g. easements, quit claiming, hold some potential for reducing costs, but these techniques remain largely untested along the shoreline. In view of the general lack of federal and state aid monies for preventive measures, other purposes must still be found to acquire lands in erosion hazard areas. To summarize, while coastal property owners have often used selling or abandoning as a way of remedying their erosion problems, the public sector has generally not been willing, or able, to purchase eroding lands.

Acquisition may provide state and local governments with a unique

opportunity to reduce damages under special circumstances. Namely, when combined with building relocation efforts or when needed to ensure a direct public shore/bluff management capability, e.g. along sand generation areas, areas adjacent to navigational structures. Under these circumstances, once erosion-prone areas are under public ownership, further development can be prohibited. And, that development which is needed for public purposes can be designed with a maximum degree of erosion sensitivity. To totally eliminate damage potential, any remaining buildings or facilities can be relocated away from hazard zones or dismantled for salvage. Public ownership of selected areas along the Great Lakes shoreline would also help ensure that reaches can be managed as "natural units" thereby increasing the effectiveness of erosion control devices and decreasing adverse impacts upon the environment. Such direct management capability could prove particularly helpful in either limiting the deployment of structural devices or making structural modifications when adverse impacts become acute.

In view of the general failure of erosion control strategies, the future of public acquisition, particularly when combined with relocation, appears somewhat optimistic. The present amount of federal interest in acquisition/relocation projects in flood-prone areas suggests that preventive approaches to hazard area management are being looked at more seriously. If Wisconsin's two projects in flood-prone areas, Prairie du Chien and Soldiers Grove, prove both economically and socially successful, some dollars could be made available for Great Lakes projects where erosion control has not, or will not, prove viable. In other instances, where state and local governments can identify their future coastal land needs, priorities could be given to the purchase of erosion hazard lands where they coincide with these needs. Accordingly, a greater probability ~~now exists that federal and state assistance programs will give multi-~~targeted projects along the shoreline a higher priority largely due to the impacts of the Federal Coastal Zone Management Act of 1972. Even in the absence of further aid, both state and local governments may be able to gain some control of, or access to, the shoreline through other less costly means, e.g. public/private sector tradeoffs. Following the City of Sheboygan example, public access to the shoreline (or other limited

rights-in-land) could be granted in exchange for some shore protection, a guaranteed future land purchase (based upon present market value), or housing relocation. In conclusion, while the extensive, statewide purchase of erosion-prone lands may not be feasible or acceptable, acquisition offer long-term benefits when combined with other public purposes.

Relocation

Erosion hazards and damages can be reduced through the physical relocation of endangered buildings and facilities. Relocation can take place on the same property or on an entirely different parcel some distance from a hazard zone. A number of factors directly affect the cost of this nonstructural option. They include lot depth, the availability of new building sites, ease of site access, building configuration and size, amount of subfloor access, number of public facility disconnections, and the availability of experienced movers. Because relocation is typically only considered during emergency periods, the amount of land lake-ward of a building is a critical factor. Between 15 to 20 feet of clearance is normally required for the safe operation of equipment. Moving costs for a small cabin or cottage, medium size ranch style house, and large mansion can be expected to range between \$3000-\$4000, \$7000-\$9000, and \$30,000-\$40,000,⁴⁹ respectively. These costs do not include site preparation costs at the new location. Moving distance has very little impact on total project costs. Most small and moderate-sized buildings can be relocated within one to three weeks. Persons displaced for public projects are entitled to special services and assistance under the provisions of Wisconsin's Relocation Law and the Federal Uniform Relocation Act of 1970 (P.L. 91-646).

Relocation has been viewed as an alternative better suited to the needs of residential property and commercial business owners. More often than not, it has served as a solution of last resort when all attempts to structurally protect a building have failed. Only relatively small number of homes and businesses, perhaps no more than 40, have been relocated over the past 30 years along Wisconsin's Great Lakes shoreline. Aside from the direct benefits which accrue to relocated individuals and businesses, a number of broader public benefits are associated with relocation. First, valuable, and often irreplaceable, housing and business

resources are not lost to shore erosion. In effect, coastal buildings can be "recycled" or redistributed with minimal interruptions. Second, additional shoreline land may be made available for public access and use. The public acquisition of erosion-prone land becomes more viable when combined with relocation. Third, irreplaceable coastal resources of significant regional importance such as historic sites and unique architectural styles can be preserved with the use of relocation. Finally, post-storm or high water period public expenditures for clean-up are also substantially reduced when endangered buildings can be removed in advance of failure.

Whether implemented on an emergency basis or well in advance of hazards, relocation can offer state agencies and local governments a cost-effective alternative for the Great Lakes shoreline. After analyzing the benefits and costs associated with a number of damage reduction techniques, the Michigan Department of Natural Resources, through the University of Michigan Coastal Zone Laboratory, concluded that "the costs of moving a home are competitive with a well-constructed shoreline structure".⁵⁰ Since relocation eliminates damage potential over a much longer period, its long-term benefits tend to far outweigh its short-term costs. Also, it should be noted that relocation, when carefully planned and implemented, does not necessarily have an adverse impact upon the tax base. Property values may even increase when relocation occurs on a different parcel or when shoreland land is exchanged for public lands.

The availability of financial assistance will often serve as the limiting factor of publically-sponsored relocation programs. Owing to the high costs of shoreline lands and the costs of moving each endangered building, few communities or state agencies are in a position to fund large-scale relocation projects alone. Since no state or federal funding programs have been exclusively designed for erosion hazard area evacuation, other public purposes must serve as the focal points of public projects. Possible purposes include the preservation of historic housing, protection of low-income housing, or increased public access and recreational opportunities. In view of the concern over "public assistance to the private sector", public acquisition (ownership) appears to be an

essential ingredient of relocation programs. Assistance programs available through such state and federal agencies as the Department of Natural Resources, Department of Local Affairs and Development, Army Corps of Engineers, Federal Disaster Assistance Administration, and Department of Housing and Urban Development all offer some funding potential under limited circumstances. Except in rural areas, no relocation assistance monies or tax subsidies are directly available to residential property owners at the present time. Commercial or business property owners may be able to obtain some assistance, largely in the form of low-interest loans, through the Small Business Administration or Farmers Home Administration.

Hazard Disclosure

Erosion hazards can be disclosed to the general public, riparians, and prospective land purchasers through both formal and informal means in Wisconsin. Disclosures or notifications of hazard conditions can occur during real estate transactions, land platting/land use siting, and general public education activities. When hazard disclosure occurs in a timely and efficient manner, both existing and future riparians along with other interested parties, e.g. real estate agents, bankers, can base management-level decisions upon the best available data. And, where necessary, other preventive and remedial actions can be taken to reduce damage potential before emergency conditions are present.

The Legislature has given both state and local governments a considerable degree of latitude in taking actions necessary for the disclosure of hazard conditions. At the state level, pursuant to Chapter 452, Wisconsin Statutes, the Real Estate Examining and Licensing Board has established guidelines and principles of conduct for real estate brokers on disclosure-related concerns, e.g. "duty not to misrepresent", "silence as misrepresentation". An in-depth summary of these concerns is contained in Wisconsin Real Estate Law (1976 edition). Interstate sales of land are covered, in part, through the Interstate Land Sales Full Disclosure Act of 1968 (this Act only applies to developments of 50 or more lots which are being sold "unimproved" as part of a common promotional plan). At the local level, subdivision platting, zoning, and land registration activities offer

alternative vehicles to disclose hazards. Licensed real estate agents are expected to be aware of any public site restrictions which have been officially recognized through planning, zoning, or platting activities. Finally, through their general educational responsibilities, both state and local governments can initiate many actions to inform the public of erosion hazards. Possible activities include the distribution of informational brochures, posting of hazard conditions in public places, and the sponsoring of special seminars/workshops for bankers, real estate agents, or the general public. To-date, few educational efforts have been aimed at hazard disclosure.

Even though erosion hazard disclosure is not required in Wisconsin, this preventive technique can still significantly reduce damage potential along the entire Great Lakes shoreline. Upon initial analysis, disclosure might appear better suited for undeveloped portions of Wisconsin's Great Lakes shoreline, i.e. to "head-off" development. However, it can play an equally important role around developed areas by ensuring that prospective business/residential property buyers are aware of any site limitations in advance of land transactions. Citizens unfamiliar with coastal environments and out-state land purchasers are particularly susceptible to being misled or uninformed. Direct land sales or exchanges between property owners (no real estate agents) receive no public regulation at the present time. Consequently, even lending institutions and insurance companies may have a role to play in hazard disclosure. To summarize, hazard disclosure offers public officials a direct means of reducing damages along undeveloped and developed portions of the Great Lakes shoreline. When linked to regulatory mechanisms, their impact and effectiveness can dramatically increase.

In considering what role hazard disclosure should (could) play in damage reduction programs, a review of basic characteristics may provide some insights. First, a significant amount of state/local cooperation and coordination is needed to insure their effectiveness. If, for example, there is a breakdown of communication or follow-thru in the field, e.g. disclosure rules ignored, hazards not officially posted, the notification system will not remain effective. Second, erosion hazard awareness must be

given a high sustained priority in coastal counties regardless of water level conditions. Any temporary lulls in attentiveness or enforcement can dramatically increase hazards at some point in the future. Third, hazard warnings are most effective when notice is given before final sales or exchanges. Disclosures of vulnerability after-the-fact may leave property owners in a "no win" situation. And fourth, hazard disclosures are generally low-cost, administratively standardized responses which can yield a high return when properly implemented. All concerned parties should have an equal opportunity to receive, and benefit by, the timely transfer of hazard-related information.

B. Options and Strategies

Through Wisconsin's Shore Erosion Study Plan, the Coastal Management Program has made a detailed examination of both traditional and innovative tools and techniques for the prevention of erosion damages. Much of this effort focused on their potential applicability and effectiveness, either singularly or in combination, along developed and undeveloped reaches of the Great Lakes shoreline. Of particular concern to this policy plan is the conclusion that many relatively simple modifications or adjustments can yield substantial long-term benefits with minimal costs. For undeveloped portions of the shoreline, the options and strategies generally seem much clearer and potentially more effective. In order to prevent the same locational mistakes from being made again, land use regulation and hazard disclosure can be made the "foundation" of preventive programs. Incentives for the nondevelopment of erosion hazard areas such as accelerated income tax deductions for land donations, use-value (circuit breaker) taxation, and property tax exemptions hold little promise of cost-efficiently achieving damage prevention. Further, in view of the limited number of benefitting riparians, even a modest reform of the tax system for damage reduction may not be warranted at this time.

For developed areas, the options and strategies appear best targeted toward reducing the adverse impacts of coastal land management practices. And, in some cases, finding incentives or public funds to promote the use of building relocation and/or public acquisition.

Sustained hazard disclosure efforts can complement both of these activities. In short, preventive strategies for developed areas may tend to be more complex and costly when regulatory options are not available.

The success of any state-level efforts to increase the use of preventive techniques, particularly regulatory-oriented ones, appears to be largely dependent upon the accurate identification of erosion hazard areas. The areal distribution and magnitude of hazards helps establish the factual basis for taking preventive actions. If, for example, land management regulations are to be the focus of state and/or local preventive efforts, the area where these regulations are to be in-force will need to be located or identified. In short, erosion hazard areas need to be mapped in such a way that ordinances, regulations, or damage reduction programs can be efficiently and consistently administered. There remains, however, a close relationship between the technical aspects of hazard area delineation and the intended management actions.⁵² In general, the more restrictive or geographically extensive the intended management actions, e.g. mandatory controls, deep setbacks, two-tier districts, the more technically accurate and comprehensive delineation procedures may have to be. Finally, although principally designed for regulatory-oriented preventive programs, erosion hazard area delineation may also assist in the prioritizing of acquisition monies, inventorying of endangered buildings, and facilitating of hazard disclosure.

Applying special district regulations to the Great Lakes shoreline is not a new concept. Several coastal communities have already created special zoning, use-districts, e.g. Lake Shore or Lake Estate districts in Mequon, Whitefish Bay, and Shorewood; Public and Semi-Public districts in Washburn, Park Land district in Cudahy.⁵³ However, the delineation of erosion hazards presents a more difficult technical challenge. In order to generate accurate maps of, or setback lines for, erosion hazard areas, bluff failure and shoreline recession processes may need to be carefully analyzed and represented through formulas. Depending upon the intended management actions and type of available technical data, a wide range of parameters can be investigated. They include historic/recent recession rates, bluff height/slope, stable slope angles, the effects of adjacent

protective structures, groundwater conditions, and vegetative cover. Perhaps the most important, and subjective, element remains that of risk assessment. That is, how far into the future should erosion hazards (processes) be projected: 25, 50, or 100 years? For most quantitative approaches, the risk assessment period has a direct impact upon the landward extent of hazard areas, i.e. recession rate (measured in feet per year) multiplied by the risk period. Finally, as a dynamic natural process, erosion poses one unique problem for mapping. Public officials must decide whether to pursue a "one-time" delineation or pursue options which may require continuous shoreline monitoring.

A great number of schemes have been developed to delineate erosion hazard areas. For the purposes of this policy plan, only three options will be briefly overviewed: site specific, area approach, and setback approach. "Erosion Hazard Area: An Alternative for Shore Management", a recently prepared Geological and Natural History Survey and Sea Grant Program working paper, provides a more complete discussion of delineation options and uses. In addition, it should be pointed out that the erosion-related investigations, reports, and maps of the Wisconsin Coastal Management Program provide a comprehensive data base for the implementation of many options.

Site Specific

Rather than placing boundaries around hazard areas through the application of formulas or through interpretations of existing data, this approach calls for the on-site analysis of coastal environments to physically identify hazard area characteristics, boundaries and, where desired, building setback distances. On-site investigations can be conducted as a prerequisite of land development by the developer, or in some instances by government. When conducted as a prerequisite of development, this approach is particularly suited to performance standard-oriented ordinances. The California Coastal Commission has adopted performance standard-type guidelines for bluff top development.

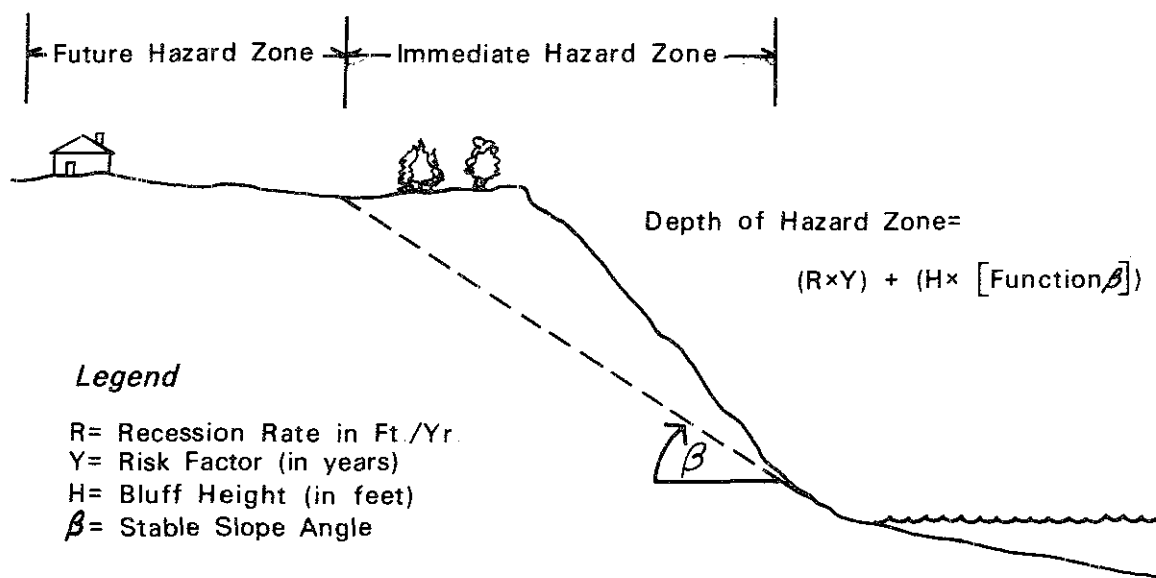
The site specific approach allows regulatory actions to be "tailor-fit" to real world conditions hence it remains technically and legally

very defensible. But, a publically-sponsored shoreline analysis program does not appear very probable in view of the high costs and amount of coastal land with relatively low development pressures. Even when undertaken by the landowner or developer, a governmental technical review and/or certification function appears essential. In short, despite its accuracy and defensibility, the administrative costs and requirements of this approach may limit its applicability in Wisconsin.

Area Approach

This approach calls for the use of generalized formulas which contain a limited number of quantifiable erosion parameters, e.g. recession rates, bluff heights, projected stable slope angle, risk assessment factor (in years), to identify a stable bluff zone (immediate hazard area) and/or the landward boundary of a future hazard zone. Figure 7 below provides a sketch of how this approach can be applied to a high bluff setting.

Figure 7: Erosion Hazard Delineation: Area Approach



Area delineation approaches can be made more accurate by relating formulas to several hazard classes, e.g. high bluff/unstable slope, low bluff/stable slope. Setbacks and other land management controls could be related to the depth and configuration of the immediate and future hazard

zones. The State of Illinois and Province of Ontario have used modified area delineation procedures to identify 100-year risk zones.

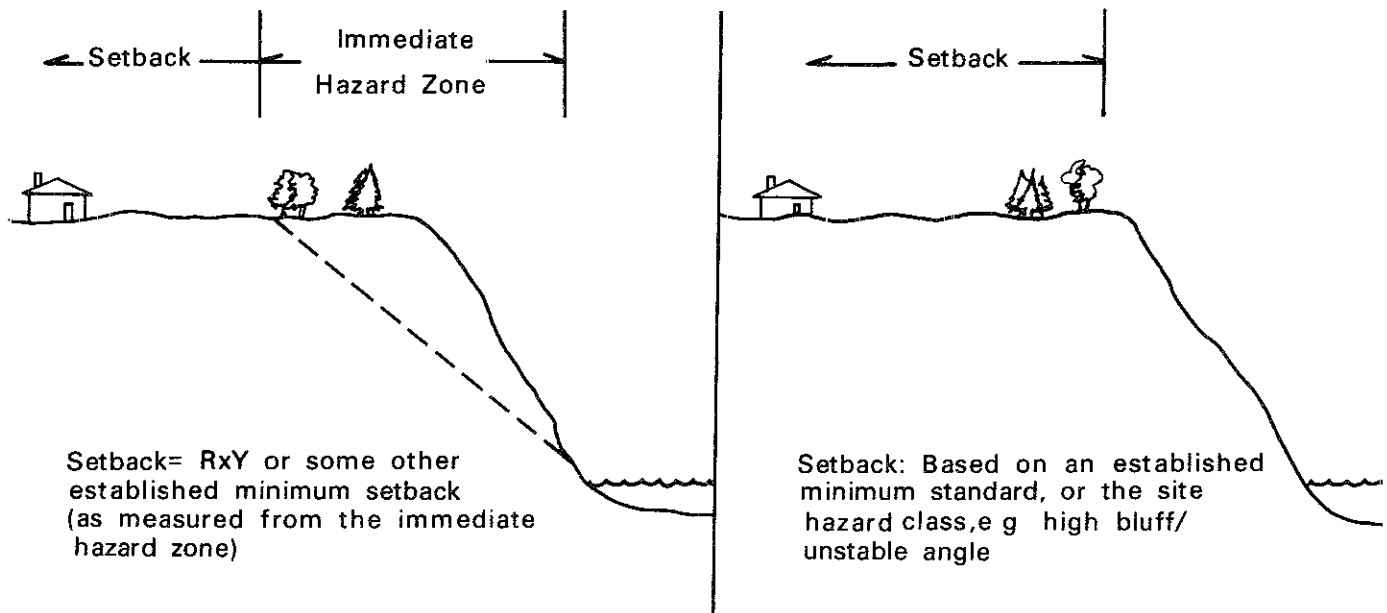
The area delineation approach provides a compromise between site-specific and simple, recession rate formula approaches. So long as sufficient data is available, a relatively high degree of accuracy can be achieved with a minimum of cost and administrative problems. For state-wide applications, each formula parameter and/or hazard class must be carefully selected, particularly the risk factors. To follow-up on hazard area conditions or changes, this approach may require a public sector commitment to shoreline monitoring and assessment.

Setback Approach

To avoid the technical and administrative problems created by "moving" boundaries, this approach focuses on the identifying of safe building setbacks. Formulas, similar to those used under area delineation options, could be used to establish a stable bluff zone (immediate hazard area). But, no attempt would be made to identify the complete depth of a hazard area. Instead, an additional distance, measured from either the present bluff edge or stable angle profile, would be determined from an analysis of recession rates and hazard conditions. Figure 8 on page 96 provides a sketch of these two options. The State of Michigan used a modified version of this approach in its Shoreland Protections and Management Act of 1970. Areas with an average annual recession rate of one foot per year or greater were required to have a setback equal to the rate of erosion, times a 30-year risk factor (measured from the existing bluff edge). Appendix O contains an amended draft of the Michigan Department of Natural Resources' administrative rules for this Act.

By offering a more limited response to public delineation needs, this approach generally appears more administratively flexible and practical than other options. In only focusing on building setbacks, this option also appears more transferable to the existing regulatory framework. But, for those public officials desiring a firm basis for taking regulatory actions, i.e. clear-cut, permanent boundaries or lines,

Figure 8: Erosion Hazard Delineation: Setback Approach



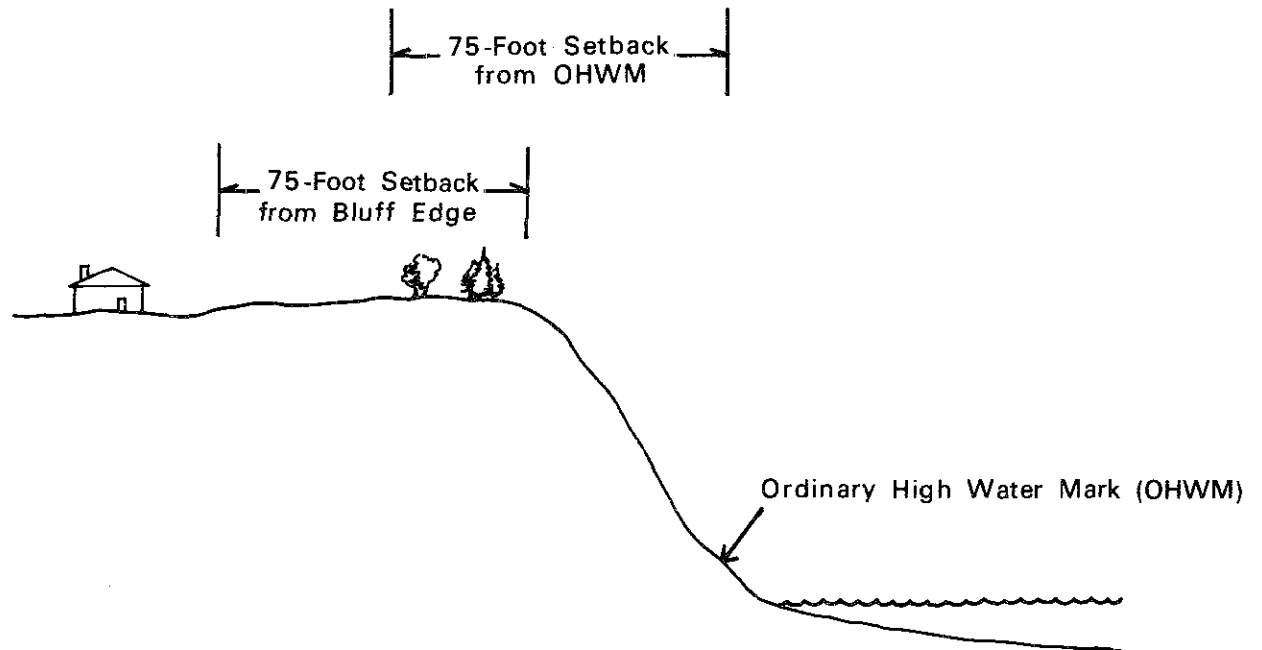
this approach may not prove satisfactory. If variable setback distance formulas were developed, their concerns may even heighten. Finally, by not officially establishing a land management zone beyond the setback line, both local and state governments could find it more difficult to adopt, and enforce, more extensive bluff top land management regulations.

Given the range of delineation options, what actions or modifications, if any, should the state seek to implement? An analysis of the setback provisions within Wisconsin's Shoreland Management Program may provide some guidance. Presently, a 75-foot setback from the ordinary high water mark (OHWM) is required in unincorporated areas. Along many reaches of the Great Lakes shoreline, this setback distance has not proved adequate. Long-term erosion rates in excess of five feet per year are common along highly erodible environments, and short-term rates can even be higher. For example, near Port Washington, one bluff retreated 25 feet in 1978.⁵⁴

Several administrative problems have served to further limit program effectiveness. First, the 75-foot setback is measured from the OHWM; not

the present (existing) bluff edge. Along high blufflines, the slope angle can account for 20 to 30 feet of the horizontally measured distance (see Figure 9 below). Second, no criteria have been recognized in the statutes to relate erosion hazards to possible setback distances, i.e.

Figure 9: Setback Measurement from the OHWM Along Coastal Bluffs



Michigan multiplies the annual recession rate by 30 in high risks areas. Counties are left free to develop their own standards for actions taken beyond the 75-foot zone in Wisconsin. Finally, the Program does not offer strong guidance for land management actions taken beyond the setback zone. Even though the entire 1000-foot shoreland management zone is regulated, no specific actions or activities are mandated or recommended beyond the setback line.

Regulatory Strategies for Undeveloped Areas

For the approximately 150 miles of erodible, undeveloped shoreline in Wisconsin, the implementation of erosion hazard zoning can lead to the efficient and effective prevention of damages. Provisions contained within ordinances for delineated hazard areas could include siting

requirements, e.g. minimum lot sizes and building setbacks; building requirements, e.g. assurances of proper construction, relocatability; land management requirements, e.g. land disturbance standards, ground/surface water controls; and hazard disclosure requirements, e.g. zoning maps, public notification. These provisions could all be combined within model ordinances for the precluding/conditioning of coastal development. Or, they could be promoted as possible independent actions of the state and local governments. Therefore, in lands that are yet undeveloped, what specific actions, if any, should the state pursue to implement hazard zoning, and at what level of government should they be aimed? The options include: (a) direct state regulation as in Chapters 30 and 31, Wisconsin Statutes, (b) state minimum standards and guidelines with local administration, perhaps in conjunction with the state Shoreland and Floodplain Management Program, and (c) local government hazard area management encouraged, but not required by the state (possibly with some state funding to local governments or state-provided technical assistance). Failure to pursue one of these strategies suggests that the existing framework, i.e. status quo, provides an acceptable public response to erosion in undeveloped areas.

The direct state regulation of erosion hazard areas would require new legislative authority. Wisconsin's present political climate combined with the questionable viability of direct state-level zoning for a relatively modest statewide problem argues against this approach at the present time. On the other hand, since the status quo has not led to extensive erosion hazard zoning along the Great Lakes shoreline damage potential has not been significantly reduced along many largely undeveloped reaches in both incorporated and unincorporated areas. While the failure to act can often be related to the lack of sufficient technical data and expertise, it nonetheless has demonstrated a willingness to wait until emergency periods for further public responses, thereby implicitly encouraging erosion control strategies. To summarize, if the state chooses to promote erosion hazard zoning, the two remaining strategies could provide the basis for action.

The first strategy, state minimum standards and guidelines with local administration, largely builds on the existing state Shoreland and Floodplain Management Program. Most significantly, this strategy deals with erosion hazard area management not as a single isolated issue, but in the context of a comprehensive public response to shoreline management needs and problems. This approach has the advantage of allowing for the utilization of existing program staff and experience as opposed to starting-up an entirely new program from the "ground-level". Comprehensive legal review⁵⁵ by the Coastal Management Program and subsequent analysis by the Department of Natural Resources indicates that there is adequate statutory authority in the Shoreland Management Program (N.R. 115), but probably not in the Floodplain Program (N.R. 116) to seek immediate implementation of hazard area zoning. Thus, it appears that the administrative rules for the Shoreland Program could be modified to provide that "in delineated hazard areas, the local zoning ordinance shall...". While such a modification would only apply to unincorporated areas, municipalities could be encouraged to adopt appropriate compatible regulations. This single administrative change has the potential for significantly reducing damages along an extensive portion of Wisconsin's undeveloped, erodible shoreline. State minimum standards and state-prepared model ordinances combined with increased technical assistance would assure some degree of uniformity and consistency along the shoreline. Legislatively, erosion hazard zoning could also be implemented through direct amendment of shoreland/floodplain management and land subdivision (Chapter 236) statutes.

The second strategy, erosion hazard area management encouraged but not required, identifies damage reduction/prevention as primarily a local concern. Hence the state role would largely be to assist local governments in taking various preventive actions. Possible state-level activities include the distribution of Coastal Management Program technical data, preparation of appropriate model ordinances, and providing of general administration assistance. Direct state assistance for the delineation of erosion hazard areas could prove particularly critical for locally initiated and administered efforts. To ensure a sustained level of assistance over time, a technical assistance capacity might be built into the Coastal Management Program, University

of Wisconsin-Extension System, and/or Wisconsin Department of Natural Resources. Alternatively, state funding might be legislatively sought for local governments so that they could largely undertake all necessary background and implementation activities. Given the number of hazard affected communities and the technical complexities of erosion hazard area management, a state-funded assistance program might prove costly and lead to a significant amount of duplication.

Regulatory Strategies for Developed Areas

Along developed portions of Wisconsin's erodible Great Lakes shoreline, the implementation of new regulatory measures would have minimal, immediate impacts upon damage reduction. One of the exceptions to this being in cases when reparians need to seek new building/zoning permits due to natural or personal disasters, e.g. fires, tornadoes. Or, in situations when changes in land use building style are desired, e.g. building expansions, single family to multi-family. And, even in developed areas, significant amounts of developable land often remain between adjacent property owners particularly in suburban coastal environs. In these instances, a complete "package" of erosion hazard zoning tools and provisions could have significant, localized impacts upon damage reduction. The options and strategies noted in the previous discussion can, therefore, be directly applied to developed areas. But, regulatory strategies oriented toward the control of land management activities and practices may prove more desirable and applicable. The need for effective land management practice control along the shoreline is heightened by the potential impact of development upon coastal bluffs. Although pre-development control is preferable, post-development action can often increase upper bluff stability thereby delaying building endangerment. Some recommended practices include additional vegetation plantsing, minimal land disturbance, subsurface dewatering, and surface water diversions.

In identified erosion hazard areas, the state could advocate, and facilitate, the use of land management practices which reduce damage potential through a number of regulatory options. The basic strategies identified for undeveloped areas could provide the basis for further

action. But, the two that seem to hold the most promise are Shoreland Management Program modification and state encouragement through technical assistance activities. Educational materials and suggested land management practice guidelines/standards might prove particularly important for a state-level technical assistance role. Model ordinance provisions which emphasize upper bluff control/stability might also be prepared for developed (incorporated) areas. The City of Highland Park, Illinois's performance standard-oriented "Bluff and Ravine Steep Slope Ordinance" might serve as a prototype for ordinance development in Wisconsin. Appendix N contains selected provisions of this recently adopted ordinance. Finally, by improving the administration of existing shoreland regulations, communities can realize a substantial reduction in damage potential without new legislation. One county which has been successful in accomplishing this task is Racine. Before issuing permits, on-site investigations are undertaken for all new construction by the Soil Conservation Service under a special "cooperator" arrangement with the County Planning and Zoning office.

Nonregulatory Strategies

State and local government regulatory responses to coastal erosion will, in some cases, need to be supplemented with nonregulatory options. Such options as acquisition, relocation, and hazard disclosure can be particularly helpful in developed areas. However, it appears unlikely that these options could serve as the "anchor" of damage reduction programs in Wisconsin due to high costs, lead-time requirements, site specific effectiveness, et cetera. In general, if these approaches are linked to broader statewide hazard area management concerns, e.g. flood-plain development, steep slope areas, their potential as individual management strategies would appear to substantially increase. Nonetheless, the state can take a number of actions to increase their use in delineated hazard areas at this time.

Acquisition

Public acquisition, whether in full or less-than-fee simple, in erosion hazard areas for the sole purpose of damage reduction appears unlikely. But, in situations where other public benefits can be identified,

e.g. recreation, public access, environmental corridor protection, acquisition may offer a viable nonregulatory option. Two situations which appear to offer a more direct application potential for damage reduction are in cases when acquisition can be combined with building relocation and when direct shore/bluff management is needed to reduce damages, e.g. for protecting public lands/facilities, to limit the deployment of structural devices along sand generation areas. Acquisition/relocation will be discussed in the next subsection.

If the state chooses to promote the use of acquisition in Wisconsin, several short-term (immediate) adjustments can be made and some long-term funding strategies could be developed. In general, short-term adjustments are aimed at improving the acquisition capabilities of local governments. Since a number of federal and state recreation-oriented acquisition programs are already in-place, e.g. LAWCON, ORAP-200, the state could seek to increase the priority of land purchases along erosion-prone reaches. Similarly, to help alleviate local government cost-share problems, existing formulas might be modified for state-controlled acquisition programs/monies. Through state-sponsored educational/informational activities, e.g. brochures, workshops, flyers, the use of more innovative land acquisition options in Wisconsin might also be increased, e.g. land exchanges (surplus public land for coastal land); public/private sector "tradeoffs" (similar to City of Sheboygan approach); land banking for future capital projects; less-than-fee simple techniques; and land donations/dedications (pursuant to Chapter 236, Wisconsin Statutes). Finally, some consideration might be given to modifying existing tax laws for acquisition projects in hazardous area, e.g. special assessments, special tax incentives.

In view of the potential costs of acquisition programs and the amount of coastal land already in public ownership (approximately 25%), direct incentive options which channel more dollars into coastal acquisition need to be carefully considered. Nonetheless, as a longer term strategy, the state might seek to develop a "one-time" acquisition program--if other statewide acquisition needs could also be identified. The State of Michigan has recently initiated a study to investigate possible coastal land acquisition priorities and needs. The State of California, through

its Coastal Conservancy (a "sister" agency of the Coastal Commission), has gone one-step further. With an initial \$10 million bond appropriation in 1976, the Conservancy has recently begun to restore coastal marshes/wetlands, enhance subdivisions, and "package" viable, undeveloped tracts for agricultural development. Closer to Wisconsin, over the past 10 years the State of Illinois purchased 1400 acres of coastal land (1200 parcels) with LAWCON and special bond monies to develop the Illinois Beach State Park. If Wisconsin wished to move in these directions, the principal funding options include direct state purchase and state/local cost-sharing. However, in view of increasing LAWCON support, any future state efforts to develop acquisition programs should be closely coordinated with federal activities. As an alternative strategy, the state could consider further advocacy efforts aimed at releasing more federal money for acquisition, e.g. Coastal Zone Management Act acquisition monies.

Relocation

In developed areas, the relocation of buildings from erosion hazard areas can offer a direct means of reducing damages, particularly when implemented before hazards become imminent. One of the principal problems limiting its application at the public sector level has been cost. Since acquisition is generally necessary to insure a longer term public benefit, e.g. access, recreation, environmental corridor protection, relocation has been made less attractive--unless coastal buildings happen to be contained within future park/waterfront development project areas. Only a small number of riparians, perhaps no more than 40, have used relocation as a damage reduction option over the past 30 years. If no changes are made within the current framework, i.e. the status quo maintained, relocation will only be occasionally used in spite of its long-term damage reduction potential.

Two broad strategies could be pursued by the state to increase the use of relocation in Wisconsin: immediate framework adjustments and long-term funding programs. In general, most framework adjustments are aimed at increasing the non-public application of relocation. First, through educational/informational activities sponsored by the state, public officials and riparians could be informed of relocation benefits, requirements, and costs (this could be undertaken in parallel with acquisition educational/informational activities). Second, since no public tax

incentives or subsidies are provided to non-business property owners, some consideration could be given to allowing residential property owners to deduct relocation costs against their state income tax. Deductions might only be allowed in delineated hazard areas for emergency and non-emergency relocation. Third, to improve the feasibility of relocation, and to partially reduce its costs, actions could be taken to increase the relocatability (moveability) of coastal buildings through zoning ordinances and building codes. One possible statewide application of this concept could be initiated under the "unique soil and geologic conditions" provision of the State's Uniform Dwelling Code. Finally, it should be noted that the feasibility of relocation may increase when innovative acquisition techniques are used at the local level, e.g. land exchanges with lease backs, public/private sector "tradeoffs", land banking.

Relocation costs will continue to be a major obstacle limiting implementation--even if many of the above adjustments are made. Therefore, should the state provide financial assistance to local governments for acquisition and/or relocation of development in erosion hazard areas where such action is consistent with a public purpose? If such financial incentives are desirable, any number of funding "packages" could be developed: full state funding, state/local cost-sharing, etc. At this time, the state-of-the-art is not such that the workability and practicality of such programs for erosion hazard areas is clear. Most early federal funding efforts have focused on flood hazard areas, i.e. Soldiers Grove, Prairie du Chien. Based upon these initial efforts, it is clear that acquisition/relocation projects require a significant amount of lead-time, planning, and inter-agency/intergovernment coordination. Hence they appear to have little practical value as emergency responses to erosion hazards. If a more responsive relocation-oriented program was desired, consideration could be given to the development of low-interest loan programs for riparians (perhaps similar to the Maryland Erosion Control Program). To summarize, all indications suggest that public acquisition/relocation projects could significantly reduce damage potential. But, given the limited number of coastal settings where other public benefits would immediately compliment the need for damage reduction, other statewide natural hazard problems would probably have to serve as the focus of a state-sponsored program.

Hazard Disclosure

Except during emergency periods, the magnitude of Great Lakes erosion hazards are not necessarily observable to, and fully appreciated by, citizens unfamiliar with coastal processes. Hence real estate transactions and decisions on land development can be made in the absence of adequate information. Land use regulation alone does not, in all cases, provide for the timely and effective delivery of hazard-related information. The public disclosure of erosion hazards in subdivision plats, offers to purchase, listing contracts, and zoning maps in combination with educational/informational activities, e.g. posting of special notices, brochures, media articles, can substantially mitigate any problems associated with inadequate advance notification. Such warnings can be accomplished through the voluntary actions of riparians, public officials, and real estate professionals or mandated (required) through state/local laws and ordinances. Although Wisconsin has in-place a number of disclosure-related mechanisms, they have not been consistently and uniformly applied to erosion hazard areas. Therefore, should the state seek mandatory disclosures of erosion hazards? Or, should disclosure activities largely remain voluntary, i.e. "let the buyer beware"?

In assessing disclosure options, it should be pointed out that all options may not offer an equal chance of success. In particular, disclosures through land recording (titles and deeds) and platting activities appear less able to significantly reduce future damage potential. Deeds and/or titles do not have to be officially recorded at the local or state levels in Wisconsin. Once a land transaction has been finalized, all that is required is a "tax transfer slip" (Chapter 706.05, Wisconsin Statutes; Formal Requisite for Record). With regard to platting, land subdividing can occur through mechanisms other than those described in Chapter 236. Certified land surveys and metes and bounds descriptions can be used in cases when less than five parcels are created, each having a size greater than 1½ acres. A study of land subdividing activities in Dane County⁵⁶ revealed that Chapter 236 land platting only accounted for approximately 50% of all land divisions over a four-year period (statewide, Chapter 236 platting may only account for less than one-third of all land subdividing). Significant legislative action appears necessary to even enable the consideration of these two vehicles as possible statewide hazard disclosure options.

At the present time, disclosures through real estate transactions and general educational activities appear to have the greatest chance of significantly reducing future damage potential. A state status quo response would have the net effect of keeping these disclosure activities largely voluntary in Wisconsin, except where individual communities and real estate associations chose to establish more formal procedures. The state-enforced, mandatory disclosure of erosion hazards could take two basic directions: either the enforcement of existing law (largely an administrative response) or the legislative resolution of existing problems through the enactment of a comprehensive "truth-in-sales" act for hazard area land transactions (probably for all major statewide hazards). Legislation dealing with disclosure might detail the substance of forms and listing contracts along with the procedures for complete advance notification. Administratively, through renewed state-level efforts, such agencies as the University of Wisconsin-Extension, Real Estate Examining and Licensing Board, and the Banking Commission might be encouraged to prepare special procedures and adopt a series of model forms. With the aid of supplemental monies, special educational/informational activities could also be targeted to key audiences on a sustained basis, e.g., real estate brokers, planning officials, riparians. One relatively modest adjustment which could bring about further disclosure is the providing of hazard area maps to real estate agents and lending institutions. This information along with additional technical assistance might serve as the basis for largely voluntary disclosure systems if no additional state action was taken at this time.

Chapter VI

SETTING THE COURSE: SOME FINAL CONSIDERATIONS

Introduction

The State of Wisconsin is now in an excellent position to move ahead with the task of further mitigating erosion damages along the Great Lakes shoreline. A coastal policy-making body, the Wisconsin Coastal Management Council, has been established by the Governor, and has given improved hazard area management a high priority. Subsequently, the Wisconsin Council Management Program has prepared a comprehensive array of technical and management-oriented information for public decision-making. In the "wake" of the 1972-1976 high water period, momentum has been established for further public action. The need for such decisive action is based upon the historical observation that coastal erosion, by its very nature and cyclic impacts, does not encourage sustained public actions or resource commitments. Even the relatively small number of affected property owners appear willing--or resolved--to seeing erosion hazards only in terms of high water period events or emergency conditions. If the damage reduction program concept, as outlined in Chapter III, is to be implemented in Wisconsin, actions should be initiated over the next few years before public interest in, and memory of, high water period damages fades even further. This opportunity for action should not be missed if Wisconsin's response to coastal erosion is to be based on foresight and not hindsight.

Regardless of what directions or actions, if any, the state pursues over the next few years, a sustained commitment to long-term damage reduction is essential. Without this sustained state-level leadership and guidance, there exists a strong possibility that significant reductions of damage potential will not be realized along the Great Lakes shoreline. Such direct involvement appears essential if Wisconsin decides to promote preventive approaches since local damage reduction activities can readily "lapse-back" to individualized remedial approaches (the present status quo). A recent Great Lakes Basin Commission and Federal Regional Council effort⁵⁷ illustrates the limited value of planning in the absence of a sustained commitment. As a response to damage losses during the early 1970's these two agencies sought to layout a comprehensive framework for damage reduction. Seven major types of options were analyzed (by state), some early and sustained actions were identified, and a five-year timetable was established.

Several principles or "knowns" were even identified to help facilitate decision-making. The "knowns", which bear a close resemblance to many of the ideas contained with the Erosion Plan, are found on Table XII below. Although this effort was only intended to serve as a "focal point" for action and discussion, as of this date, the longer term findings and recommendations have gone unimplemented (several short-term adjustments were made).

Table XII: Factors Influencing the Development and Implementation of Damage Reduction Strategies

- No single alternative will bring about a major reduction in losses from erosion and flooding, but the potential exists to bring about a major reduction over time through a strategy which combines all available alternatives.
- It appears that Federal, State, and local agencies have authority and programs to assist in planning and implementing many of the alternatives.
- Extensive public funding support is not available for protection of privately owned property.
- Future losses should be controlled by nonstructural land use controls whenever possible and structural means should be employed only as supplemental management efforts when needed to adequately protect vulnerable lands from excessive erosion and flooding.
- In most instances, permanent structural control measures cannot be justified economically for protection of extensive reaches of shoreline, especially as short-term solutions.

The Wisconsin Coastal Management Program has, through its Shore Erosion Study Plan, attempted to provide a complete range of information for decision-making. However, given the complexities of damage reduction planning and the ever-changing nature of Wisconsin's coastal environment, at best, this effort can only provide a limited feeling for those state-level policy considerations which need to be assessed in Wisconsin. Changes in technology, land use trends, public attitudes and laws along with court decisions may have significant impacts upon the nature of future damage reduction efforts. All of the answers are not in. Ultimately state and local officials may simply have to base their decisions upon the best

available data. With this in mind, two aspects of damage reduction planning which merit some separate attention are monitoring/research needs and inter-state coordination/cooperation.

A. Monitoring and Research Needs

To improve the efficiency of public responses to coastal erosion and to provide for accurate evaluations of damage reduction program impacts, consideration should be given to the coordination of data collection activities along the Great Lakes shoreline. All too often, past data collection efforts have only been targeted to specific reaches for relatively short periods of time. Such approaches may be suitable for single-purpose research investigations but they are not suitable for multi-faceted damage reduction programs. Thus, there remains a need to systematically and continuously monitor erosion hazards and land use activities along the shoreline. By improving shoreline monitoring/data collection activities, a physical hazards warning system could be developed; existing recession rate data could be expanded; a statewide network of sampling stations could be established for continuous damage assessments and erosional process research; and accurate inventories of coastal buildings, shore protection structures, and land use activities could be made available to federal, state, and local agencies in a timely manner. With careful planning and a comprehensive analysis of supplier/user problems, development costs for an upgraded monitoring/data collection system can be kept to a minimum.

To follow-up on Shore Erosion Study Plan findings, a number of special research investigations could be initiated to aid in damage reduction program planning. In particular, research is needed to identify those areas where protective devices could pose long-term, reachwide problems. The inventorying of Wisconsin's sand generation areas and isolating of major nearshore littoral cells (areas under the continuous influence of longshore currents) would substantially aid in this effort. This information could provide a strong technical basis for either allowing or discouraging various structural measures along coastal reaches. A parallel analysis of in-place shore protection devices might also serve to identify those coastal settings and construction techniques more suitable for longer term protection efforts in Wisconsin. Reducing erosion damages and hazards along medium to high blufflines has proved extremely difficult and expensive. Well over half of

Wisconsin's erodible shoreline falls into this category. To-date, limited experimentation has been done with innovative and/or moderate-cost techniques in these areas. A one-time demonstration project program might prove valuable in documenting the relative effectiveness, costs, and practicality of various alternatives, e.g. stepped, slope cutbacks with dewatering and vegetating; dewatering wells and surface water diversions; exotic/indigenous plant experimentation. Finally, to aid public officials in assessing the shore and long-term impacts of implementating various structural and nonstructural options, consideration could be given to refining decision-making tools and techniques for damage reduction planning purposes. Particular attention might be given to benefit/cost analyses, coastal process modeling or simulation, and simple formulas for on-site (in-field) use.

B. Interstate Coordination and Cooperation

In order to achieve damage reduction in the most efficient manner, interstate coordination may have to be given some added attention over the next few years. From a natural process standpoint, the need for such coordination is clear. Since shore protective actions affect littoral processes and erosion rates irrespective of political boundaries, adjoining Great Lakes states need to closely scrutinize, and monitor, major shoreline projects. Evidence of the potential political and regulatory problems which can be generated by coastal projects is still being seen from the construction of the Trident Marina at the Wisconsin/Illinois State Line.⁵⁸ General awareness of the need for interstate coordination appears to be on the rise. In a recently completed plan for the Illinois Beach State Park,⁵⁹ it was noted that close coordination with Wisconsin will be needed to help ensure the effectiveness of protective actions in Illinois. Although complete interstate coordination and cooperation has been difficult to attain, at the minimum, it would appear that a potential now exists to make regulatory processes more sensitive to interstate impacts. One regulatory process adjustment which could yield substantial benefits would be the signing of "memos of understanding" on the standards to be applied to coastal projects in proximity to state lines.

Interstate coordination and cooperation can yield several other benefits as well. One of the most significant contributions could be made in the area of data collection and shoreline monitoring. Traditionally, both state

and federal agencies have had difficulty sustaining data collection/shoreline monitoring activities because of limited coastal access, equipment needs, seasonal weather problems, and high costs. Moreover, the information generated through these efforts has often had limited reachwide value because of acquisition techniques, timing, and final information display. A multi-state, Great Lakes Data Collection Program could provide a viable means of providing better management information for coastal decision-making. Articulation of interstate data collection/shoreline monitoring concerns through the Great Lakes Basin Commission might have the added benefit of encouraging a higher degree of federal involvement and action.

Finally, the ability of Wisconsin and other Great Lakes states to reduce future damage potential may be partially dependent upon the joint articulation of assistance needs at the federal level. Those states participating in the national Coastal Zone Management Program may be in a more favorable position to initiate such actions over the coming years. Pursuant to the Coastal Zone Management Act amendments of 1976, all participating states were to have established a "planning process" for mitigating the effects of coastal erosion (Federal Register, March 1, 1978; 15 CFR 923.25) by October 1, 1978. Wisconsin's compliance with the amendments was documented in Wisconsin Coastal Management Program Amendments 1978.⁶⁰ If Wisconsin and other Great Lakes states formally decide, either independently or collectively, to pursue courses of action which necessitate some federal financial and technical assistance, e.g. relocation/acquisition projects in developed areas, added shore protection around public facilities, collective inquiries and pressures should prove more effective and persuasive in releasing assistance monies. Agencies such as the Great Lakes Basin Commission and Federal Regional Council might be able to play important roles in initially "spearheading" basin-wide responses.

*WHERE DO WE GO FROM HERE?

This report has presented a set of possible alternative actions to reduce shore erosion damages in Wisconsin. The actions can be grouped in three broad policy issue areas:

1. improving the state/local framework for regulating protective structures;
2. adopting a state policy regarding structural measures and defining the state assistance role; and
3. determining what nonstructural strategies to pursue.

In order to take action on any of the alternatives outlined in this report, certain basic policy questions must be answered. As noted in the Introduction to this report, the answers to many of these questions are based more on personal values and perceptions than on purely technical factors. The questions below are intended to suggest some key considerations in choosing among the varied policy options presented herein. Whether the answers to such questions are "yes" or "no" will determine what specific alternatives should be selected from this report.

1. Improving the regulatory framework. Is there a need to specify or modify the basis on which permitting decisions are made? Is there a need to improve the quality and consistency of the review itself (by improving the technical capacity for reviewing permit applications via training, by improved information dissemination and use, etc.)? Does the process by which these decisions are made need clarification? Can the efficiency of the regulatory process be increased (by improved and more systematic coordination among involved agencies at all levels, by streamlining the permit application review process, by standardizing forms, etc.)?

2. State structural policy and role. Assuming that the conditions and criteria under which erosion protection structures are authorized are acceptable, and that interest in structural approaches will continue in the future, in addition to regulation, what role (if any) should government play? Should there be any form of state financial assistance for structural measures? If so, what should be the nature of state funding? full funding? cost-sharing? low-interest loans? And what activities should be eligible (construction, engineering feasibility studies)? Or, should the state simply maintain a capability to provide non-financial assistance to those

interested in structural erosion protection (by providing information and sources of data and assistance, disseminating Coastal Program technical data and new research findings, etc.)?

3. Nonstructural strategies. As noted in Chapter V, a wide number of regulatory and nonregulatory preventive options are available to reduce erosion damages. In erosion-prone areas, which of these should be pursued, if any, and by whom? For example, in largely undeveloped areas, which of the nonstructural strategies presented herein should be implemented? What should the respective roles of state and local government be in any such undertaking? In developed areas, what role should regulatory options such as land management play in reducing damages? And how can acquisition and relocation strategies be encouraged, where appropriate, in coastal decision-making?

Alternately, the focus of nonstructural efforts to reduce erosion damages could be on disclosure. Should there be mandatory disclosure or hazard warnings tied to real estate transactions? Or, should disclosure efforts be voluntary, such as educational efforts targeted at financial institutions, realtors, and prospective buyers?

Finally, should state agencies and local governments be encouraged to adopt the guidelines for damage reduction programs presented on page 31 (or some modification thereof)? This might provide the means for improving coordination among the many governmental actors involved with shoreline management. The specific recommendations emanating from the answers to the questions posed above will provide the basis for an erosion damage reduction policy framework for Wisconsin. This plan is the starting point. Subsequent actions by policy-making bodies--and the commitment to follow through on implementation--will determine if we can capitalize on this opportunity.

*The Wisconsin Coastal Management Council responded to many of these policy questions in March of 1979. A listing of council actions is contained in the PREFACE.

ENDNOTES

Chapter II

1. Army Corps of Engineers, North Central Division, National Shoreline Study - Great Lakes Region Inventory Report, August 1971, page 29.
2. Short term recession rate measurements were taken along the Lake Michigan shoreline by the Wisconsin Department of Natural Resources during 1976 under a Coastal Management Program grant. Aerial photographs from the mid-1960's to mid-1970's were used to calculate these figures. A similar investigation was conducted along the Lake Superior shoreline during 1978 for a longer time span (1938-1975) by the Geological and Natural History Survey.
3. This figure was taken from the Department of Natural Resources' computerized inventory of shore protection devices; a product of the Coastal Management Program's Shore Erosion Study Plan.
4. In August of 1978, the water levels of Lakes Michigan and Superior were 2 and .8 feet below their recent highs, respectively. Source: Monthly Bulletin of Great Lakes Levels - August 1978, Army Corps of Engineers, Detroit District.
5. Corps of Engineers, National Shoreline Study, page 29.
6. Phil Keillor and Bob DeGroot, Recent Recession of Lake Michigan Shorelines in Racine County, Wisconsin. Wisconsin Sea Grant College Program, August 1978, page 14.
7. Richard Berg and Charles Collinson, Bluff Erosion Recession Rates and Volumetric Losses on the Lake Michigan Shore in Illinois. Illinois State Geological Survey, "Environmental Geology Notes", July 1976, page 7.
8. Illinois Coastal Zone Management Program, "Harmony with the Lake: Guide to Bluff Stabilization", April 1978.
9. Louis Vallejo, Mechanics of the Stability and Development of the Great Lakes Coastal Bluffs. Ph.D. Thesis, University of Wisconsin-Madison. Dept. of Civil & Environmental Engineering, Dec. 1977, p. 199.
10. Wisconsin Geological and Natural History Survey, field observation, June 1977.
11. Water Resources Management Workshop and Lake Superior Project, An Analysis of the International Great Lakes Levels Board Report on Regulation of Great Lakes Water Levels: Summary Report. Wisconsin Coastal Management Program, September 1976, pages 6-8.
12. Letter from Governor Patrick Lucey to International Joint Commission and Great Lakes Basin Commission through Governor William Milliken (State of Michigan), October 15, 1975.

13. Army Corps of Engineers, Great Lakes Division, Preliminary Examination Report on Property Damage on the Great Lakes Resulting from Changes in Lake Levels: Main Report. June 1952, pages 62-71.
14. Army Corps of Engineers, National Shoreline Study: Great Lakes Region Inventory Report, pages 34, 42, 45, and 53.
15. Army Corps of Engineers, North Central Division, Great Lakes Damage Survey: Labor Day 1972-Labor Day 1976 (Preliminary). September 1978.
16. Army Corps of Engineers, St. Paul District, Field Investigations of High Water Damages and Flood Potential on the Lake Superior Shoreline-1968.
17. International Great Lakes Levels Board, Regulation of Great Lakes Water Levels: Appendix C. Shore Property. International Joint Commission, December 1973, page C-83.
18. City of Oak Creek, Bender Park Boat Marina Justification. April 1975, page 3.
19. Army Corps of Engineers, North Central Division, Summary Report of the Pilot Study Program: Great Lakes Shoreland Damage Study. May 1976.
20. City of Oak Creek, Bender Park Justification, pages 2 and 3.
21. Wisconsin Department of Natural Resources and Center for Great Lakes Studies (UW-Milwaukee), Great Lakes Shoreline Damage Survey; Brown, Douglas, and Racine Counties, Wisconsin - Appendix II. Army Corps of Engineers, North Central Division, May 1976, pages 20 and 78.

Chapter III

22. Ann Prezyna and Robert Taylor, Wisconsin Department of Natural Resources, "The Role of the Department of Natural Resources in the Protection of the Public Interest in Navigable Waters". Wis. Coastal Management Program working paper, April 1978, page 19.
23. Defined as the common law right of riparians along navigable waterways to extend possession beyond (the present bank), or otherwise intrude within the natural shore of a navigable water because of the natural wearing away and overtopping of the banks (Diedrich v. Northwest Union Railway Company, 1877). Protective actions taken under this doctrine are seen as essential to the self-preservation of the riparian estate.
24. Southeastern Wisconsin Regional Planning Commission, Lake Michigan Estuary and Direct Drainage Area Subwatersheds Planning Program Prospectus. Waukesha, Wisconsin, September 1978.

Chapter IV

25. Milwaukee County Park Commission, meeting transcript, Feb. 4, 1965.
26. Great Lakes Basin Commission, Relocation and Public Acquisition Alternatives for the Reduction of Shoreland Damages: A Benefit/Cost Study. Ann Arbor, Michigan, February 1976, page 14.

27. Tetra Tech, Final Report: Beach Erosion Analysis and Protection Plans for Illinois Beach State Park. Illinois Department of Conservation and Illinois Coastal Zone Management Program, December 1978, page 58.
28. In attempting to clear-up some questions regarding the right of counties to issue permits for structures and activities below the Ordinary High Water Mark (OHWM), the DNR recently requested, and received, an internal legal opinion (78-25, November 1978). This opinion noted that counties can issue special exception permits below the OHWM providing their shore-land ordinances are in compliance with Chapters 144.25 and 59.971, Wisconsin Statutes. However, the granting of such a permit does not over-ride the denial of a state permit pursuant to Chapters 30 or 31.
29. Department of Natural Resources, Public Access: A Policy Study. Wisconsin Coastal Management Program, May 1976.
30. Diana Shooting Club v. Husting, 156 Wisconsin 272 (1914).
31. An internal legal opinion was requested on these matters in December 1978 by the Bureau of Water Regulation and Zoning, Dept. of Natural Resources.
32. Confirmed by internal DNR legal opinion dated November 1978.
33. Prezyna and Taylor, "Role of the Department of Natural Resources in the Protection of the Public Interest Along Navigable Waterways", page 11.
34. Ibid, page 13.
35. Ibid, page 19.
36. Ibid, page 10.
37. State permits for riprap-type projects are not required so long as the material is confined above the OHWM and involves a project area less than 10,000 square feet. Any shore protection/filling projects which include actions below the OHWM require a state permit -- regardless of those actions taken above it.
38. Diane Kurtz and Elizabeth David, Wisconsin Department of Natural Resources, "Disposal of Dredged Materials from Wisconsin's Great Lakes Harbors" working paper, Wisconsin Coastal Management Program, April 1978, page 6.
39. Prezyna and Taylor, "Role of the Department of Natural Resources....", page 20.
40. David Thomas, "Federal Tax Deductions for Flooding and Erosion Losses on the Great Lakes". Lake Superior Project, Center for Geographic Analysis-Institute for Environmental Studies, UW-Madison, May 1975, page 1.
41. Discussion with Frank Poquette, City of Sheboygan Planning and Zoning Office, July 1978.
42. Discussion with Tom Morris, Assistant Administrator, Maryland Erosion Control Program, Maryland Department of Natural Resources, September 1978.

43. J.C. Day, J.A. Fraser, and R.D. Kreutzwiser, "Assessment of Flood and Erosion Assistance Programs Rondeau Coastal Zone Experience, Lake Erie", Journal of Great Lakes Research. October 1977, pages 39 and 40.
44. Ibid, page 40.

Chapter V

45. Great Lakes Basin Commission, Standing Committee on Coastal Zone Management, Erosion Hazard Insurance Study. June 1978.
46. In taking the position that insurance does not offer a viable mechanism, the subcommittee recommended that "the erosion hazard insurance provisions should be repealed to eliminate the insurmountable technical and administrative problems that have resulted since 1973 from attempts to implement an insurance program for coastal erosion." The principal reason being that shoreline erosion and its associated damages are not insurable-- they occur continually, not catastrophically.
47. In 1976, the Attorney General issued an opinion (OAG 38-76) which concluded that towns which have adopted village powers according to Chapter 60.47, Wisconsin Statutes, can zone shoreland areas concurrently with the county, provided that the town ordinance is in conformance with, or more restrictive than, the county shoreland ordinance.
48. Richard Lehmann, Paul Mueller, and Paul Van Berkel, Institute of Governmental Affairs, Capabilities of County Land Regulation Programs in the Wisconsin Coastal Area. Wisconsin Coastal Management Program, December 1976, page 42.
49. Phone conversations with building movers Del L'Anglois, Menominee Falls and E.R. Kessler, Janesville, February 1978.
50. Coastal Zone Laboratory, University of Michigan, Engineering/Economic Analysis of Shore Protective Systems (Appendix VI Great Lakes Shoreland Damage Survey - Pilot Study). Army Corps of Engineers, May 1976, page 29.
51. Although hazard disclosure is not officially required, in a 1974 Attorney General's Opinion (OAG 65-74) involving the Real Estate Licensing and Examinings Board implementation of Executive Order 67, it was noted that "There is an implicit suggestion that a broker has a duty to inquire as to the status of each property he is attempting to sell with respect to inclusion in floodplain ordinances,..." And, that Board efforts to have brokers contact the Department of Natural Resources on the hazard status of coastal lands constituted a reasonable precaution on the part of the broker when the status is in question.
52. Carol Schultz, "Erosion Hazard Areas: An Alternative for Shore Management (draft)". Wisconsin Geological and Natural History Survey and University of Wisconsin Sea Grant College Program, October 1978, page 23.

53. David Owens and Michelle Rothenburg, Office of State Planning and Energy, Land Use and Coastal Management in Wisconsin Coastal Municipalities. Wisconsin Coastal Management Program, January 1978, page 29.
54. This bluff failure was documented by Bob Sterrett, Ph.D. candidate, UW-Madison Department of Geology and Geophysics while monitoring eight shoreline sites along Lakes Michigan and Superior during 1978.
55. Rich Cohen, Office State Planning and Energy, "Bluff Erosion Control Under Wisconsin Shoreland Zoning Provisions", working paper Wisconsin Coastal Management Program, August 1977.

Dave Thomas, Dave Owens, and Michelle Rothenburg, Office of State Planning and Energy, "Addressing Coastal Erosion Through Flood Plain Zoning--Is it Feasible in Wisconsin?" working paper Wisconsin Coastal Management Program, September 1977.

Memo: Larry Larson and Joe King, Department of Natural Resources to Roger Springman, Wisconsin Geological and Natural History Survey, October 26, 1977.

Memo: Jim Kurtz, Department of Natural Resources to Roger Springman, Wisconsin Geological and Natural History Survey, October 28, 1977.

56. Fred C. Welz, Department of Agricultural Economics, University of Wisconsin-Madison, "Parcel Creation Activity in Unincorporated Dane County" (Independent Study Paper) 1974.

Chapter VI

57. Federal Regional Council and Great Lakes Basin Commission Task Force for Great Lakes Shorelands Damage Reduction, A Strategy for Great Lakes Shoreland Damage Reduction. Federal Regional Council, Region V, Chicago, March 1974, pages 29-34.
58. For the past ten years, the Wisconsin Department of Natural Resources and Kenosha County have had a series of regulatory problems with the Trident Marina--some of which remain unresolved. Several of these problems were due, in part, to the location of dragline operations (for maintenance dredging), public boat launching facilities (for Illinois Beach State Park), and the Marina turning basin in Illinois. Through negotiations with the Illinois Coastal Zone Management Program, the maintenance dredging problem (placement of Wisconsin sand on Illinois shoreline) was largely resolved. Other differences of philosophy regarding shoreline protection and management between Wisconsin Department of Natural Resources and Illinois Department of Transportation have also surfaced during discussions on Trident Marina.
59. Tetra Tech, Final Report: Beach Erosion Analysis and Protection Plans for Illinois Beach State Park. Page 171.
60. "Shore Erosion/Mitigation Planning in Wisconsin", Wisconsin Coastal Management Program Amendments 1978 (Draft). July 1978.

Glossary

- Accretion** - The natural or artificial build-up of sediment on coastal beaches. Natural accretion can occur as a result of both the waterborne and air-borne deposition of soil materials. Structural devices such as groins, breakwaters, and jetties along with beach-fill projects can all promote the accretion of coastal beaches.
- Artificial Nourishment** (also called beach nourishment) - The process of replenishing a beach with material (usually sand) obtained from another location.
- Beach Starvation** - The loss of beach-building materials (principally sand-like particles) along coastal environments often due to the downdrift impacts of shore protection devices. Continued beach starvation can serve to locally increase beach and bluff erosion rates.
- Failure Plane** - The general term used to define the immediately stable and unstable portions of coastal bluffs, i.e. lakeward of the failure surface a greater probability exists for bluff failure (erosion). Where they are not directly observable, the location of potential failure surfaces can be predicted through examinations of groundwater conditions, slope geometry, and the engineering properties of bluff soils.
- Flanking** - Erosion at, and around, the outward ends of land-connected shore protection projects or other "hardened" portions of the shoreline. When not stopped or controlled, flanking can result in the failure of shore protection devices.
- Flows** - A type of downslope movement where the soil mass, saturated with water, moves like a viscous liquid under the influence of gravity.
- Littoral drift** (also called longshore drift) - The movement of sediment (usually sand) along beaches and in the nearshore zone by the prevailing currents and oblique waves.
- Nearshore Zone** - An indefinite area or zone extending lakeward from the shoreline to beyond the line of breaking waves.
- Offshore Zone** - The general term used to define that area lying beyond the nearshore zone where wave action and motion is not significantly affected by water depths.
- Reach** - A length of shoreline normally possessing fairly uniform physical and developmental characteristics. Often, those areas under the influence of specific littoral cells and currents can be defined as reaches. Resistant points or places tend to divide reaches defined on the basis of nearshore processes.
- Recession** - The net landward movement or retreat of coastal bluffs and beaches over time due to erosional processes. When recession is linked directly to a given time interval, a short-term and/or long-term rate can be measured and projected into the future.

Slides - A type of downslope movement which takes place along a definable, relatively flat surface of failure (failure plane). Usually the sliding mass is not deformed as it is in a flat.

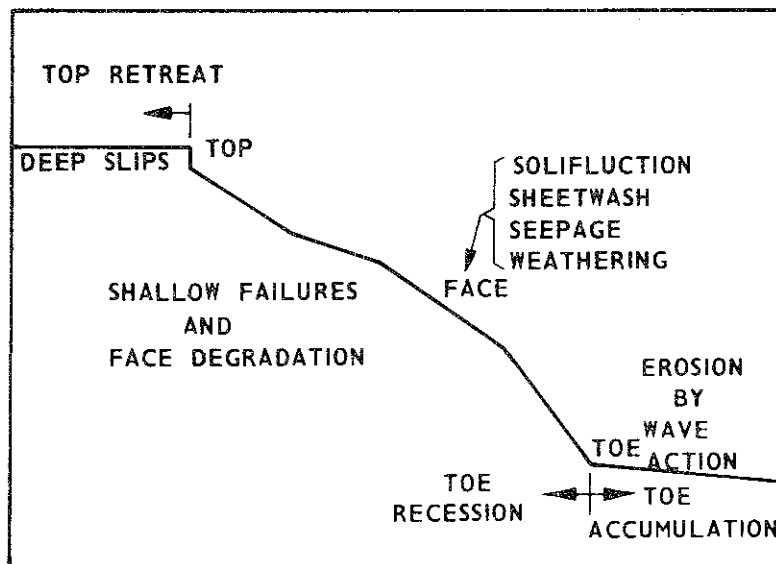
Slumps - A type of slide where failure takes place along a curved failure surface and the moving mass rotates backwards in the upslope direction. This very common form of failure along the Great Lakes shoreline leaves a scalloped bluff top affect.

Slump Blocks - The mass of material which moves down-slope as a result of slumping. Large slump blocks, some as wide as fifty feet and several hundred feet long, have been reported along the Lake Michigan shoreline.

Solifluction - The process of slow flowage from higher to lower ground of masses of soil materials saturated with water. Frost penetration and subsequent freezing/thawing cycles along coastal bluffs is a significant cause of solifluction, and related flowage actions.

Till - Poorly sorted, poorly stratified material deposited directly by glacial ice.

Toe Erosion - That erosion which occurs at the toe of bluffs (see diagram below) largely as a result of the continuous removal of earthen materials by waves or flows.



Source: Mechanics of Coastal Landslides and the Influence of Slope Parameters, Edil and Vallejo; UW-Madison, Department of Civil and Environmental Engineering.

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APPENDICES

APPENDIX A

EROSION-RELATED REPORTS AND PUBLICATIONS OF THE
WISCONSIN COASTAL MANAGEMENT PROGRAM

Shore Erosion - A Study Plan, 1976.

Provides an overview of the Coastal Program's initial process for studying, examining, and selecting alternative damage reduction plans for Wisconsin.

"Shore Erosion/Mitigation Planning in Wisconsin", Wisconsin Coastal Management Program Amendments, July 1978.

Documents Wisconsin's compliance with Section 305(b)(9), Coastal Act Management amendments of 1976.

Shore Erosion - A Bibliography, 1976.

Inventories available geologic, hydrologic, soils, and climatological information on coastal erosion processes in Wisconsin.

Shore Erosion Study Technical Report, 1977.

Examines the geotechnical causes of erosion along Wisconsin's critical reaches, and provides additional data on recession rates, shore protection devices, and shoreline stability. Technical Appendices are available for Kenosha, Racine, Milwaukee, Ozaukee, Sheboygan, and part of Manitowoc Counties. A special Lake Superior Appendix is in preparation.

Wisconsin Coastal Atlas, 1977.

Contains multi-county strip maps on land use/ownership, zoning, natural areas and historic sites, wildlife habitats, and erosion hazards for Wisconsin's Great Lakes shoreline.

An Analysis of the International Great Lakes Board Report on Regulation of Great Lakes Water Levels, 1976.

Reviews the possible economic and environmental impacts of implementing several lake level regulation schemes. Shore Property and Recreation takes an in-depth look at coastal damages.

Ordinary High Watermark, 1976.

Analyzes the legal aspects of high watermark determination, examines the alternative methods for delineating high watermarks, and provides several recommendations for improving the present framework.

Lake Bed Grants: Great Lakes, 1976.

Provides a complete inventory and description of coastal lake bed grants. Maps of all grant areas are included.

Public Access: A Policy Study, 1976.

Provides an overview of boating/non-boating needs, identifies public access problems, and provides some policy options.

Feasibility of Compensation for Man-Induced Shore Erosion, 1978.

Reviews legal and administrative options for compensating aggrieved property owners, and analyzes the technical feasibility of providing such compensation.

Some Nonstructural Alternatives for the Reduction of Shore Damages, 1977.

Provides a general discussion on the possible use(s) of hazard disclosures, zoning, insurance, relocation, and acquisition along Wisconsin's Great Lakes shoreline.

"Addressing Coastal Erosion Through Floodplain Zoning", 1977.

A working paper that analyzes the problems associated with using N.R. 116 (Floodplain zoning) for erosion damage production.

"Bluff Erosion Control Under Wisconsin Shoreland Zoning Provisions", 1977.

A working paper that analyzes the possible ways of increasing the erosion hazard sensitivity of N.R. 115 (Shoreland Zoning).

Nonregulatory Techniques for Urban Growth Management in Wisconsin, 1978.

Examines and analyzes such techniques as public land acquisition, public investment planning, preferential taxation, and transferable development rights for better coastal land use management.

"The Role of the Wisconsin Department of Natural Resources in the Protection of the Public Interest in Navigable Waters", April 1978.

Examines the basic permitting authority of the Department, reviews permit actions taken under Chapter 30, Wisconsin Statutes; and provides some recommendations for improving the existing regulatory process. The appendix contains a wide range of procedural and organizational material.

Great Lakes Shore Erosion Protection: A General Review with Case Studies, 1977.

Reviews the planning and technical aspects of shore protection device construction, and analyzes structural failures and successes at nine sites in Wisconsin.

Great Lakes Shore Erosion Protection: Structural Design Examples, 1978.

Provides a detailed cost and engineering layout for long term, intermediate life, and emergency structural devices based upon nine design site locations along Lake Michigan.

Inventory of Shore Protection Devices, 1977.

A computerized listing of over 800 shore protection devices along the Lake Michigan shoreline.

APPENDIX B

METHODOLOGY FOR SHORELINE INVENTORY AND COST - LAYOUT

The procedures used to inventory unprotected coastal reaches and arrive at structural protection costs for Lakes Michigan and Superior varied slightly due to a lack of data along Lake Superior. Specifically, a set of oblique aerial photographs was not available, work on a Geotechnical Appendix was not completed, and reliable cost figures for temporary and long-term devices were not available. To facilitate a clear comparison of the assessment procedures used along each Great Lake, section A will review shoreline inventory procedures and section B will review cost - layout procedures.

Lake Michigan

Section A.

With the aid of an oblique set of aerial photographs (May 1976-Illinois State Line to Sturgeon Bay; flown by the Wisconsin Department of Natural Resources and funded by the Wisconsin Coastal Management Program), shoreline base and reach maps, National Shoreline Study strip maps, U.S.G.S. 7 $\frac{1}{2}$ and 15 minute topographic maps, and the Coastal Management Program Shore Erosion Study Technical Report series, each of the following was determined:

1. The unprotected portions of each section in each reach through Sturgeon Bay, and their bluff and beach characteristics. Bedrock areas and lands having durable, well-maintained devices were determined to be adequately protected. Marshes and wetlands were excluded from consideration.
2. Totals of unprotected and eroding, or potentially eroding, coast (in linear feet) by county and reach. Well-vegetated slopes and unendangered parks were not included in totals.
3. Categories of unprotected shoreline:
 - a. Sandy plain or low bluff (less than 20 feet high) -- little indication of erosive conditions.
 - b. Stable bluff (20 feet or higher) -- little indication of erosive conditions.
 - c. Unstable bluff (20 feet and higher) -- evidence of seepage, sliding, slumping, or other erosive processes.

Section B.

Using the above classification scheme and figures as a base, a cost-layout was then conducted along the Lake Michigan shoreline with information provided by Owen Ayres and Associates; a consulting firm engaged in work on another Coastal Management Program project entitled Great Lakes Shore Erosion Protection: Structural Design Examples. Average costs per linear foot for temporary, intermediate, and long-term protection were then determined. Intermediate and long-term costs were found to vary according to bluff characteristics, i.e. whether or not a bluff stabilization technique was needed. The

base figures listed below were used to generate cost figures for the Lake Michigan shoreline.

<u>Level of Protection</u>	<u>Bluff Characteristic</u>	<u>Average Cost Per Linear Foot</u>
Temporary		\$ 60
Intermediate	Sandy Plain or Low Bluff	\$120
	Stable Bluff	\$ 95
	Unstable Bluff	\$255
Long Term	Sandy Plain or Low Bluff	\$165
	Stable Bluff	\$295
	Unstable Bluff	\$375

Table VII on page 37 contains a county-by-county breakdown of all cost figures and erodible, linear footage for Lake Michigan.

Lake Superior

Section A.

With the aid of U.S.G.S. 7 $\frac{1}{2}$ and 15 minute topographic maps, National Shoreline Study strip maps, Coastal Management Program shoreline base and reach maps, and Wisconsin's Lake Superior Shoreline (a physical inventory of the shoreline by Zube and Dega Associates), each of the following was determined:

1. The unprotected portions of each section in each reach, and their general bluff and beach characteristics. Bedrock areas and lands having durable devices were determined to be adequately protected. Marshes and wetlands were excluded from consideration.

2. Totals of unprotected and eroding, or probably eroding, coast (in linear feet) by county and reach. The lakeward side of Wisconsin Point was totaled, but other sand points or spits were not. The eastern and southern sides of Madeline Island were examined and inventoried.

Section B.

Using the above figures and shoreline analysis as a base, a general cost-layout was then conducted. Costs for temporary protective devices were averaged from Lake Michigan as per Owen Ayres research since figures for temporary devices along the Lake Superior shoreline were not available. The intermediate life figures were derived from three Lake Superior projects: Port Wing, Madeline Island, and Madigan Beach. The long-term protective device figures were derived from Owen Ayres research and Lake Superior project costs (Lake Park, Port Wing, and Madeline Island). Costs per linear foot along Lake Superior were found to average as follows:

<u>Level of Protection</u>	<u>Cost Per Linear Foot</u>
Temporary	\$ 60
Intermediate	\$130
Long-Term	\$295

Table VII on page 37 contains a county-by-county breakdown of all cost figures and erodible, linear footage for Lake Superior.

APPENDIX C

PRE-ENGINEERING INVESTIGATION OF LAKE MICHIGAN SHORELINE (KENOSHA THROUGH MANITOWOC COUNTY)

REACH	COUNTY	FOOTAGE SUBJECT TO EROSION (1976)	PREDOMINANT SHORELINE SETTING	POSSIBLE STRUCTURAL SOLUTIONS	LONG TERM STRUCTURAL PROTECTION COST* PER REACH	
					HIGH	LOW
1	Kenosha	8000	Sand Plain Low Bluff	Stone Revetments Stone Groins Concrete Revetments	1 600 000	1 084 000
2	Kenosha	500	Low Bluff	Stone Revetments Stone Groins Sheet Steel Bulkheads	100 000	66 500
3	Kenosha Racine	5000	Med Bluff	Stone Revetments Sheet Steel Bulkheads Concrete Revetments	1 325 000	925 000
4	Racine	250	Harbor Area Med Bluff	Sheet Steel Bulkheads Drainage Concrete Seawalls	66 250	46 250
5	Racine	3000	Med Bluff	Stone Revetments Concrete Bulkhead	795 000	555 000
6	Racine Milwaukee	17 000	Med. Bluff High Bluff	Stone Revetments Regrading & Drainage Concrete Bulkheads	6 131 000	4 042 000
7	Milwaukee	11 500	High Bluff	Regrading Sheet Steel Bulkheads Concrete Seawalls	4 715 000	3 047 000
8	Milwaukee	24 000	High Bluff	Stone Revetments Concrete Revetments Regrading	9 840 000	6 360 000
9	Milwaukee	0	Harbor Area		0	0
10	Milwaukee	14 000	High Bluff	Stone Revetments Sheet Steel Bulkheads	5 740 000	3 710 000
11	Milwaukee Ozaukee	13 000	High Bluff	Concrete Seawalls Sheet Steel Bulkheads	5 330 000	3 445 000
12	Ozaukee	34 000	High Bluff	Concrete Bulkhead Regrading and Drainage Stone Revetments	13 940 000	9 010 000
13	Ozaukee	27 000	High Bluff	Sheet Steel Bulkheads Concrete Revetments	11 070 000	7 155 000
14	Ozaukee	0	Harbor Area		0	0
15	Ozaukee	18 000	High Bluff	Regrading and Drainage Stone Revetments	7 380 000	4 770 000
16	Ozaukee	4 000	Med. Bluff Low Bluff	Sheet Steel Bulkhead Stone Revetments	995 000	688 000
17	Ozaukee	4 000	Low Bluff Sand Plain	Concrete Revetments Stone Revetments	800 000	532 000
18	Sheboygan	40 000	Sand Plain Low Bluff	Stone Groins Stone Revetments Sheet Steel Bulkheads	9 300 000	6 360 000
19	Sheboygan	2 500	Low Bluff Med. Bluff	Concrete Bulkheads Stone Revetments	581 000	397 000
20	Sheboygan	3 000	Med Bluff	Concrete Seawalls Stone Revetments	795 000	555 000
21	Sheboygan	12 000	Med Bluff	Sheet Steel Bulkheads Regrading Concrete Revetments	3 180 000	2 220 000
22	Sheboygan	12 000	Med Bluff	Sheet Steel Bulkhead Regrading Stone Revetments	3 180 000	2 220 000
23	Sheboygan Manitowoc	20 000	Med Bluff	Stone Revetments Concrete Bulkhead	5 300 000	3 700 000
24	Manitowoc	15 000	Med Bluff	Stone Groins Concrete Revetments Sheet Steel Bulkheads	3 975 000	2 775 000
25	Manitowoc	31 000	Med. Bluff High Bluff	Stone Revetments Concrete Bulkheads	9 338 000	6 354 000
26	Manitowoc	7 000	High Bluff Med Bluff	Concrete Seawalls Concrete Revetments	2 108 000	1 434 000
27	Manitowoc	250	Med Bluff	Stone Revetments Sheet Steel Bulkheads	66 250	46 250
28	Manitowoc	29 000	Low Bluff Sand Plain	Stone Groins Stone Revetments Concrete Bulkheads	5 800 000	3 857 000
29	Manitowoc	12 144	Low Bluff Med Bluff	Sheet Steel Bulkheads Stone Revetments Concrete Seawalls	2 823 000	1 930 000
30	Manitowoc	24 288	Med. Bluff	Regrading Concrete Revetments Sheet Steel Bulkheads	6 436 320	4 493 000

* Average costs from the Structural Design Example Report served as the basis for this investigation. Low bluffs/sand plains, medium bluffs, and high bluffs averaged \$165, \$220, and \$335 respectively. The high and low costs on this table represent a 20% deviation from these averages. Only initial construction costs are presented in this table; maintenance costs and any special siting costs are excluded. This table should not be taken as an endorsement of structural solutions for the entire shoreline of Lake Michigan by the Coastal Management Program.

PLANNING CONSIDERATIONS FOR SHORE/BLUFF PROTECTION DEVICES

Wave Interception and Attenuation Methods

1. Offshore Breakwaters

Definition: An offshore structure, normally oriented parallel to the shoreline, which prevents waves from reaching the beach and reduces waves energy in the nearshore zone.

Planning Considerations: Offshore breakwaters must be located far enough offshore to allow ample flow of longshore currents between the structure and shore. Since they tend to trap beach materials in this calmer water environment, downdrift beach material starvation and erosion will occur.

Offshore breakwaters are generally more difficult and expensive to construct than other shore protection devices in the Great Lakes due to water level fluctuations. In order to efficiently absorb or reflect wave energy, they must be large and durable. Repair and maintenance is difficult and expensive.

However, breakwaters leave the shoreline open for recreational uses and they do not seriously affect shoreline aesthetics. Also, they could provide some shelter for small boats during storms.

Construction Materials:

Quarrystone; placed in a rubble mound.
Precast and poured concrete armor units.
Cantilevered steel sheet pile walls or cellular units.
Rock-filled timber cribs and gabions; used in shallow water and low-energy environments.

Costs: (initial construction per linear foot)

General cost range -- \$500 - \$1000
Massive, rubble mound -- \$1,500 - \$1,900

Beach Accretion Methods

2. Inshore Breakwaters

Definition: A structure or series of structures constructed parallel to the shore in the shallow inshore area to reduce wave energy and promote beach accretion.

Planning Considerations: Inshore breakwaters are normally only used in shallow waters (two to four feet), on low slope beaches, and within 100 to 200 feet of the shore. The area between the structure and shore is subject to accretion. In the event of complete beach accretion, the structure may function as a perched beach.

Inshore breakwaters tend to be low to moderate-cost devices which can be deployed fairly easily, e.g. rubber tire mats, precast concrete z-wall, small rubble mounds. Also, because some are relatively simple in design and construction, they can be deployed in a timely manner. While beach use and aesthetics may not be severely affected by these structures, swimming and fishing is often precluded.

Inshore breakwaters are often short-lived devices since they can readily be destroyed or grounded during heavy storms and high water periods. Excessive beach accretion can bury them. Without an abundant supply of suitable beach materials, inshore devices may fail to accrete a beach. They can also pose navigational obstacles, and may prove difficult to remove. Inshore breakwaters should not be used with groins unless a thorough beach and wave analysis has been conducted. Periodic to continual maintenance is often needed to keep them properly aligned and effective.

Construction Materials:

Precast concrete; often placed in zig-zag fashion.
Rubber tires; linked together to form floating mats.
Quarrrystone; placed in small mounds.
Longard tubes.

Costs: (initial construction per linear foot)

General cost range -- \$70 - \$170
Precast z-walls -- \$80 - \$140
Rubber tire mats -- \$75 - \$110
Longard tubes -- \$70 - \$160

3. Groins

Definition: A structure, either permeable or impermeable, normally constructed perpendicular to the shore to trap littoral drift and reduce wave energy. Beaches tend to accrete on the updrift side thereby starving the downdrift side.

Planning Considerations: Groins are most effective when extended into the breaker zone, and need not be placed into water deeper than three to five feet or 100 feet lakeward of the shoreline. They can be deployed as a single long unit or as a series of units, spaced approximately two to three times their length apart. Groins should extend well back into the beach to prevent flanking and undermining. The outer end has to withstand the full impact of waves and their associated scour. Since the presence of suitable beach materials in longshore currents is critical, all coastal environments are not suited to groins.

Groins have been extensively used along Wisconsin's shoreline. A wide variety of materials can be used to construct groins, e.g. nylon bags and tubes, timber cribs, quarrrystone, steel sheet pile. Thus, they can serve as temporary as well as

permanent type solutions. Permanent construction generally calls for specialized equipment and expertise. Groins offer viable options near recreational beaches and resort areas since they may not interfere with swimming and fishing.

Groins must be carefully designed, placed, constructed, and maintained to provide maximum levels of protection. Proper design elevation and construction is essential since storms and high water periods can render them ineffective or inoperable. Groins should be tied-back into the bluff or beach to prevent flanking. Since groins have a tendency to accelerate downdrift erosion, all potential adverse impacts should be assessed in advance. Maintenance costs can be high due to settling, flanking, scouring, and storm damage. Artificial nourishment is often recommended to maintain maximum effectiveness -- and reduce downdrift impacts. Groins may pose navigational hazards and obstacles, particularly if the lakeward end settles.

Construction Materials:

Quarrrystone; placed in mounds.
Nylon bags; used as temporary protection.
Longard tubes.
Steel sheet piles.
Precast concrete members and piles; permeable and impermeable.

Costs: (initial construction per linear foot)

General cost range -- \$70 - \$250
Longard tubes -- \$90 - \$160
Steel sheet pile -- \$120 - \$190
Nylon bags filled with sand -- \$60 - \$90
Steel sheet pile with sand fill -- \$520

4. Beach Nourishment

Definition: Artificial addition of sand or coarse particles to the beach regime so as to build-up, and maintain, protective beaches.

Planning Considerations: Beach nourishment can best be used as a protective measure along gently sloped beaches with low erosion rates. Also, it may be used to enhance the effectiveness of groin systems where the littoral drift supply is insufficient. The materials to be added should have the same grain size properties as the existing beach materials. Placement of cleaned sand or gravel materials can be done by spreading or by dumping piles along the updrift end. Factors which assist in determining the applicability of this technique include longshore current orientation and rates, foreshore slope, erosion rates, and littoral drift rate.

Where appropriate, beach nourishment could offer a viable, low-cost form of protection. The location, quality, and quantity of suitable beach materials largely determines its economic feasibility. Dredged material from river mouths and harbors

can provide a viable source. Permanent sources of material should be identified before initiating this alternative. Beach nourishment has minimal effects upon shoreline use and aesthetics. This technique is particularly valuable around recreational facilities and resorts where a natural environment and solution is sought.

During periods of accelerated erosion, the maintenance costs of continual beach nourishment can be high. Also, some supplemental shoreline armoring may be desirable near high value properties and facilities. Because trucks and other heavy equipment are generally needed to implement this technique, beach access and movement should be carefully planned and timed. Winter and early spring dumping can be effective in remote beach areas.

Construction Materials:

Sand, clean, no fine content.
Gravel, clean, no fine content.

Costs: (sand supplement and maintenance per linear foot)*
General cost range -- \$40 - \$110

*Where it is necessary to re-establish or restore beaches before nourishing begins, costs can be substantially higher. Perhaps as high as \$200 to \$400 per foot.

Shore Armament Techniques

5. Revetments

Definition: A sloped layer or facing of erosion resistant material placed along the backshore edge or bluff toe to resist wave attack and erosion.

Planning Considerations: Revetments, like other forms of shore armoring, are used when erosion must be stopped along a specific zone or line. Revetments are frequently used to provide toe protection along bluffs. They can be constructed of individual armor units or of interlocking ones. Any number of materials and techniques can reduce the erosive forces of waves, e.g. concrete, rock, grouted tires, nylon bags and tubes.

However, the most effective ones are designed to withstand specific storm and lake level conditions. A bedding layer of stones, gravel, and filter cloth is essential for all intermediate and permanent life revetments to prevent scouring during wave attack and wave run-up. Tie-backs are often needed to prevent flanking at the ends.

Revetments are the most common form of shore protection along Wisconsin's Great Lakes shoreline. Their popularity can be largely attributed to material availability, ease of deployment, and their low to moderate cost. The installation of small revetment units can be done on a "do-it-yourself" basis. Also, because they can be deployed very quickly, they can be used as temporary solutions

during emergency conditions, e.g. stone or rock riprap. Erosion rates and hazards can often be reduced on a spot-by-spot basis with revetment techniques.

When used as temporary or emergency devices, revetments are subject to extensive, and sometimes immediate, failure due to flanking, overtopping, and scouring. Such failures may add to the costs of constructing more permanent solutions. Revetments do not protect the foreshore beach and they can accelerate erosion rates on adjacent properties. Aesthetically, revetments may seriously alter the shoreline setting, particularly when loose dumping is used. Beach access and use can be seriously hampered by revetments. Upon failure, many materials can prove to be long-term hazards for swimmers and beach users. Maintenance costs for temporary and intermediate life structures are likely to be high and continuous.

Construction Materials:

Sorted quarrystone, used for intermediate and long life solutions. Unsorted stone and rock (riprap); not recommended except under emergency conditions).

Nylon bags; either filled with grout or sand.

Longard tubes; one single or several stacked.

Tires; grouted and anchored.

Precast concrete; interlocking blocks or cobblestones, nami rings.

Costs: (initial construction per linear foot)

General cost range -- \$60 - \$250

Stone or rock (riprap) -- \$60 - \$100

Stone or rock (long life) -- \$125 - \$180

Sand-filled nylon bags -- \$60 - \$90

Anchored rubber tires with sand -- \$110 - \$150

6. Seawalls and Bulkheads

Definition: Vertical structures, often designed as walls, constructed along the backshore zone or bluff toe to resist wave attack and, in the case of bulkheads, to hold back earthen materials.

Planning Considerations: Although closely linked, seawalls and bulkheads have differing primary purposes. Seawalls are generally more massive in character and are designed to withstand full wave attack. Bulkheads are normally designed to retain and support earthen materials with the secondary function of resisting wave attack. To serve in these capacities for any length of time, both techniques require highly durable materials which are specifically designed for site geologic and wave setting conditions. Seawalls are particularly viable options near steep offshore zones. Both techniques are used in conjunction with upper bluff stabilization. Curved or irregular surfaces can be built into these devices to better dissipate wave energy. Bulkheads require strong and flexible anchoring and connecting techniques, e.g. deadmen, timber whalers, cables. Adequate protection against scouring, washout, and flanking is essential for both techniques.

As long as they are properly placed, designed, and constructed, seawalls and bulkheads provide reliable, long-term protection for the shoreline. Also, they greatly enhance the viability and durability of upper bluff stabilization activities. With careful design, seawalls, and bulkheads may not seriously affect shoreline aesthetics. Beach use and access can be facilitated through the construction of stepped walls, access corridors, and ladder systems. Maintenance costs are normally relatively low, assuming proper design and construction. Major storms can cause some settling, scour, and displacement.

Seawalls and bulkheads have not been widely used in Wisconsin except around marinas, harbors, and public facilities. Not only are they more expensive than other armoring techniques, generally over \$150 per foot, but they are not universally applicable to the entire shoreline. Generally, they are not suited to "do-it-yourself" projects. Low-cost versions of these devices should be carefully analyzed prior to implementation. Accelerated erosion of the immediate fronting (foreshore) beach and unprotected flank area are common effects of seawall and/or bulkhead projects. These structures may limit some recreational and natural shoreline uses.

Construction Materials: (Seawalls)

Nylon bags; grout filled and anchored.
Longard tubes; single or stacked.
Steel sheet pile; often reinforced.
Concrete; poured-in-place or precast blocks.

Costs: (initial construction per linear foot - seawalls)

General cost range -- \$120 - \$500
Grout-filled nylon bags -- \$100 - \$150
Massive, concrete wall -- \$500 - \$650
Longard tubes -- \$150 - \$350

Construction Materials: (Bulkheads)

Steel sheet pile.
Timber piles.
Concrete; piles and poured-in-place.

Costs: (initial construction per linear foot - bulkheads)

General cost range -- \$90 - \$300
Timber piles -- \$30 - \$150
Sheet steel piles -- \$175 - \$300
Concrete piles -- \$120 - \$250

7. Bluff Stabilization Methods

Definition: Any technique or management activity which increases the overall stability of soil and subsoil horizons in bluffs by reducing or removing those factors creating instability, e.g. groundwater seepage, steep slopes, hydrostatic pressures, surface water runoff.

Planning Considerations: Where bluffs in excess of ten feet adjoin the shoreline, the geotechnical and hydrogeologic aspects of shoreline erosion should be investigated. Aside from the undercutting action of waves at the bluff toe, a number of factors can contribute to bluff recession. They include a steep angle of repose, groundwater movements which cause sapping and sloughing, exposed bluff faces, sand or silt lenses, surface water runoff, and upland management practices. Thus, armament of the bluff toe does not ensure the permanent cessation of erosion processes.

A wide range of techniques have been devised to increase the stability of coastal bluffs. Generally, they either attempt to remove soil and excess groundwater, prevent or reduce surface water movement and infiltration in the bluff area, or armor and protect the bluff face. Techniques which accomplish these objectives include terracing, retaining walls, regrading, granular backfills, dewatering wells, horizontal drains, catch basins with outlet pipes, epoxy soil binders, and vegetating. In determining which technique is best suited to a given bluff setting, specialized geologic and hydrologic equipment and expertise is often needed. Along high bluffs with seepage problems, several techniques may have to be implemented. Regrading and terracing may be impractical where upland buildings are close to the bluff edge.

By including bluff stabilization in erosion control programs, bluff recession can be reduced more quickly and shore armament devices will normally perform better -- and last longer. Some stabilization techniques which are land management oriented can be implemented on a "do-it-yourself" basis. Access to the bluff is normally not limited by water level conditions, except when oversteepened slopes are present. Once completed, maintenance requirements are normally moderate but continual for most techniques, e.g. reseeding, pipe cleaning, addition of granular material. Bluff stabilization and management does not normally adversely affect aesthetics and shoreline use.

Generally, bluff stabilization requires careful planning and design prior to implementation. In many cases, bluff stability can be increased through improved upland management techniques. Consultations with soil scientists, geologists, hydrogeologists, and engineers may be necessary to develop a total site plan. Costs for high bluffs with complex geotechnical/hydrologic problems can be very high. When the costs of toe/beach protection are added to those costs associated with bluff stability, many coastal property owners and managers may find it difficult to readily finance large projects.

Construction Materials:

Pipes and tiles; metal, plastic, and clay.
Pumps.
Granular fill and soil binders.
Plastic sheets and liners.
Grasses, shrubs, and trees.
Steel or timber retaining walls.

Costs: (initial construction)

- 6-foot deep trench with drain pipe -- \$1.50 - \$3.00 per foot.
- 15-foot deep trench with drain pipe -- \$12.00 - \$15.00 per foot.
- Surface water drop-outlet -- \$3000 - \$4000 per project.
- 12-inch well discharge pump and pipe -- \$35.00 per foot plus
\$500 for pump.
- Reinforced earth methods (concrete) -- \$17.00 - \$20.00 per
square foot of wall.

PRINCIPAL SOURCES OF FINANCIAL AND
TECHNICAL ASSISTANCE RELATED TO
EROSION HAZARDS IN WISCONSIN

APPENDIX

PRINCIPAL* FINANCIAL AND TECHNICAL ASSISTANCE PROGRAMS
RELATED TO EROSION HAZARDS IN WISCONSIN

WISCONSIN
G&NHS 1978

PROGRAM	SPONSORING AGENCY	PROGRAM DESCRIPTION			PROGRAM CONTACT	
		TYPE OF ASSISTANCE		SCOPE		CONDITIONS OF ASSISTANCE
		Financial	Technical			
Emergency Protection of public facilities (Section 14 projects)	U.S. Army Corps of Engineers (COE)	X	X	Construction of remedial works under emergency conditions for essential public facilities, e.g. highways, bridges, intakes, Not to exceed \$250,000 per project.	Only public entities are eligible. Emergency conditions must be documented and a reconnaissance study must be conducted.	Lake Michigan: Chicago District, COE Lake Superior: St. Paul District, COE
Small beach erosion control projects (Section 103 projects)	"	X	X	Design and construction of remedial works, and restoration of shorelines. For non-federal lands a 50% match is required; a 30% match may be required for parks/conservation areas. Federal funds limited to \$1 million per project.	Only public entities are eligible. Applicant must participate in project. A reconnaissance investigation must be conducted before approval.	"
Correction of federal navigation project erosion (Section 111 projects)	"	X	X	Study impacts of navigation projects and correct (lessen) damages to the maximum reasonable extent. Federal government will cover all costs up to \$1 million per project. Projects above \$1 million must be approved by Congress.	Both public entities and private sector interests are eligible. Damages must be attributable to a federal structure.	"
Technical and engineering assistance for public entities (Section 55 projects)	"		X	Services provided can include site inspections, consultations, technical aid, design reviews, and construction inspections. Projects are handled promptly within the limits of available resources.	Limited to non-federal public entities. Services must be officially requested. This program is intended for open and/or unprotected shores.	"
Resource conservation and development projects	U.S. Department of Agriculture; Soil Conservation Service (SCS)	X	X	Permits multi-county land management/pollution control projects. Would be most helpful for upper bluff management. Only two R.C.&D. areas are approved: Py-Ru-Tau and lumberjack along Lake Superior.	Upland erosion control must be a designated objective. Local governments or non-profit agencies must initiate (sponsor) a project.	County (District) Soil and Water Conservation Office
Conservation assistance (operations)	"		X	Technical assistance provided for site evaluations, upland device designs and vegetation plantings to property owners and public entities upon request. Assistance rendered based on resource availability and coastal priorities.	Cooperator status increases request priority. Coastal priorities are established by local soil and water conservation district.	"
Small watershed projects (P.L. 566 projects)	"	X	X	Could provide land management assistance in direct drainage watersheds along shoreline. Maximum funding without congressional approval is \$1 million. Cost-sharing is worked out with individual land owners in project area.	Area must be officially delineated and a plan is required. Local governments or non-profit agencies must initiate (sponsor) a project.	"
Rural credit program; soil and water loans	U.S. Department of Agriculture; Farmers Home Administration (FmHA)	X		Competitive loans for many conservation/land management purposes to working farms. Maximum loan principal is \$100,000 per project. SCS often provides technical advice on projects.	A farm improvement plan is needed along with documentation of financing difficulties.	FmHA; County office or state office (Stevens Point)
Single-family loan program (Section 502 projects)	"	X		Competitive loans for building, improving, or relocating homes in rural areas (less than 10,000 population). Maximum loan limit is \$50,000.	Financing difficulty must be well documented.	"

Community develop- ment grants; small cities program	U.S. Department of Housing and Urban Development (HUD)	X		Could provide monies for housing-related projects along the shoreline. Possible activities include relocation assistance, sewer/water/curb improvements, and limited shore protection. A point system selects projects for funding.	Cities under 50,000 are the program focus. A housing component for low and moderate income families is required. A project plan must be available.	Wisconsin Department of Local Affairs and Development (DLAD)
Federal disaster relief	"	X		Can provide loans and direct payments of up to \$5,000 for private individuals and families. HUD can cost-share up to 75% with state.	Federal disaster declaration status is essential. Special status may be needed for coastal hazards.	DLAD; Division of Emergency Government
Disaster loan assistance	Small Business Administration (SBA)	X		Can provide money for the replacement of damaged structural devices. Also, low-cost loans may be released to property owners and businesses ranging between 1% and 6%.	Federal disaster declaration status is essential. Special status may be needed for coastal hazards.	Small Business Administration Regional Office, Chicago
Land and Water Conservation Fund	U.S. Department of Interior (DOI)	X		Funds to acquire lands and/or to develop projects for recreational/public access purposes. Up to 50% local/state cost-sharing may be required. Coastal projects have a high priority.	Only available to public entities. A public need appears. A project plan in a recreation plan.	Wisconsin Department of Natural Resources; District Office
Outdoor Recreation Action Program (ORAP-200)	Wisconsin Department of Natural Resources (WDNR)	X		Funds to acquire lands and/or develop projects for recreational, public access, or pollution abatement purposes. ORAP funds can be combined with federal monies to reduce local match to 25% - 45%. Coastal projects have a high priority.	Only available to public entities. Projects need to be fit closely with program objectives. Bonding authorization ends in 1981.	"
Wisconsin Fund	"	X		Could provide some funds to reduce pollution from non-point sources within one mile of a navigable stream mouth along the shoreline. Local cost-share amounts will range between 30% - 50%.	Area adjacent to stream must be recognized in Section 208 plans. Shoreline and stream managing agency. Funding criteria are being finalized.	WDNR; Office of Intergovernmental Programs
Shoreland-Floodplain Zoning Program*	"	X		Provides technical assistance on non-structural alternatives; primarily land use control measures; and land management techniques. Assistance rendered as resources allow.	Requests be received as early as possible.	WDNR; District Office Investigator State Office Bureau of Water Regulation and Zoning
Wisconsin Highway Disaster Fund	Wisconsin Department of Transportation (DOT)	X	X	Improving of non-state highways after disaster events. DOT will pay full costs to pre-disaster status; and 1/2 of costs to be covered.	Local government(s) must petition for assistance within 60 days of a disaster event.	Office, DOT District Highway
Marine Advisory Services Program	University of Wisconsin; Sea Grant College Program	X		Can provide limited on-site and research assistance to individuals, businesses, and public entities for coastal engineering, problem analysis, and environmental monitoring assistance rendered as resources allow.	Requests be received as early as possible.	Sea Grant Program; Regional Advisory Services Office
Wisconsin Coastal Management Program (CMP)	Wisconsin Coastal Management Council	X	X	Provides both general and on-site technical assistance. Financial assistance provided for planning and feasibility studies. Applicants must provide a 20% match; no single project can exceed 10% of program budget.	Applicants for financial assistance must be a public entity and have direct management authority. A special GAMA designation might be required.	Technical Assistance: Wisconsin Geological and Natural History Survey Financial Assistance: Office of State Planning and Energy

* Under special circumstances, a great number of additional programs may be available to residential property owners, businesses, local governments, and state agencies when erosion concerns can be combined with other broader community objectives, e.g. economic development, community facility improvement, water pollution abatement, housing relocation. Those agencies and programs of special interest include the Agricultural Stabilization and Conservation Service; Economic Development Administration; Upper Great Lakes Regional Commission; Community Development Administration; Section 208 Water Quality Planning; Environmental Protection Agency; and Department of Housing and Urban Development.

APPENDIX F

ISSUANCE OF WATER REGULATORY PERMITS UNDER CHAPTER 30, WISCONSIN STATUTES

The generalized procedure for Chapter 30 permits is set out in Manual Code 3506.1 (Figure 1). Under this process the applicant submits a permit request to the district director. In the Northwest and Lake Michigan districts, the district office fields the application out to the appropriate area office for investigation (Figure 2). In the Southeast district, which has no area offices, the field investigation is conducted by the district office. Copies of the application are also sent by the district office to the central office (Bureaus of Water Regulation and Zoning and Environmental Impact) and to the county zoning administrator.

Field review is conducted by the area fish manager, the area wildlife manager, the area conservation warden, and the area water management investigator in the Northwest and Lake Michigan districts and by their functional counterparts in the Southeast district office. The field report is primarily environmental (Form 3500-23). It examines impacts on fish, considering the value of the species, its class and abundance; impacts on productivity, especially the effect on nursery and spawning areas; habitat, including bottom type and vegetation; wildlife (considering their value and abundance); the stability of the shoreline; flood plain and shoreland zoning considerations (zoning classification; present land use within 300 feet of the shoreline; conflicts with NR 115 or 116, Wis. Adm. Code; and the existence of other required regulatory authority - village or city, town, county, and federal (Corps of Engineers); special environmental considerations (aesthetic values, for example); and the overall impact on the environment, considering the ecological diversity of the area and its contribution to the stability of the lake. In addition to these environmental considerations, the water regulation investigation also looks at present public use of the project site (for navigation, hunting, fishing, trapping, swimming, etc.); the presence of areas of historic, scientific, or archeological value; and the impact on adjacent property owners. Copies of the field report are sent to the central office for review. In addition, the central office will be consulted where technical input beyond that available at the district level is required.

The area supervisor will return the completed field report to the district office with the area office's recommendations: no objection or objection on the basis of written facts. Manual Code 3551.1 requires the district's evaluation to reflect standards for flood plain management (under Sec. 87.30, Wis. Stats. and NR 116, Wis. Adm. Code), shoreland standards (under Sec. 144.26, Wis. Stats. and NR 115, Wis. Adm. Code) and erosion hazards (under Executive Order 67, dated 11/26/73).

Once the field report is deemed sufficient, the application is forwarded to the district's environmental impact coordinator for assessment pursuant to NR 150, Wis. Adm. Code. The impact coordinator will prepare Form 1600-1, the environmental impact assessment screening worksheet. The EIA considers the existing environment, the purpose of and need for the project, all beneficial and adverse impacts (physical, biological, economic and social), the probability of adverse impacts that cannot be avoided, any irreversible or irretrievable commitments of resources, and the possibility of implementing reasonable alternatives. On this basis, the impact coordinator will evaluate any perceived

secondary effects, new environmental effects, the effects on geographically scarce resources, energy impacts, economic impacts and social impacts. In the course of this evaluation, the following questions will be answered: will the action be precedent-setting? Do reasonable alternatives exist? How controversial is the project? Will it be consistent with long-range policies and plans? Are there foreseeable cumulative impacts which are major or significant? What is the impact on historic, scientific or archeological sites? Will future options be foreclosed?

On the basis of the field report and the environmental impact assessment worksheet, a final assessment, consisting of both a technical analysis and professional opinion, will be made of the probable environmental impact of the proposed project. If the permit request is not subject to notice and hearing under Sections 30.02 and 31.06, Wis. Stats., the district director will proceed to grant or deny the request at this point. Summary action can be taken on applications for bulkhead lines under Section 30.11, Wis. Stats. (although adoption of a municipal ordinance does require notice and hearing); sand blankets, fish cribs and riprap under Section 30.12, Wis. Stats.; and dredging under Section 30.20, Wis. Stats. All are processed almost entirely at the district level, although informal interaction with the central office is maintained regarding questions which cannot be locally answered.

The reasons for exempting certain types of permit actions from the requirements of notice and hearing is based on the legislative judgment that most projects of these types are of relatively minor public impact and generally are noncontroversial in nature. That is, past experience indicates a lack of public concern for the great majority of these projects. Of course, an additional consideration is expediting the process vis-a-vis the applicant, making it easier both in terms of the expense and the time involved (Meyer 1978).

In particular, riprap permits are excluded because the right to protect property against the action of water by building works along the banks is a basic riparian right at common law. Installing riprap is also important to erosion control. Therefore, it was thought desirable to make the process short and simple. Similarly, the desirability of fish cribs for fish management purposes encouraged simplification of the permit review process (Meyer 1978).

All other types of permit requests, namely applications for structures under Section 30.12, Wis. Stats. and waterway enlargements under Section 30.19, Wis. Stats., are subject to notice and hearing. In lieu of once-mandatory hearing requirements, however, permits of this type are now subject to the so-called 30-day notification procedure (Chapter 90, Laws of 1973).

Section 31.06, Wis. Stats. provides that upon receipt of an application for a permit, the department may order a hearing of its own accord, or it may waive the hearing requirement absent a specific request for one being submitted within 30 days. The district office will send copies of the notice to DNR personnel (the Bureau of Legal Services, the Bureau of Water Quality, the Bureau of Environmental Impact, the Bureau of Water Regulation and Zoning and the Office of Coastal Zone Management), the Scientific Areas Preservation

Council, the Department of Health and Social Services, the State Board of Soil and Water Conservation Districts, the attorney general's office, various environmental groups, the applicant, the local zoning administrator, county and municipal clerks, adjacent property owners and the Corps of Engineers. In addition, the central office sends notification to the local newspaper for informational purposes. The applicant is required to publish notice as well in each county in which affected riparian lands are located (Lawry 1978).

After publication of notice, the district must wait 30 days before continuing the permit review process. If no objections are received, the water management investigator consults with the environmental impact coordinator and submits recommendations to the district director. The district director will then approve or deny the permit. Copies of the district's order are sent to the Bureaus of Water Regulation and Zoning, Legal Services and Environmental Impact and to the county zoning administrator.

If there are written objections to a particular project, the water management investigator will draft a memo to Madison requesting a hearing and transferring the environmental assessment and other files to the Bureaus of Water Regulation and Zoning, and Legal Services. Objections may be initiated from within the department itself or from without. If the objections are made on the basis of written fact and are deemed to be reasonable, a hearing will be held. At the conclusion of the hearing, the hearing examiner will determine whether a permit will be issued. From that point on, the process is in the hands of the central office (Manual Code 3505.1).

Source: "The Role of the Department of Natural Resources in the Protection of the Public Interest Along Navigable Waters," Wisconsin Coastal Management Program Working Paper, April 1978.

APPENDIX G

CALIFORNIA SHORELINE EROSION PROTECTION POLICY

I. General

Development of the lands adjacent ot large bodies of water carries with it an element of danger from wave action, which can threaten the safety of public and private property and recreational values.

It is the policy of the Resources Agency that the use of these lands avoid hazardous and costly situations caused by erosion and minimize or resolve existing problems. Only in those situations where structures or areas of public use are threatened should the State resort to funding or approving remedial projects. When necessary, projects should restore natural processes, retain shoreline characteristics, and provide recreational benefits to the extent possible.

II. Planning and Regulation

A. In planning for the use of land adjacent to the shoreline, State agencies shall assure the following:

1. Effective land use plans and regulations to prevent existing and future developments from being endangered by erosion of sand beaches or the base of bluffs;
2. Measures to reduce surface runoff, groundwater effects, and other activities that create bluff stability problems;
3. Measures for the orderly demolition or relocation of damaged or threatened structures and facilities and for the disposition of parcels of land that cannot be safely developed.

B. Projects constructed within the coastal watersheds can increase the natural shoreline erosion rates by blocking the flow of sediment to the shoreline. It is therefore the policy of the Resources Agency that developments planned, developed, or authorized by State agencies shall meet al least one of the following conditions:

1. The development, together with other adjacent developments allowed under local land use regulations, will not reduce the natural sediment beyond that needed to adequately supply the shoreline;
2. Mitigation measures to include providing an adequate sediment supply are included as a part of the project; or
3. A regional plan exists that would provide an adequate supply of sand to protect the shoreline, even if the development is permitted.

- C. Beach and dune sand, and similar sediment lying in river beds, estuaries or in harbor channels is a valuable resource that should be used for shoreline protection. It is, therefore, the policy of the Resources Agency that all such dredge or excavation material removed within the coastal zone or near-shore waters, which is suitable in quantity, size, distribution, and chemical constituency, be discharged as follows:
1. Directly onto a natural beach in an appropriate manner for effective beach nourishment and in a manner to protect significant natural resources and the public use of such resources at those locations; or
 2. When beach nourishment is not needed or appropriate at the time of dredging, the sand should be deposited at locations for eventual use for beach nourishment, provided that suitable locations are available and steps are taken to protect both significant natural resources and the public use of such resources at those locations; or
 3. In those instances where quantity, distribution, or chemical constituency of dredge or excavation material limit its use as described in paragraphs one and two, the material should be used to optimize its mineral values or its utility as construction material;
- D. Under California law, artificially induced shoreline accretions do not affect property boundaries. To preserve evidence of the position of reconstruction boundaries, it shall be the policy of the Resources Agency that before approving any shoreline erosion control measure, a Record of Survey map shall be filed with the State Lands Commission to preserve and protect public and private boundaries showing at least the following:
1. An accurate positioning of the present, preconstruction, high-water line;
 2. Sufficient ties to at least two existing record monuments, which will not be disturbed by proposed construction;
 3. The accurate position of any monument shown on a map filed in an office of public record, and which will be disturbed by the proposed construction, together with a plan to replace the monument in its original position or to nearby record monuments.
- E. The planning and improvement of parks and beaches should be done in a way consistent with protection against the potential erosion of the affected segment of the coastline, and any structures located in areas subject to erosion damage should be expendable or moveable.

III. Shoreline Protection Projects

Shoreline protection projects are proposed by both private parties and public agencies. It is the policy of the Resources Agency that the following policies should be followed when evaluating project applications:

- A. Nourishment of beaches to protect against erosion shall be encouraged where the following conditions are met:
 - 1. This does not conflict with significant living marine resources;
 - 2. This will not result in adverse effects elsewhere on the coast; and
 - 3. Measures are included in the project to maintain the affected beaches in a nourished state.

- B. Construction of seawalls, revetments, breakwaters, or other artificial structures for coastal erosion control shall be discouraged unless each of the following criteria is met:
 - 1. No other non-structural alternative is practical or preferable;
 - 2. The condition causing the problem is site specific and not attributable to a general erosion trend, or the project reduces the need for a number of individual projects and solves a regional erosion problem;
 - 3. It can be shown that a structure(s) will successfully mitigate the effects of shoreline erosion and will not adversely affect adjacent or other sections of the shoreline;
 - 4. There will be no reduction in public access, use, and enjoyment of the natural shoreline environment, and construction of a structure will preserve or provide access to related public recreational lands or facilities;
 - 5. Any project-caused impacts on fish and wildlife resources will be offset by adequate fish and wildlife preservation measures; and
 - 6. The project is to protect existing development, public beaches or a coastal-dependent use.

- C. No project shall be approved that will cause loss or destruction of State mineral resources, or that will subject State mineral rights to trespass. All royalty considerations shall be determined by the State Lands Commission and implemented pursuant to the terms of a permit or lease granted by the Commission.

IV. Project Financing

- A. It shall be the policy of the Resources Agency to recommend State financial participation in shoreline erosion protection projects only

when all of the following conditions are met:

1. The protection project considers the long term effects of erosion on all adjacent coastline sections subjected to similar or related erosional mechanisms and takes into consideration the needs of the entire region;
 2. Any project-caused impacts on fish and wildlife will be offset by adequate fish and wildlife preservation measures;
 3. The public benefits including the long term environmental, social, and economic effect of the project are found to be greater than the public costs. The coastal section to be protected should contain substantial and valuable public-owned lands or facilities of greater value than the cost of the proposed project, or the protection scheme should provide, maintain, or improve the public use and enjoyment of the beach or shoreline;
 4. The project plan should use non-structural solutions such as beach nourishment as the recommended alternative or as a part of the recommended alternative, unless it is not feasible;
 5. Public access is provided to the shoreline area where the protection project is to be carried out unless the area is unsafe.
- B. In an emergency situation when erosion is threatening structures, State agencies should respond immediately by offering technical assistance for temporary protective actions. Assistance should first be directed to emergency situations involving public assets.

Source: California Coastal Commission,
September, 1978.

APPENDIX H

MARYLAND LOAN FUND FOR EROSION CONTROL PROJECTS

Section 8-1002. Powers and duties of Department.

The Department shall:

- (1) Develop and implement a program to educate the public on every phase of shore and bank erosion, its causes and effects, the locations where erosion is a problem, and steps to be taken to control it;
- (2) Review petitions for formation of shore erosion control districts presented to any county and report to the county as provided in Article 25, S 167B of the code;
- (3) Provide technical assistance to individual property owners, municipalities, and counties having specific shore and bank erosion problems;
- (4) Design, or cause to be designed, shore erosion control structures, including vegetative cover, in shore erosion control districts;
- (5) Enter into agreements with any person to construct shore erosion control structures;
- (6) Administer the fund to provide loans to any person in support of construction of shore erosion control structures;
- (7) Supervise or provide supervision of design and erection of any shore protective device the fund finances in whole or part;
- (8) Prepare requests for appropriation of funds necessary to maintain the fund;
- (9) Cooperate with the following units: The State Highway Administration for shore erosion control where essential to protect municipal, county or state roads; the United States Army Corps of Engineers to conduct shore erosion studies; and the Soil Conservation Service of the United States Department of Agriculture to evaluate and apply vegetative measures for shore erosion control;
- (10) Design, construct, and maintain shore erosion control works on state-owned lands if these projects are included in the Budget for the Fund;
- (11) Actively seek to obtain available funds from the Federal Government for shore erosion control projects; and
- (12) Promulgate rules and regulations to implement this subtitle.

Section 8-1003. Shore Erosion Control Projects.

- (A) Application for assistance in project. The owner of any property abutting on any body of water in the State may file a written application with the Department requesting State assistance in the design, construction, and financing of a shore erosion control project for the property. The application shall be in a form and contain information the Department prescribes. Each application form shall contain a notice warning that the applicant is responsible for maintenance of any project after it is constructed.
- (B) Location of project. A project may not be approved unless it lies within a physiographic unit established by the Department; is within a shore erosion control district established under Article 25, SS 161 - 167E, inclusive, of the code, or is of a nature that its inclusion within a physiographic unit or shore erosion control district is neither necessary nor feasible in the Department's judgment.
- (C) Participation of every property owner required for approval of physiographic unit project. A physiographic unit project may not be approved unless every property owner within the physiographic unit participates in planning, construction, and financing of the project. However, the Department may exclude any property owner within the physiographic unit if this exclusion does not affect materially the remainder of the project.
- (D) Schedule of priorities for projects. The Department shall establish a schedule of priorities for shore erosion control projects, and upon approval of an application, assign the project to a priority list number. The schedule shall take into consideration the rate of erosion, amount of silt being deposited in the waters involved, date of Department's approval, nature and amount of public benefits provided by the project, and any other factors set forth in rules and regulations the Department promulgates. If at any time the cost of an approved project at the top of the priority list exceeds the unobligated balance of the fund, the Department may proceed with construction of a lower priority project.
- (E) Property owner's cash contribution placed in escrow. The property owner's cash contribution shall be placed in escrow immediately after a construction contract is awarded but before construction begins.

Section 8-1004. General Fund appropriation to be included in operating Budget of the Department.

The operating budget of the Department shall contain a general fund appropriation sufficient to provide engineering, technical, and administrative services required to implement SS 8-1002 and 8-1003 or this subtitle, including but not limited to, review and evaluation of requests for assistance in shore erosion control; design of shore erosion control structures and projects; supervision over construction of approved projects; and inspection of completed projects to insure adequate maintenance. Costs of the services enumerated in this section are not considered part of the construction cost of the project and shall be borne solely by the State.

Section 8-1005. Shore Erosion Control Construction Loan Fund; Construction of project; payment of contractor; levy of tax; maintenance of completed projects; funds for State-owned properties.

- (A) The "Shore Erosion Control Construction Loan Fund" is created and continued. The Department shall administer the fund solely to provide interest-free loans to persons, municipalities, or counties for construction of shore erosion structures. The fund shall be maintained by:
- (1) Repayments of principal on loans made from the fund, with the repayments made through a special real estate tax the State levies on privately owned property benefited by shore erosion control projects. The tax shall compensate the State for net project construction cost. The tax may be levied at a uniform rate over a period not exceeding 25 years, as the State and the property owner agree; and
 - (2) Annual appropriation of general funds to restore the fund to a level sufficient to carry out an effective shore erosion control construction loan program during the succeeding year.

A property owner whose project is approved is eligible to receive an interest-free loan covering 100 percent of the first \$40,000 of project construction cost, 50 percent of the next \$20,000 of project construction cost, 25 percent of the next \$20,000 of project construction cost, and ten percent of the part of construction cost exceeding \$80,000. However, where two or more property owners are included within a shore erosion control project, and project construction costs exceed \$80,000, the land of each property owner is considered a separate shore erosion project for the purpose of computing net project construction cost under this formula.

- (B) During the first month of each fiscal year, the Department shall submit to the Department of Budget and Fiscal Planning as estimate of the amount of revenues the fund expects to receive from repayment of outstanding loans, and the amount of general funds required to reestablish an adequate balance in the fund to make loans during the next fiscal year.
- (C) When the Department approves a shore erosion control project and signs an appropriate agreement with the owner of the benefited property, stipulating how the State will be reimbursed for net project construction cost, the Department shall proceed, within budgetary limitation, to construct the project. On satisfactory completion of construction, any property owner's cash contribution shall be indorsed to the credit of the contractor. The fund shall pay the balance of the payment due the contractor. Within 30 days thereafter, the Department shall certify to the Board of Public Works payment of the construction costs and transmit a copy of the agreement specifying how the State will be reimbursed for the net project construction cost. The Board of Public Works shall levy a special tax, beginning in the next fiscal year, on the benefited property in conformity with this agreement.
- (D) Costs to maintain shore erosion control projects are the sole responsibility of the benefited property owner. The Department periodically

shall inspect these projects to recommend to the property owner any measures required to maintain the project.

- (E) Any county or any municipal corporation may borrow interest-free funds from the fund for any approved project without the project construction cost limitation stated in this section. The county, or municipal corporation shall repay the funds at a uniform rate over a period not exceeding 25 years as stated by agreement between the State and county or municipal corporation.
- (F) Funds for shore erosion protection for state-owned properties. The Department shall include in its budget a request for funds necessary to provide and maintain shore erosion protection for state-owned properties.

Source: Annotated Code of Maryland,
Natural Resources, Sections
8-1001 thru 8-1005

APPENDIX I

NORTH CAROLINA COST-SHARE PROGRAM
FOR CIVIL WORKS PROJECTS

.0101 Preamble

Pursuant to Chapter 684 of the 1963 Session Laws, an amount of one million dollars (\$1,000,000) was appropriated to the Department of Water Resources for the purposes of building sand dunes and other civil works projects. Pursuant further to the order of the July 11, 1963 meeting of the Advisory Budget Commission as to this appropriation and by authority of G.S. 143-354 and G.S. 143-355, the North Carolina Environmental Management Commission do enact the following rules and regulations contained in this Section.

.0102 Cost Sharing on Federally Programmed and Funded Projects

Certain portions of funds appropriated to the Department of Water Resources by Chapter 684, Session Laws of 1963, may be used for the purpose of permitting state participation in the costs of planning, construction, operation and maintenance of civil works projects selected by the North Carolina Environmental Management Commission, which shall have been approved by or pursuant to the laws enacted by the United States Congress as a part of its program for the planning, construction, operation and maintenance of civil works projects within the State of North Carolina; provided, however, that 80 percent of the total non-federal costs of any particular civil works project, as hereinafter defined, as calculated during any particular fiscal year, shall be expended from the said appropriation by the Department of Natural and Economic Resources, and that the remaining 20 percent of the total non-federal costs of said particular project shall be appropriated by the local political subdivision or unit of government.

.0103 Cost Sharing on Projects not Federally Programmed

Certain portions of the appropriation, as referred to in the Preamble, Regulation .0101 of this Section, may be used for the purpose of defraying the costs of planning, construction or operation of any civil works project, as hereinafter defined, for which there may be no federal funds available for any of these purposes, or if, in the opinion of the Environmental Management Commission, the federal funds available are insufficient; provided that 80 percent of the total costs of any particular civil works project, as calculated during any particular fiscal year shall be expended from the said appropriation by the Department of Natural and Economic Resources, and the remaining 20 percent shall be appropriated by the local political subdivision or unit of government.

.0104 Projects Eligible for 100 Percent State Funding

In a case where no local political subdivision or unit of government would have a legal obligation in a civil works project in that the State of North Carolina owns or is in legal possession and control of the area adjacent to the location of the proposed civil works project, as hereinafter defined, and that in the opinion of the North Carolina Environmental Management Commission the particular civil works project would be beneficial to the State of North

Carolina, the said commission may appropriate up to 100 percent of the total costs of planning, construction, or operation of said civil works project if no federal funds or funds from other sources in the opinion of the said commission are available, or, if federal funds are available, up to 100 percent of the total non-federal cost, if no funds from other sources are available, for the planning, construction or operation of said civil works project.

.0105 20 Percent Local Funding Requirement

Expenditures from the appropriation of funds referred to in Regulations .0102 and .0103 of this Section shall not be allocated or made until it shall appear to the satisfaction of the North Carolina Environmental Management Commission that local governmental units or other political subdivisions of the State of North Carolina interested in any particular civil works project have provided or will provide the remaining 20 percent of the total non-federal costs of any particular civil works project under Regulation .0102 of this Section, or the remaining 20 percent of the costs as to any particular civil works project in which the state may participate under the terms and provisions of Regulation .0103 of this Section. Donations or grants of funds on account of or for the planning, construction, operation or maintenance of any civil works project by non-governmental interests, private enterprise or from any other source to the local governing body or to the North Carolina Environmental Management Commission shall be authorized for acceptance by the governing board of any local governmental unit and by the North Carolina Department of Natural and Economic Resources and the North Carolina Environmental Management Commission and when paid or approved to be paid to the satisfaction of the North Carolina Environmental Management Commission shall be calculated as part of the local participation in the cost of any civil works project under Regulations .0102 and .0103 of the Section.

.0112 Special Project Requirements

The following requirements are applicable to any beach erosion control or hurricane protection project in which the state participates by action of the commission:

- (1) Before the start of project construction, the department will establish a project protection line in accordance with the provisions of Section 104B-11, North Carolina General Statutes. Enforcement of this project protection line will be a responsibility of the sponsoring local government(s).
- (2) Before the start of project construction, the sponsoring local government(s), will establish land-use controls to conserve protective dunes and to insure that the damage potential is not significantly increased by further development. Such land-use controls must be acceptable to the Secretary, Department of Natural and Economic Resources.
- (3) The sponsoring local government(s) must provide adequate public access to the project area.

Source: North Carolina Administrative Code; Ner-Environmental Management (Subchapter 2G-Water Resources Programs).

Section .0200 - State Standards for
Non-Federal Projects

.0201 Purpose

The desired project, to be recommended by the Department of Natural and Economic Resources for approval by the Environmental Management Commission must be one which is not eligible for execution under one of the federal water resources programs, or other state or local programs. The objective of a program of non-federal projects in the state will be to fill the gaps between federal programs, and not to set up a large state program, nor one which duplicates or conflicts with federal programs.

.0202 Economic Justification Required

It shall be economically justified. It is not intended that the program shall simply make possible projects which the federal government has found unworthy.

.0203 Formal Approval Required

It must have the formal approval of the governing bodies of all affected counties or municipalities.

.0204 Sound Engineering Required

The project must be soundly engineered by the local government making the request prior to submission to the commission for approval.

.0205 Compatibility with North Carolina Water Plan

It must be compatible with the North Carolina water plan, as the development of the plan proceeds.

.0206 Approval of All Affected State Agencies

It should have the approval of all affected state agencies, normally those administering the fish and wildlife, state lands, ports, highways, recreation and health.

.0207 Assumption of Responsibility by Local Governments

Local (below the state level) interests shall formally assume the responsibility for the following, and have clearly the power to provide them (such as the power of eminent domain, which not all counties in the state presently have):

- (1) Provision of lands, easements, and rights-of-way to provide adequate public lands for the project;
- (2) Maintenance and operation after the completion of construction;
- (3) Cost-Sharing. The state will normally provide 80 percent of costs attributable to public benefits, not including costs of lands, easements, and rights-of-way;
- (4) Hold and save the state free from damages due to the project.

APPENDIX J

MICHIGAN TAX LEGISLATION FOR
SHORE PROTECTION PROJECTS

A. Property Tax Exemption (Public Act Number 187, 1973)

Enrolled Senate Bill No. 515

An act to amend Act No. 206 of the Public Acts of 1893, entitled as amended "An act to provide for the assessment of property and the levy and collection of taxes thereon, and for the collection of taxes heretofore and hereafter levied; making such taxes a lien on the lands taxed, establishing and continuing such lien, providing for the sale and conveyance of lands delinquent for taxes and for the inspection and disposition of lands bid off to the state and not redeemed or purchased; to define and limit the jurisdiction of the courts in proceedings in connection therewith; to limit the time within which actions may be brought; to prescribe certain limitations with respect to rates of taxation; to provide penalties for the violation of this act; and to repeal all acts and parts of acts in anywise contravening any of the provisions of this act," as amended, being sections 211.1 to 211.157 of the Compiled Laws of 1970, by adding section 7g.

The People of the State of Michigan enact:

Section 1. Act No. 206 of the Public Acts of 1893, as amended, being sections 211.1 to 211.157 of the Compiled Laws of 1970, is amended by adding section 7g to read as follows:

Section 7g. The value of a seawall, jetty, or groin or other structure whose primary purpose is to prevent or control erosion on property affected by waters or levels of the great lakes of their connecting waters is exempt from taxation. The department of natural resources shall, when requested by the owner or the assessor, determine if such seawall, jetty, groin, or other structure has as its primary purpose the prevention or control of erosion.

This act is ordered to take immediate effect.

B. Special Assessments Allowed (Public Act Number 143, 1976)

Enrolled House Bill No. 4432

An act to amend sections 2 and 3 of Act No. 188 of the Public Acts of 1954, entitled as amended "An act to provide for the making of certain public improvements by townships; to provide for paying for the same by the issuance of bonds; to provide for the levying of taxes; to provide for assessing the whole or a part of the cost of public improvements against property benefited; and to provide for the issuance of bonds in anticipation of the collection of such special assessments, and for the obligation of the township thereon," section 2 as amended by Act No. 143 of the Public Acts of 1974, being sections 41.722 and 41.723 of the Compiled Laws of 1970; and to add section 9a.

The People of the State of Michigan enact:

Section 1. Sections 2 and 3 of Act No. 188 of the Public Acts of 1954, section 2 as amended by Act No. 143 of the Public Acts of 1974, being sections 41.722 and 41.723 of the Compiled Laws of 1970, are amended and section 9a is added to read as follows:

Section 2. (1) The following improvements may be made under this act:

- (a) The construction and maintenance of storm or sanitary sewers or combined storm and sanitary sewers.
- (b) The construction of water mains.
- (c) The improvements of public highways by grading, graveling, paving, curbing, or draining the same or constructing driveway approaches or sidewalks thereon.
- (d) The maintenance and improvement of parks or the trimming and spraying of trees.
- (e) The installation of elevated structures for foot travel over highways in the township.
- (f) The collection of garbage and rubbish.
- (g) The construction, maintenance, or improvement of bicycle paths parallel to public highways.
- (h) The construction, maintenance, repair, or improvement of erosion control structures or dikes.

Section 3. An improvement shall not be made hereunder unless a petition shall be filed with the township board, signed as follows: (a) In case of highway improvements, by the record owners of lands whose frontage constitutes at least 65% of the total frontage upon the highway improvements; and (b) in case of water mains or sewers, or erosion control structures or dikes, by record owners of lands constituting at least 51% of the total land area in the special assessment district as finally thereafter established by the township board. In a township with a population in excess of 5,000, after notification by mail to the owners of lands whose names appear on the latest tax roll, a petition shall not be required for water mains or sewers or erosion control structures or dikes and the township board may exercise the powers granted by this act on its own initiative in accordance with this act, except as they relate to a petition or action with reference thereto, but an improvement shall not be made without petition if the record owners of land constituting more than 20% of the total land area in the special assessment district file their written objections thereto with the township board at or before the hearing described in section 4 of this act. Record owners shall be determined as of the records in the register of deeds' office on the day of the filing of the petition, or in case written objections are filed as above provided, then on the day

of the hearing. In determining the sufficiency of the petition, lands not subject to special assessment and lands within public highway and alleys shall not be included in computing frontage or assessment district area. Any filed petition may be supplemented as to signatures by the filing of an additional signed copy or copies thereof, and in that case the validity of the signatures thereon shall be determined by the records on the day of filing the supplemental petition.

Section 9a. (1) An owner of property who by reason of hardship is unable to contribute to the cost of an assessment for an improvement authorized in section 2(1) (a),(b),(c),(g), or (h) may have the assessment deferred by application to the assessing officer. Upon receipt of evidence of hardship, the township may defer partial or total payment of the assessment.

(2) The township board of trustees may enact an ordinance to define hardship and to permit deferred or partial payment of an assessment pursuant to this section. As a condition of granting the deferred or partial payment of an assessment, the township board shall require that any deferred assessment will constitute a recorded lien against the property.

This act is ordered to take immediate effect.

SELECTED LAND USE INFORMATION ON
INCORPORATED AND UNINCORPORATED
COASTAL AREAS

INFORMATION ON COASTAL UNINCORPORATED AREAS

Counties	Shoreland Zoning	Floodplain Zoning	Subdivision Ordinance	Sanitary Code	# of Coastal Towns w/shore frontage	# adopting Co. Gen. Zoning	# adopting Town Zoning	# w/o Gen. Zoning
Douglas	yes	no	yes	yes	3	3	0	0
Bayfield	yes	no	yes	yes	9	9	0	0
Ashland	yes	no	yes	yes	2	1	1	0
Iron	yes	no	yes	yes	1	1	0	0
Door	yes	yes	yes	yes	12	4	0	8
Marquette	yes	no	no	no	1	N/A	1	0
Oconto	yes	yes	yes	yes	4	2	1	1
Kewaunee	yes	yes	no	yes	5	N/A	0	5
Brown	yes	yes	yes	yes	3	N/A	2	1
Mantowoc	yes	yes	yes	yes	5	3	1	1
Sheboygan	yes	yes	yes	yes	4	N/A	4	0
Ozaukee	yes	yes	yes	yes	3	N/A	3	0
Racine	yes	yes	yes	yes	2	1	1	0
Kenosha	yes	yes	yes	yes	2	2	0	0
Milwaukee	N/A	N/A	N/A	N/A	No Civil Towns	N/A	N/A	N/A
Totals:	14 yes	9 yes 5 no	12 yes 2 no	13 yes 1 no	56	26	14	16

SOURCE: WISCONSIN OFFICE OF STATE PLANNING AND ENERGY, 1976.

INFORMATION OF COASTAL INCORPORATED AREAS

<u>NAME:</u>	<u>Miles of Shore Frontage (Estimated)</u>	<u>Population (1974 Estimates)</u>	<u>Legal Classification</u>	<u>Zoning Ordinance</u>	<u>Subdivision Ordinance</u>
<u>SOUTHEAST</u>					
1. Bayside	2.08	4,690	Village	Yes	Yes
2. Cudahy	2.58	22,120	3rd Class	Yes	Yes
3. Fox Point	2.77	8,039	Village	Yes	Yes
4. Kenosha	5.21	82,839	2nd Class	Yes	Yes
5. Mequon	6.06	14,271	4th Class	Yes	Yes
6. Milwaukee	8.33	683,146	1st Class	Yes	Yes
7. S. Milwaukee	3.13	23,881	4th Class	Yes	Yes
8. North Bay	.34	253	Village	Yes	No
9. Oak Creek	4.45	15,672	4th Class	Yes	Yes
10. Port Washington	2.00	9,538	4th Class	Yes	Yes
11. Racine	5.02	94,905	2nd Class	Yes	Yes
12. Shorewood	1.23	14,874	Village	Yes	Yes
13. St. Francis	1.89	9,995	4th Class	Yes	Yes
14. Whitefish Bay	2.77	16,699	Village	Yes	No
15. Wind Point	2.56	1,320	Village	Yes	Yes
<u>BAY-LAKE</u>					
1. Algoma	2.63	3,951	4th Class	Yes	Yes
2. Cleveland	1.14	934	Village	Yes	Yes
3. Egg Harbor	5.32	204	Village	No	No
4. Ephraim	4.48	242	Village	Yes	Yes
5. Green Bay	10.10	85,541	2nd Class	Yes	Yes
6. Howard	4.22	6,042	Village	Yes	No
7. Kewaunee	2.33	2,935	4th Class	Yes	Yes
8. Manitowoc	5.18	33,063	3rd Class	Yes	Yes
9. Marinette	3.33	12,272	3rd Class	Yes	Yes
10. Oconto	3.00	5,000	4th Class	Yes	No
11. Sheboygan	5.54	49,246	2nd Class	Yes	Yes
12. Sister Bay	2.66	535	Village	Yes	Yes
13. Sturgeon Bay	8.66	7,212	4th Class	Yes	Yes
14. Two Rivers	3.26	13,400	3rd Class	Yes	Yes
<u>NORTHWEST</u>					
1. Ashland	8.48	9,255	3rd Class	Yes	No
2. Bayfield	1.36	841	4th Class	Yes	No
3. Superior	11.89	31,183	2nd Class	Yes	Yes
4. Washburn	3.75	2,009	4th Class	Yes	No
TOTALS	137.75	1,239,107	22 Cities 11 Villages		
33 incorporated areas on the Great Lakes	22% of Coastline	64% of Coastal Counties' Population			
		27% of State Population			

APPENDIX L

CHAPTER NR 115, WISCONSIN'S ADMINISTRATIVE
CODE: SHORELAND MANAGEMENT PROGRAM

NR 115.01 Introduction. (1) The water resources act (chapter 614, laws of 1965) requires counties to enact regulations for the protection of all shorelands in unincorporated areas by January 1, 1968. Shorelands as defined by the law are lands within 1,000 feet of a navigable lake, pond or flowage and lands within 300 feet of a river or navigable stream or to the landward side of the floodplain, whichever distance is greater.

(2) The statute defines the purposes of regulations enacted for shoreland protection: "to further the maintenance of safe and healthful conditions; prevent and control water pollution; protect spawning grounds, fish and aquatic life; control building sites, placement of structures and land uses and reserve shore cover and natural beauty."

NR 115.02 Nature of the program. (1) The water resources act creates section 59.971, Wis. Stats., which requires the zoning of shorelands in the unincorporated areas of each county. Such zoning shall not require the approval of the town boards. To assure that such zoning will be accomplished, section 59.971 (6), Wis. Stats., states that if any county does not adopt an ordinance by January 1, 1968, or if the department, after notice and hearing, determines that a county had adopted an ordinance which fails to meet reasonable minimum standards in accomplishing the shoreland protection objectives, the department shall adopt such an ordinance.

(2) To comply with the water resources act, it is necessary for a county to enact shoreland regulations, including zoning provisions, land division controls, sanitary regulations and administrative provisions ensuring enforcement of the regulations.

(3) It is the policy of the department, in the discharge of its responsibility under section 144.26, to require adherence to certain specific standards and criteria. The standards and criteria are intended to define the objectives of the regulations.

NR 115.03 Shoreland regulation standards and criteria. (1) ESTABLISHMENT OF APPROPRIATE ZONING DISTRICTS. Shoreland area development can usually be controlled by regulations appropriate to wetlands (conservancy district), recreation-residential districts and general purpose districts. Where detailed land use planning has been accomplished, other types of districts may also be desirable.

(2) ESTABLISHMENT OF LAND USE ZONING REGULATIONS. The zoning provisions adopted must provide sufficient control of the use of shorelands to afford the protection of water quality as specified in Wis. Adm. Code chapters NR 102 and 103. The provisions shall include the following:

- (a) Minimum lot sizes. All future lots in the shoreland area shall afford protection against danger to health and hazard of pollution of the adjacent body of water.

1. Lots served by public sewer shall have a minimum width of 65 feet and a minimum area of 10,000 square feet.
 2. Lots not served by public sewer shall have a minimum average width of 100 feet and a minimum area of 20,000 square feet.
- (b) Building setbacks. The permitted location of buildings and structures shall conform to health requirements, preserve natural beauty and reduce flood hazards.
1. Unless an existing development pattern exists, a setback of 75 feet from the normal high waterline shall be required.
 2. No building shall be erected in the floodway of a stream (see chapter NR 116, definitions).
 3. Boathouses or similar structures which require a waterfront location shall not be used for habitation nor extend toward the water beyond the ordinary high waterline.
 4. Buildings and structures shall be subject to any applicable floodplain zoning regulations.
- (c) Trees and shrubbery. The cutting of trees and shrubbery shall be regulated to protect scenic beauty, control erosion and reduce the flow of effluents and nutrients from the shoreland. In the strip 35 feet inland from the normal high waterline, no more than 30 feet in any 100 feet shall be clear cut. In other areas, trees and shrub cutting shall be governed by consideration of the effect on water quality and should be in accord with accepted management practices.
- (d) Filling, grading, lagooning, dredging. Filling, grading, lagooning and dredging may be permitted only in accord with state law and where protection against erosion, sedimentation and impairment of fish and aquatic life has been assured.

(3) ESTABLISHMENT OF SANITARY REGULATIONS. The protection of health and the preservation and enhancement of water quality require sanitary regulations to be adopted by the county.

- (a) Where public water supply systems are not available, private well construction shall conform to Wis. Adm. Code chapter NR 112.
- (b) Where a public waste collection and treatment system is not available, design and construction of private sewage disposal systems shall fully comply with Wis. Adm. Code section H62.20.

(4) ADOPTION OF ADMINISTRATIVE AND ENFORCEMENT PROVISIONS. Each ordinance required by these regulations shall provide for:

- (a) The appointment of an administrator and such additional staff as the work load may require.
- (b) A planning agency (planning and zoning committee) and a board of adjustment as required by law.

- (c) A system of permits for all new construction, reconstruction, structural alteration or moving of buildings and structures, including sanitary waste disposal and water supply facilities. A copy of all applications shall be filed in the office of the county administrator.
- (d) Regular inspection of permitted work in progress to insure conformity of the finished structures with the terms of the ordinance.
- (e) A variance procedure relating to the use, change of use or alteration of nonconforming lands and structures, and a special exception procedure for uses presenting special problems of pollution or flood hazard. The county shall keep a complete record of all proceedings before the board of adjustment and planning agency.
- (f) Timely notice to the floodplain-shoreland management section of the department of natural resources of hearings on proposed variances, special exceptions and amendments and delivery to that section of copies of decisions on such variances, special exceptions and such amendments, when adopted.
- (g) Mapped zoning districts and the recording, on an official copy of such map, of all district boundary changes.
- (h) The prosecution of all violations of shoreland zoning ordinances.

(5) ESTABLISHMENT OF LAND SUITABILITY REVIEW. The county shall review all land divisions which create 3 or more parcels or building sites of 5 acres each or less within a 5-year period. In such review the following factors should be considered:

- (a) Hazards to the health, safety or welfare of future residents.
- (b) Proper relationship to adjoining areas.
- (c) Public access to navigable waters, as required by law.
- (d) Adequate storm drainage facilities.
- (e) Conformity to state law and administrative code provisions.

NR 115.04 Role of the Department of Natural Resources. (1) Role. The department of natural resources is directed by the legislature to assist the counties in carrying out their responsibilities under the law and to review and evaluate the administration of the regulations. If necessary, the department may recommend to the natural resources board the adoption of an ordinance for a county, if the county failed to meet these standards and criteria.

(2) COMPLIANCE DETERMINED BY EVALUATING COUNTY REGULATIONS WITH SECTION NR 115.03. (a) Compliance with the requirements of section 59.971 will be determined by comparing the county shoreland regulations with the state minimum standards for shoreland protection as contained in section NR 115.03. Counties that have enacted regulations that meet the minimum standards for shoreland protection will be considered as complying with section 59.971, Wis. Stats.

- (b) Compliance status shall also be maintained by the county during subsequent reevaluation of the regulations to ascertain their effectiveness in maintaining the quality of Wisconsin water. A county shall keep its regulations current, effective and workable to retain its status of compliance. Failure to do so shall be deemed noncompliance.
- (c) Compliance with chapter NR 115 shall not affect a county's responsibility to comply with chapter NR 116, floodplain management standards.
- (d) The department shall issue a certificate of compliance when a county has, in the opinion of the department, complied with section 59.971, Wis. Stats.

(3) NONCOMPLIANCE. (a) Counties that have regulations that do not meet the minimum rules as contained in section NR 115.03 shall be considered as not complying with the requirements of the water resources act pertaining to shoreland regulations. For these counties to achieve compliance status, they shall modify their regulations to meet the minimum standards within a time limit established by the department.

- (b) Counties that have not drafted shoreland regulations shall be deemed noncomplying counties. They shall state to the department of natural resources their reasons, if any, for failure to comply with the water resources act. The department shall then require the county:
 1. To proceed with regulation formation within a given time period, or;
 2. a. To have the staff of the department of natural resources draft the regulations, or;
b. Contract with a consultant to draft the regulations. All costs for such actions by the department of natural resources shall be borne by the noncomplying county.

NR 115.05 Assistance to counties. To the full extent of its resources, the department of natural resources will provide advice and assistance to the counties, seeking the highest practicable degree of uniformity consistent with the objectives of the shoreland regulation provisions of the water resources act.

APPENDIX M

EXECUTIVE ORDER #67, 1973

Participation by State Agencies in Flood Hazard Evaluation
and Wetland Protection - and Coordination with a Comprehensive
Flood Plain-Shoreland Management Program

The heads of all State agencies shall provide leadership to encourage a broad and unified effort to prevent the uneconomic use and development of the flood plains and wetlands of the State and, in particular, to lessen the risk of flood losses as related to State-owned lands and installations and State-insured or approved or supported improvements and, to ensure consistency of activities with rules and regulations regarding land use and flood plain and shoreland development and management as promulgated by the Department of Natural Resources under provision of Chapter 614, Laws of 1965. Specifically:

1. All State agencies directly responsible for the new construction of State buildings, structures, roads or other facilities shall evaluate existing or potential flood hazards associated with the construction and shall assist and cooperate with the Department of Natural Resources, under provisions of the Water Resources Act, and applicable rules promulgated pursuant to the Act.
2. All State agencies responsible for the administration of State grants, loans, mortgage insurance or other State-approved financing programs involving the construction of buildings, structures, roads or other facilities shall, together with the assistance and cooperation of the Department of Natural Resources, evaluate flood hazards in connection with such facilities and in order to minimize the exposure of facilities to potential flood damage and the need for future expenditures for flood protection and flood disaster relief, shall, as far as practicable, preclude the uneconomic, hazardous or unnecessary use of flood plains in such connection.
3. All State agencies responsible for review and approval of applications for subdivision plats, buildings, structures, roads, sanitary or other facilities, shall evaluate existing or potential flood hazards associated with such activities and shall as may be permitted by law, prevent actions which will expose citizens to unnecessary hazards or cause future public expenditures for flood disaster relief.
4. The Real Estate Examining Board, in order to preclude purchasers of property from unknowingly exposing life and property to flood and erosion hazards, should in license review, suspension and revocation proceedings pursuant to section 452.10(2) of Wisconsin Statutes consider the failure by a real estate broker, salesman or agent to properly inform a potential purchaser that property under consideration lies within an area subject to a flood or lakeshore erosion hazard recognized by the Department of Natural Resources (as determined from Department, regional planning commission, local ordinance, United States Department of Housing and Urban Development, United States Geological Survey, or Army Corps of Engineer's maps, reports or other documents) to constitute a "substantial

misrepresentation", a "false promise of character" or a "demonstrated untrustworthiness or incompetence to act as a broker...or...salesman in such a manner as to safeguard the interests of the public."

5. All State agencies responsible for programs which entail land use planning shall reflect flood and erosion hazards when evaluating and preparing plans and shall encourage land uses appropriate to the degree of hazard involved.
6. The Department of Natural Resources shall compile and distribute to all concerned State agencies a report listing where flood hazard boundary maps compiled from federal, state, regional, local and private sources are available. In consideration of specific projects in areas of known flood hazard where no flood documentation is available, the concerned agency should ask the Department of Natural Resources to make a flood evaluation of the particular case in question. In undertaking these evaluations the Department may require the affected agency to furnish stream cross sectional survey information and base maps in the vicinity of the project site.
7. The Department of Natural Resources and each of the affected State agencies through mutual cooperation, shall as soon as possible, prepare and put into operation administrative guidelines implementing the provisions of this Order. The guidelines should be written to reflect time restraints, manpower, fiscal requirements and other factors relevant to each agency.
8. As may be permitted by law, each agency shall issue appropriate rules and regulations to govern the carrying out of the provisions of this Order.

At the end of seven months a report assessing the implementation of this Order by State agencies shall be prepared by the Department of Natural Resources and forwarded to the Governor.

As used in this Order, the term "State agency" includes any office, department, commission, committee, board, authority or other organizational entity of State government, listed in Chapter 20 of the Wisconsin Statutes, with the exception of "judicial" and "legislative" bodies.

APPENDIX N

CITY OF HIGHLAND PARK, ILLINOIS
BLUFF AND RAVINE STEEP SLOPE ORDINANCE

Section 155.001. Statement of Purpose.

- A. Development Policies. The ravine and coastal steep slopes are an inherent natural resource which imparts a unique and substantial character to the City of Highland Park. It is vital to understand that these steep sloped areas are interdependent throughout their reaches. Erosion, slope failures, and loss of vegetation along one portion of a slope can have a profound impact upon adjacent and subservient sloped areas. Because these areas may be abused to create hazardous building conditions which lead to the jeopardy of life and property and the destruction of the delicate natural ecosystem, appropriate controls are necessary to ensure that construction in these fragile environments enhances rather than detracts from, or ignores, the natural topography, vegetation, and visual quality. Thus, it is the intent of this ordinance to ensure that all development controlled by this ordinance:
1. Strives for maximum preservation of natural features and qualities of steep sloped sites.
 2. Encourages innovative and imaginative building techniques within the criteria stipulated in this ordinance for steep sloped bluff and ravine properties.
 3. Ensures that the land will support new structures for a minimum life span of fifty (50) years, and that construction will not contribute to erosion or slope stabilization problems.
 4. Provides for stable ecological relationships and prevents environmental degradation of the land and Lake Michigan.
 5. Protects people and property from potentially hazardous geological and hydrological conditions peculiar to ravine and bluff areas.
 6. Requires retention of trees and other vegetation which stabilizes slopes, prevents erosion, and enhances the natural beauty.
 7. Facilitates adequate conditions for police, fire, and other emergency service.
 8. Demonstrates a concern for the view of as well as from the bluff and ravine areas.
- B. Sophisticated Technical Standards. All construction proposals shall take into account and be judged by the application of current understanding of landscape planning, soil mechanics, engineering, hydrology, geology, environmental design and architecture. Such current understanding includes but is not limited to:
1. Planning of development to fit the topography, soils, geology, hydrology and other existing conditions on the proposed sites.

2. Orienting development so that grading, excavation, landscaping, terracing and other site preparation is kept to an absolute minimum.
3. Preserving and enhancing the landscape through minimized disruption of natural terrain, and existing plant formations.
4. Minimizing disruption or alteration of natural drainageways.
5. Developing so as to minimize the time in which areas are bare and exposed.
6. Landscaping areas around structures to blend into the natural landscape.

Section 155.010. Application of Ordinance.

- A. Property Regulated. The procedures, standards and requirements contained in this ordinance shall apply to all properties that are within one hundred (100) lineal feet of the top edge of a steep slope.
- B. Mandatory Steep Slope Setbacks. Except as permitted elsewhere within this section the following mandatory development setbacks are established:
 1. No construction or earth moving activity which disturbs the natural grade or removes existing vegetation may occur closer to the ravine bottom than a setback line established twenty (20) lineal feet across the tableland from the top edge of a steep ravine slope. Structures may be cantilevered over this twenty (20) foot setback for a maximum horizontal distance of ten (10) feet beginning at a minimum of nine (9) feet above the natural adjacent tableland grade.
 2. No construction or earth moving activity which disturbs the natural grade or removes existing vegetation may occur closer to the bottom of the bluff than a setback line established fifty (50) lineal feet across the tableland from the top edge of a steep bluff slope. Structures may be cantilevered over this fifty (50) foot setback for a maximum horizontal distance of ten (10) feet beginning at a minimum of nine (9) feet above the natural adjacent tableland grade.
- C. Administrative Setback Exceptions. The following steep slope setback exceptions are permitted as a matter of administrative review by the Director of Community Development:
 1. Accessory Structures. Stair structures, mechanical or electrical lifts, bridges, fences which do not obstruct the flow of light and water, utility service lines, patios on grade extending a maximum of ten (10) feet toward the steep slope from the mandatory setback line, all may be permitted within the mandatory ravine and bluff setbacks and elsewhere on steep slopes as long as they comply with the other conditions of this ordinance and related codes and ordinances.

2. Construction Excavation. This ordinance shall not be interpreted to prohibit excavation within the mandatory setback area, but no closer than ten (10) feet from the top edge of a steep slope, for the purposes of construction otherwise permitted by this ordinance. However, all excavated material must be removed from the mandatory setback area and no material storage, even temporary, may occur within that area.
- D. Discretionary Setback Exceptions. Certain steep slope setback exceptions may be permitted by the City Council upon recommendation of the Plan Commission after formal public hearing. The requirements for such exceptions shall be as follows:
1. Permitted Exceptions.
 - a. Conservation Activities. Work to shore-up, stabilize, fill, or regrade slopes, bluffs, and ravine bottoms when required for purposes of restoration and conservation.
 - b. Unique Situations. Any construction or earth moving activity where the proposed site contains unique features, which are demonstrably different from the general characteristics of other bluff and ravine lots, and which contribute to the stability of the proposed activity. Such unique features may be interpreted to include extra-ordinary engineering efforts far in excess of the minimums required by this ordinance.
 2. Application Fee. Before any action is taken upon any application as provided in this section either by the Plan Commission or the City Council, the applicant shall deposit with the City Clerk the sum of one hundred and fifty dollars (\$150.00), no part of which shall be refundable, to cover the approximate cost of the procedure and the clerk shall then cause the deposit of this amount to the credit of the General Corporate Fund of the City of Highland Park.
 3. Public Hearing Requirements.
 - a. Published Notice. Notice shall be given of the subject time, and place of the hearing not more than thirty (30), nor less than fifteen (15), days before the hearing by publishing a notice thereof at least once in one or more newspapers published in or with a general circulation within the City of Highland Park.
 - b. Personal Notice. Not more than thirty (30), nor less than fifteen (15), days before the hearing the applicant, his agent or attorney, must notify, either in person or by certified mail, the owners of all properties within two hundred and fifty (250) feet of the legal boundaries of the hearing subject site. Such notification shall include a written record of the subject, time, and place of the hearing. Proof of such notification must be presented at the hearing.
 - c. Hearing Procedure. The procedure and administrative requirements of the hearing shall be the same as those adopted by the Plan Commission for all of their public hearings.

4. Burden of Applicant. Applicants for a discretionary setback exception shall bear the burden of establishing conclusively that their proposed project will meet the following criteria:
 - a. Public Welfare. The proposed project must be so designed, located, constructed, and maintained that the public health, safety, and welfare will not be endangered or detrimentally affected.
 - b. Welfare of Nearby Property. The proposed project must not substantially lessen or impede the suitability for permitted use and development of, or be injurious to the use and enjoyment of, or substantially diminish or impair the value of, or be incompatible with, other property in the immediate vicinity.
 - c. Conformance with Development Policies. The proposed project must conform closely with the development policies specified in Section 155.001(A) of this ordinance.
 - d. Conformance with Technical Standards. The proposed project must meet or exceed the technical standards specified in Section 155.001 and Section 155.020 of this ordinance.
5. Additional Regulations. In order to assure that a proposed project will comply with the criteria found in paragraph 4 above, the City Council may require such additional protective regulations as they deem necessary.

APPENDIX O

ADMINISTRATIVE RULES*, MICHIGAN'S SHORELAND
PROTECTION AND MANAGEMENT ACT

R 281.22. High risk erosion areas.

Rule 2. (1) Prior to designation of a high risk erosion area, the department shall mail pre-designation letters to the affected landowners of record as shown in the last assessment rolls. The letter shall explain that the property is being considered for designation as a high risk erosion area and shall invite comments from the affected landowners.

(2) The department shall designate a high risk erosion area upon its finding that bluffline recession has been occurring at an average annual rate of 1.0 foot or greater per year, based on a minimum period of 15 years. The designation shall contain the minimum required setback from the bluffline for any future permanent structure. The setback shall be based on a 30-year period of bluffline recession.

(3) In designating a high risk erosion area, the department shall notify the landowner of record and the local governmental agency affected thereby. The notice of designation shall be delivered personally or sent by certified mail to the landowner of record at the address given in the last assessment roll.

(4) The notice of designation to affected landowners and local governmental agencies shall include all of the following information:

- (a) The authority and reasons for designation of high risk erosion areas.
- (b) A description, graphic or otherwise, of the limits of the high risk erosion area.
- (c) An explanation of any regulatory measures which may be required in the high risk erosion area and the regulatory role of the local governmental agency.
- (d) The procedure by which the designation may be appealed.

(5) The department shall consider additional high risk erosion areas as may be proposed by local governmental agencies, citizens or interested groups.

(6) A regulation may be modified upon presentation of engineering studies acceptable to the department documenting annual recession rates at variance with department recession rate data. Upon department acceptance of the data as accurate and compatible with the objectives of the act, a structure setback from the bluffline shall be calculated and implemented based on the new recession rate information.

(7) In the absence of an approved local ordinance enacted pursuant to sections 7, 8, 9, and 10 of the act, any person or local governmental agency proposing to erect, install, or move a permanent structure on a parcel, any portion of which is a designated high risk erosion area, shall submit to the

* Modified and Amended August,
1978

department for its approval a permit application. The permit application shall contain all of the following information:

- (a) A legal description of the property.
- (b) A description of the proposed permanent structure.
- (c) A sketch of the proposed site, showing the location of the proposed permanent structure in relation to the location of the bluffline.
- (d) The signature and address of the applicant.

(8) A permit application in a designated high risk erosion area shall be approved if the proposed permanent structure meets or exceeds the minimum setback requirements established by the department.

(9) If a parcel which has been established prior to the high risk erosion area designation does not have adequate depth to provide the minimum required setback from the bluffline for a permanent structure, a permanent structure, which can be moved prior to damage from erosion, may be allowed by a special exception. A special exception shall be granted only if criteria (a) and (b) and either (c) or (d) of this subrule are met:

- (a) If a sanitary sewer is not used, the septic system shall be located on the landward side of the permanent structure.
- (b) The permanent structure shall be located as far landward of the bluffline as local zoning restrictions allow:
- (c) The permanent structure is designed and constructed to be moveable and in all instances, except a mobile home, shall meet the following minimum standards:
 - (i) The permanent structure, excluding the septic system, shall be erected on a full basement foundation constructed of concrete blocks.
 - (ii) The permanent structure, excluding the septic system, shall be square or rectangular with no wall to wall length in excess of 60 feet.
 - (iii) The permanent structure, excluding the septic system, shall not exceed a wall to wall width of 26 feet.
 - (iv) The permanent structure shall not exceed a height of 24 feet from bottom of floor joist to peak of roof or top of chimney, whichever is higher.
 - (v) Floor joists shall be one size larger than the local standard code requirement.
 - (vi) The bottom of the floor joists shall be a minimum of 16 inches above the grade of the terrain.
 - (vii) All chimney and fireplace construction shall have a concrete block foundation.

(viii) Ingress and egress to the permanent structure shall be of sufficient width and acceptable grade to allow the moving of the permanent structure from the parcel.

(d) A department approved erosion control device is constructed and maintained by a state, county, municipal or township government.

(10) Not more than 60 days after receipt of a permit application, the department shall send by certified mail to the applicant a notice of its approval or disapproval. In case of disapproval, the reasons therefore shall be stated.

(11) Approval of a permit does not exempt the applicant from complying with other statutes, ordinances and regulations.

(12) Any aggrieved party that contests the designation of a high risk erosion area or the disapproval of a permit application shall be granted a hearing if a petition is filed with the department not more than 60 days after the designation letter or the notice of disapproval is sent. The hearing shall be conducted in accordance with the provisions for contested cases in Act No. 306 of the Public Acts of 1969, as amended, being 24.271 et seq. of the Michigan Compiled Laws and R299.3071 to R299.3081 of the Michigan Administrative Code.

(13) The landowner of record and the local governmental agency shall be sent a notice by certified mail if the high risk erosion area designation is removed.

(14) All high risk erosion area designations in existence at the effective date of these rules shall remain in full force and effect.

R 281.25. Zoning ordinances.

Rule 5. (1) After the date on which the department designates a high risk erosion area, environmental area, or flood risk area, a local governmental agency may enact, and thereafter enforce, a zoning ordinance approved by the department, pursuant to sections 7, 8, 9, and 10 of the act.

(2) Not more than 30 days after a zoning ordinance or amendment thereto has been submitted by a local governmental agency pursuant to section 10 of the act, the department shall notify the local governmental agency in writing of its approval or disapproval. The zoning ordinance or amendment shall be approved by the department if it adequately enforces the provisions of the act and it shall take effect upon receipt by the local governmental agency of the department approval. At that time the existing state permit requirements as specified in subrules 2(7), 3(9), and 4(4) of these rules shall be discontinued.

(3) All amendments to approved local ordinances affecting high risk erosion areas, flood risk areas, and environmental areas shall be submitted to the department for review and approval in the same manner and subject to the same requirements as specified for original ordinances regulating shoreland areas in this rule.

(4) All variances relating to high risk erosion areas, flood risk areas, and environmental areas shall be submitted to the department.

(5) Any aggrieved party that contests the disapproval of a zoning ordinance or amendment to an ordinance by the department, shall be granted a hearing if a petition is filed with the department within 60 days after the notice of disapproval is received. The hearing shall be conducted in accordance with the provisions for contested cases in Act No. 306 of the Public Acts of 1969, as amended, and in R299.3071 to R299.3081 of the Michigan Administrative Code.

(6) Failure of a local governmental agency to properly administer an approved ordinance in a manner consistent with Act No. 245 of the Public Acts of 1970, as amended, shall result in the rescinding of approval of the ordinance by the department, and the reinstatement of the state permit requirements as specified in subrules 2(7), 3(9), and 4(4) of these rules.

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