EROSION HAZARD AREAS:
AN ALTERNATIVE FOR SHORE MANAGEMENT

Prepared by:
Carol J. Schultz

Wisconsin Geological and Natural History Survey
and
University of Wisconsin Sea Grant College Program

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I. INTRODUCTION

Erosion along the Great Lakes shoreline has received an increasing amount of attention in recent years, especially through the efforts of the Wisconsin Coastal Management Program, the Wisconsin Department of Natural Resources, the Wisconsin Geological and Natural History Survey, and the University of Wisconsin Sea Grant College Program. In an attempt to improve Wisconsin's capability to deal effectively with shore erosion problems, these agencies have collected extensive technical data to build an information base for shoreline decision making. To supplement these efforts, a state shore erosion policy plan has been developed to guide future shore management.

This report, Erosion Hazard Areas: An Alternative for Shore Management, focuses on one aspect of the shore erosion plan, use of non-structural approaches to erosion damage reduction. In particular, it outlines procedures for establishing and administering Erosion Hazard Areas (EHAs). Delineation and management of EHAs can provide a number of options for lessening the effects of shore erosion at the local level. This report is intended to increase public awareness of these options as they exist under current statutory authority and to encourage their application in Wisconsin coastal communities.

II. NATURE OF THE SHORE EROSION HAZARD

A. Shore Erosion Defined

The natural phenomenon of shore erosion has been defined as "the set of processes by which more shore material (i.e., sand, rock, other sediments) is removed than deposited". (Natural Hazard Management in Coastal Areas, p.II-25) Four natural agents of erosion act on shoreline material: waves, mass wasting, surface water runoff, and ice. (Feasibility of Compensation for Man-Induced Shore Erosion: Relation of Human Activities to Shore Erosion, pp.1 ff.) Along the Great Lakes shoreline two types of erosion characteristically occur: 1) upper bluff erosion due to non-wave related causes; 2) bluff toe and beach erosion as a result of wave action.

The rate of upper bluff erosion may be influenced by natural or human-induced factors. Natural factors like bluff height and angle or resistance of bluff material directly affect erodibility. In addition, the stability of the bluff will be influenced by human-induced factors like increased water runoff due to vegetation removal or loading by structures on the bluff top. Because land usage in upland areas directly affects upper bluff erodibility, this type of erosion responds to land management practices aimed at lessening the impact of construction and development.

In general, wave-induced erosion affects the shoreline through removal and transport of shore materials and is most severe during storm events and periods of high water. While regulation or restriction of shore uses can lessen the damages to property and buildings caused by this type of erosion, reducing the actual amount of erosion

that occurs depends on construction of shore protection structures. In coping with shore erosion it is important to remember that its causes and effects differ and respond to different techniques for damage reduction.

B. Shore Erosion Damages

Erosion damage figures for the Great Lakes shoreline have been estimated for two recent periods of high water levels. According to an Army Corps of Engineers survey the total estimate during the 1951-52 period was $61 million, or approximately $168 million in 1973 dollars. Revised estimates for the total damage during 1972-74 were somewhat less than the originally estimated $400 million, but still a significant increase from the early 1950's. (Erosion/Insurance Study, p.6)

Wisconsin alone has lost over two square miles of land to shore erosion since 1900. Along the Lake Michigan shoreline of Wisconsin long-term recession rates of 2-12 feet per year have been recorded for sand plains and of 2-4 feet per year for high bluffs. Recession rates of 2-5 feet annually are common along many erosion-prone reaches of the Lake Superior shoreline. (Wisconsin's Shore Erosion Plan, p.1)

Preliminary damage estimates from a study conducted by the Wisconsin Department of Natural Resources for the Army Corps of Engineers produced the following figures for the high water period of 1972-76. These totals include the results of previous pilot studies done in Brown, Douglas, and Racine counties as well.

	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	1,124,000	30,000
Total	$15,133,000	$ 804,500

(Summary of Great Lakes Flood and Erosion Damages, Labor Day 1972-Labor Day 1976: Preliminary Draft)

In economic terms erosion damages have been costly. If the social costs of the disruption that erosion causes in the lives of shore property owners could be calculated, the figures would be even higher. And, although these studies have concentrated on high water periods, shore erosion is a continuing process and its effects are felt even after a period of crisis has passed.

C. Need for Concern

Coastal communities have an important stake in finding solutions to shore erosion problems. Several reasons for concern are especially important: 1) to reduce economic costs due to erosion damages; 2) to protect public health, safety, and welfare; 3) to develop effective shoreline management.

1) Reducing erosion damages to private and public property benefits the community by maintaining its economic base for development and taxation and protecting its investments. Structures placed on private property lose their value rapidly when threatened by erosion, and land

lost to the erosion process is simply not available for any type of use. In many areas shore property has a higher market value and assessment than neighboring inland properties due in part to its location and its aesthetic and recreational benefits, making the economic losses even more significant. Expensive public investments, such as power plants, transportation corridors, and communication systems, may be threatened as well. Repair or replacement of these types of facilities is costly for the community and to be avoided if possible.

2) Protecting public health, safety, and welfare is a primary responsibility of all government. Shore erosion may create specific problems which should be guarded against. Septic systems may fail due to bluff recession, buildings may be abandoned and become delapidated when threatened by a receding bluff, or transportation and communication systems may be disrupted because of massive erosion. In the first two cases the impacts are primarily individual, affecting relatively few property owners. Disruption of transportation or communication, however, could have an adverse effect on the community, possibly cutting it off from other necessary services like fire protection or medical care. The public interest would be well served if these or similar situations were prevented.

3) Developing effective shoreline management is a complex task, mandated by federal and state legislation. In general terms shore management means planning and carrying out optimal uses of the shoreline area both for the present and the future, with a focus on preserving and enhancing its usefulness and beauty. Within that framework, management encompasses a variety of tasks: increasing public

awareness of natural shoreline processes and of human impact on the shore; controlling non-point source pollution and sedimentation; protecting structures and natural environments; and guiding community development and construction so its negative impacts on the shore are minimal. Erosion control and damage reduction are key aspects in setting up an effective shoreline management program.

D. Dealing with Shore Erosion

Approaches to dealing with the effects of shoreline erosion can be categorized as remedial or preventive. Remedial solutions are aimed at slowing down the erosion process, and they focus on the construction of shore protection devices. While remedial techniques can and should be applied in circumstances where valuable property can be protected in no other way, they present problems as well. Structural devices are expensive to construct, sometimes exceeding the cost of potential erosion damages, as a study of the Canadian Great Lakes shoreline demonstrates. (Canada/Ontario Great Lakes Shore Damage Survey, pp.51, 96) Constructing the most durable and effective shore protection depends on having an engineering analysis of the shoreline. Land-water interactions along the shore are complex, and disrupting them in one area may have a negative impact on another area. Since it is not always feasible to utilize remedial measures to reduce erosion damages, it becomes advisable to have preventive options available.

Preventive, i.e., non-structural, approaches concentrate on reducing erosion-caused damages primarily through shoreline management and guidance of land use activities. Rather than trying to stop

the natural process of erosion, these approaches attempt to lessen its impact on people and property through forethought and planning. Techniques like maintaining a hazard information system, establishing construction setbacks from the shore, or zoning to restrict the uses of erosion-prone areas are potentially useful preventive strategies. If the critical issue is the proximity of people and their possessions to an erosion-threatened area, a sensible solution is to forestall the problem through management strategies which help people avoid hazardous situations as much as possible.

E. Erosion Hazard Areas (EHAs)

In an effort to minimize the effects of other types of natural hazards, communities have utilized the preventive technique of delineating and managing the hazard-prone areas. Attention has been focused on a number of hazards, including floods, landslides, earthquakes and avalanches. In each case the analysis is similar:

1) Delineate the areas potentially affected by extreme natural events;
2) Estimate the benefits derived from use of resources in vulnerable areas as well as the risk of possible loss due to human occupation of those areas;
3) Identify the range of possible adjustments to the hazard;
4) Assess the present and future impacts of adjustments being made, remembering that over time or distance a beneficial action may produce negative effects;
5) Recognize that protecting an area from more frequent, less severe events may encourage its use in a way that will produce disastrous damages from the rare, severe events. (Natural

Hazard Management in Coastal Areas, p.i-2)

This technique could be used to further efforts toward erosion damage reduction along the Great Lakes shoreline. An Erosion Hazard Area (EHA) could be established in a community to designate any areas of the shoreline that are threatened by severe erosion damages. This EHA would consist of a geographic area including the immediate shoreline which is subject to erosion and adjacent impacted property. It could be identified by lines on a map and specific property descriptions. Figure 1 illustrates an EHA. EHA delineation focuses attention on a hazard area, encourages planning for shore erosion problems before they reach serious proportions, and provides a legitimate geographic framework for establishing and implementing preventive solutions to shore erosion problems.

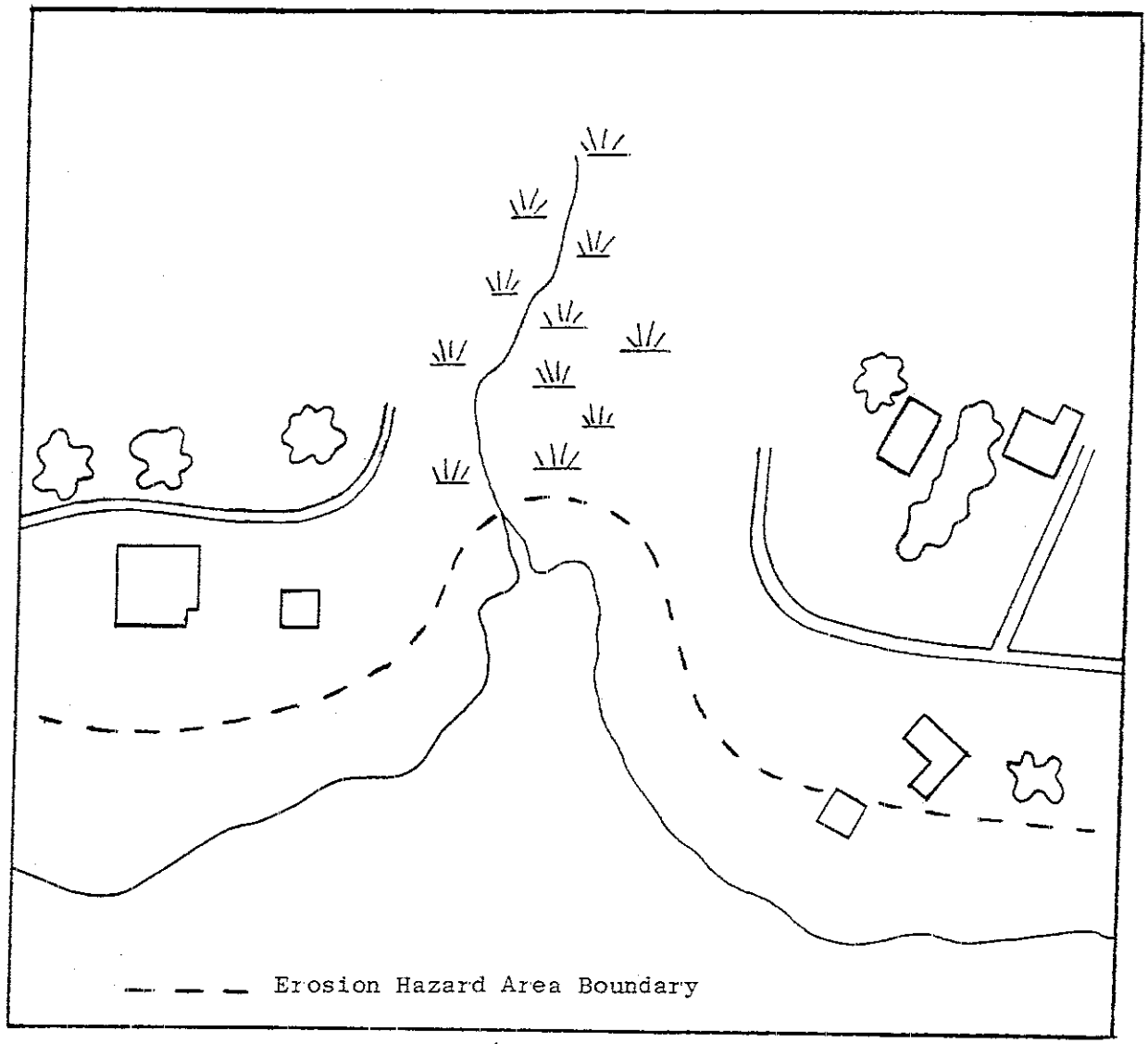


FIGURE 1

After an EHA is delineated, a number of management techniques can be applied, ranging from simply recognizing the existence of the erosion hazard to strictly regulating the land uses within the area. The institutional framework within which this delineation procedure might operate is not fixed. Several alternatives are possible: 1) direct action at the state level; 2) a state-local government partnership; 3) complete control and administration by the local government.

1) Under this alternative it would be possible for a state agency, in response to a legislative mandate, to directly delineate EHAs and set regulations for their management. The state of Michigan did this in 1970 as part of its Shorelands Protection and Management Act. Under the act the state Department of Natural Resources designated the boundaries of high risk erosion areas and set recommended shore use restrictions, based on a 30-year mortgage lifespan. Local zoning ordinances were required to be in accordance with state standards, or individual proposals for development had to be submitted to a state permit procedure. This legislation has provided the framework for utilizing shoreline recession rates and establishing construction setbacks to protect buildings from erosion damage. (Erosion, pp.1,4)

2) A state-local partnership could be formed which would rely on local adoption and administration of state guidelines. Wisconsin shoreland and floodplain zoning legislation provides a model for this alternative. Under these laws local units of government were required to adopt zoning ordinances for specifically defined areas in accordance with state standards. Once this was accomplished, the local government was responsible for

administration of the ordinances. Under this alternative the impetus for action comes from the state level, but the actual implementation takes place at the local government level.

3) Local units of government could utilize their existing authority to take independent action to delineate and administer EHAs within their own jurisdictions. In Wisconsin local governments have the power to plan, zone, levy taxes, pass ordinances, and enforce the accompanying regulations. This power could be readily extended to the management of EHAs with no state level involvement. The local government would have complete control over the EHA delineation and administration process as long as its actions did not conflict with pre-existing laws and regulations.

Administering EHAs occurs in two phases: 1) delineation of physical boundaries based on technical data and risk assessment; 2) selection and administration of management strategies for the EHA. The following sections of this report will examine each of these phases in turn.

III. EROSION HAZARD AREAS: DELINEATION

A. Delineation Defined

Delineation of EHAs is generally based on two procedures: technical data gathering and risk assessment. Technical data are required to provide detailed information about shoreline conditions so EHAs can be accurately and consistently determined. Before a decision can be made on whether or not a shoreline area fits the criteria for an EHA, data about the erosion rate and the geologic and hydrologic conditions must be available. In addition, these data will help determine the selection criteria by presenting an overall view of shoreline conditions to which a particular area can be compared.

The technical data used to delineate EHAs are closely linked to the management of these areas as well. Management techniques chosen for an EHA will indicate the types of data that are necessary to substantiate their choice. The more restrictive the regulation will be, the more accurate and detailed the data should be. If, for example, a community wants to restrict construction of buildings along the shoreline through a setback requirement based on the recession rate, it will be necessary to have reliable recession rate data. On the other hand, the types and technical quality of the data available may determine the delineation and management choices which can logically be made. For instance, it would be unreasonable to try to enforce strict development controls in an area which had been evaluated on the basis of non-quantitative observations only. If challenged, such controls would be open to charges of arbitrariness because they have no basis in documented and measured data.

The technical data base also provides the necessary information for assessing the degree of risk involved along an area of shoreline. Risk becomes a factor in evaluating a shoreline erosion hazard when the erosion begins to impact human lives and property. In assessing erosion-related risk it is important to understand the unique features of the erosion hazard. Shore erosion is a deterministic process. Unless conditions are altered, an area that is eroding will continue to erode although the rate may vary over time. Unlike flooding or other periodic hazards, erosion does not lend itself to probability statements. It is possible, for example, to determine that a bluff is unstable and subject to massive slumping yet be unable to predict when that slumping will take place. Large-scale erosion occurs episodically rather than periodically. Storms and periods of high water affect the relationship between lake level, wave action, and wind and may alter the episodic intervals. To further complicate erosion risk assessment, historic records are too sketchy to permit accurate predictions of storms, high water levels, or amounts of shore erosion during a particular time period.

Determining the risk of erosion-related damages for any shoreline area should take into consideration the factors of time, distance, and use. Time has both a present and a future aspect to be considered. The timing of large-scale erosion is unpredictable, and a present hazard could increase or decrease substantially in the future, affecting the types of compensating measures that would be appropriate. If, for example, the future possibility of sudden, massive erosion is known to exist, should the community and property owners plan their use of that area with the worst future scenario in mind? If so, what

does that mean in terms of present use of the shoreline? Are all uses restricted or only certain ones?

Distance from the shoreline is important because the most immediate threat from erosion is to the area directly adjacent to the shore. Further inland the hazard lessens and becomes of no significance to property owners who do not feel any of the direct impacts of erosion. Setting an appropriate landward boundary for an EHA or establishing adequate setbacks within it are directly related to the distance between the hazard-prone area and the desired use. Defining "appropriate" and "adequate" will require an additional determination of the degree of risk that is acceptable and the amount of damage that can be tolerated.

Use is vital because certain land use practices, like removing blufftop vegetation, can accelerate erosion. Other management practices, like proper drainage of blufftops, can act to stabilize the situation. On the other hand, the severity of the erosion threat will influence the choice of land uses in an erosion-prone area. The more severe the problem, the more concern there is apt to be with preventing damage to expensive investments by locating them outside the hazard area whenever possible.

Taking all of these factors into consideration still does not answer the specific question of which types and amounts of erosion damage can be tolerated and which constitute a hazard. The problem arises of establishing guidelines for consistently evaluating erosion-prone areas, and each coastal community will want to be able to exercise flexibility in setting standards for itself. Depending on the actual or proposed uses of a shoreline, what appears to be an acceptable level of erosion in one area or at one time may be unacceptable

in another. The assessment of risk will vary from one area to another depending on shoreline conditions and from community to community depending on the outcome of their measurements and evaluations.

B. Data Gathering

There are three commonly used methods for gathering technical shoreline data: comparison of historical land surveys; evaluation of aerial photography; and direct observation through ground surveys. All of these techniques establish a basis for determining recession/accession rates and, in addition, ground surveys provide specific on-site information about conditions apt to cause massive erosion or bluff failures. Details of the procedures for applying these techniques are provided in the Technical and Management Information Sources referenced in the Appendices. Two basic types of measures can be derived from these methods: a qualitative appraisal of the shoreline, providing a general impression of where and how rapidly it is eroding; and a quantitative analysis of recession/accession rates for the shoreline. The qualitative approach relies primarly on data derived from observation and historical records, and it does not attempt to accurately measure actual rates of change. Instead it aims to create a reasonable impression of shoreline conditions by noting features like the presence and condition of shore protection devices, the angle and height of a bluff, and the presence or absence of vegetative ground cover. As a result, this method does not require a high degree of technical expertise or unusual staffing or budgeting provisions. It is most aptly applied to delineating an EHA that will have minimal regulation or to initially delineating a temporary EHA boundary before more technical and detailed

data are available.

When Michigan surveyed its shoreline between 1971-74 in order to record erosion data, investigators classified the shoreline according to a number of features, including vegetation removal, bank slumping, and damaged land structures. These field surveys showed which areas were subject to serious erosion, and any length of shoreline bluff receding at a long-term rate of one foot or more per year was classified as a High Risk Erosion Area. (Erosion, pp.5-6) This classification was, however, considered preliminary until recession rate studies could confirm it.

A quantitative measurement of recession/accession rates relies on fairly sophisticated procedures and analysis, requiring technical expertise and specialized equipment. Measurements of the amount of erosion or accretion are made at intervals along the shoreline and generalized to the areas between these sites. These calculations can then be compared to others made at different times and these can be averaged over the period of years for which records are available. This type of evaluation provides an average annual rate which estimates how much the shoreline is changing in terms of a quantifiable distance. The capability of this procedure to accurately reflect the actual shoreline situation depends on the truth of two assumptions: 1) the sites chosen are representative of the adjoining shoreline areas to which their measurements are generalized and will produce an average measurement for these areas rather than an especially high or low figure; 2) averaging the measurements over a period of years implies that the amount of erosion at a particular site will be nearly constant from year to year. Neither of these assumptions is valid at all times or

for all areas. The sites chosen for study may be subject to higher or lower rates of change than the adjacent areas, and this may not be discovered even if the interval distances are relatively short. The process of averaging measurements over a period of years tends to downplay the impact of large-scale erosion, especially when the averaging is done over long periods of time. Consequently, average annual rates should be evaluated carefully when they are used as a basis for shoreline management decision-making.

C. Boundary Determination

Deciding whether or not a particular shoreline area should be included in an EHA depends on two evaluations related to the risk involved: the amount of erosion that is unacceptable by community standards and the placement of the landward boundary that marks the depth of the EHA. Annual recession rates are useful as a standard for erosion hazard determination. For example, any shoreline with a recession rate exceeding a pre-determined maximum may be judged to involve too great a risk and therefore by included in an EHA. Michigan has chosen 1 foot per year as its maximum rate, and Illinois utilizes .5 foot per year because of the highly developed nature of its shoreline. Both are reasonable models and can be modified to meet local needs and conditions.

The landward boundary that is selected will reflect the impact of the water on the land as erosion progresses and the impact of land use and management on the rate at which erosion proceeds. A rapid rate of erosion will mean a high degree of risk to property located a greater distance from the shore. Consequently, both the rate of

erosion and the presence of any natural features apt to accelerate it will influence the location of the landward boundary. On the other hand, land use practices may increase or decrease the rate of erosion and, as a result, the boundary may include all areas which impact on shoreline erosion.

Determining the landward boundary of the EHA can be done in different ways, using previously drawn boundaries or establishing new ones. Existing boundaries which might be useful are landward property lines of the first tier of shoreline lots or the boundary of the shoreland zone established by statute. In Illinois the designation of coastal zone boundaries presents an analogous procedure which could be adapted to delineation. Included in that coastal zone are coastal waters within the jurisdiction of the state of Illinois, shorelands strongly affected by coastal waters, and Geographic Areas of Particular Concern (GAPCs). Coastal lands and facilities under federal government jurisdiction are excluded. The recommended landward boundary corresponds to the most inland of the following:

> The first platted property line or continuous major transportation right-of-way inland of the 100 year Lake Michigan flood plains; or the inland extent of any GAPC and of the 100 Year Flood-Induced High Risk Erosion Hazard Area. (Illinois Coastal Zone Management Program: Preliminary Draft, p.51)

Establishing new boundaries unique to the EHA requires careful evaluation of the purpose of the district and determination of a reasonable boundary in that context. The width of the EHA can be chosen in relation to the degree of regulation and restriction which

will be used to manage the area. For example, it is more reasonable to employ strict regulations along a narrow strip of shoreline in order to provide maximum protection with a minimum of disturbance to property owners. Likewise, a deeper EHA may be associated with less restrictive management. Alternatives include drawing a boundary line at a designated uniform distance from the bluff crest or determining the boundary based on the recession rate and a multiplier factor. The first approach may have a qualitative rather than a quantitative orientation based on knowledge of shoreline features. Setting a uniform distance has the advantage of being straightforward and simple to administer, however, it could be subject to criticism on the basis of being arbitrary or unrelated to shoreline conditions. Consequently, it would be advisable to clearly articulate the reasons for choosing this alternative. As an example of this approach, the city of Highland Park, Illinois, has proposed an ordinance which regulates all properties within 100 lineal feet of the top edge of steep slope. (Draft: Bluff and Ravine Steep Slope Ordinance, p.5)

Determining a landward boundary on the basis of the recession rate and a multiplier factor has the advantage of linking the boundary directly to shoreline conditions. For example, if the recession rate were calculated at 1.5 feet per year and the multiplier factor were 100, the inland boundary would be 150 feet away from the existing bluffline. This could be interpreted to mean that the boundary represents the predicted 100 year recession. (Some Non-Structural Alternatives for the Reduction of Shore Damages, p.4) The 100 year erosion limit for the Ontario, Canada shoreline was established by extending the average annual recession rate multiplied by 100 years inland from

the edge of the bluff, with an additional distance added on for a stable slope. Figure 2 illustrates this designation. Only rates referenced to the bluff edge were used. Data referenced to the water edge or high water mark were not used because water level variations and seasonal beach changes make them difficult to interpret, and they do not show the changes in the bluff face. (A Guide for the Use of Canada/ Ontario Great Lakes Flood and Erosion Prone Area Mapping, p.16)

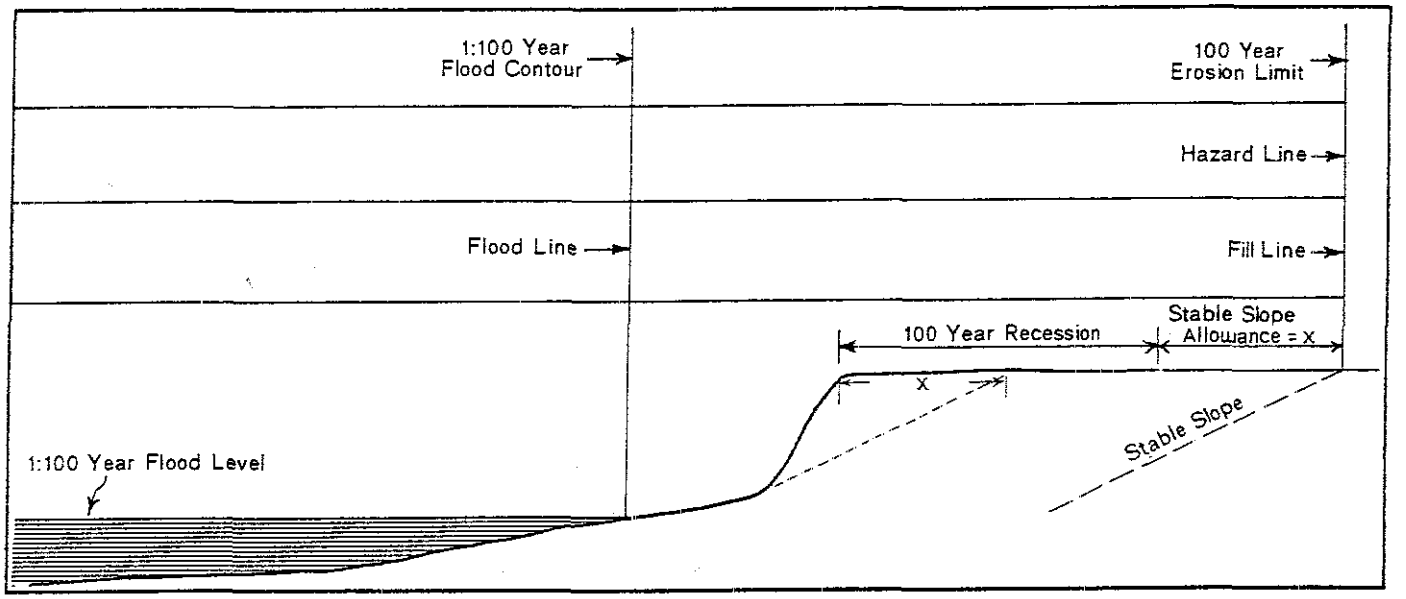


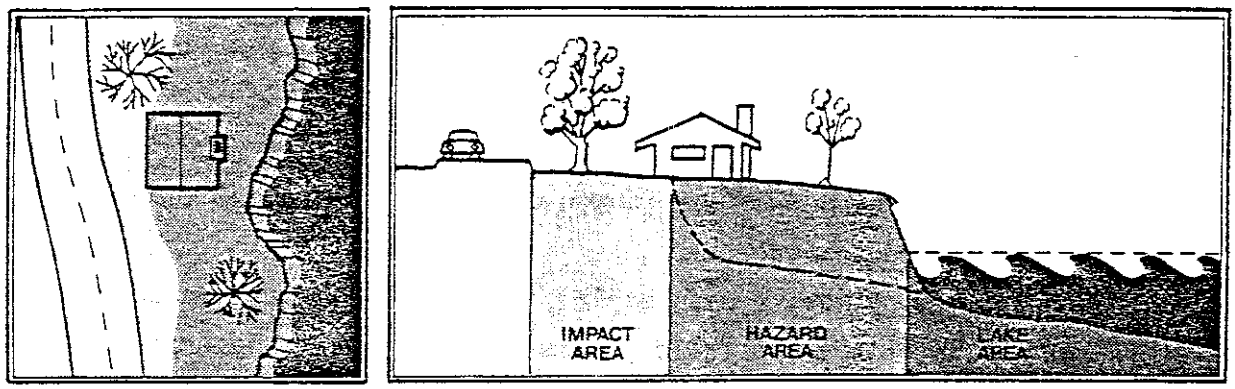
FIGURE 2

(Source: A Guide for the Use of Canada/Ontario Great Lakes Flood and Erosion Prone Area Mapping)

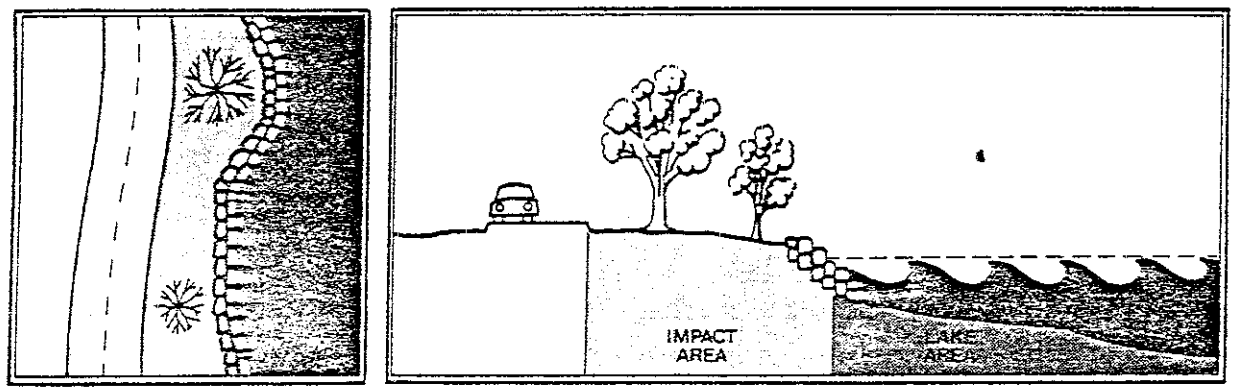
More than one landward boundary may be drawn, in recognition of the fact that erosion-related impacts decrease further inland from the shoreline. The problems caused by erosion-induced property damage are less severe or non-existent away from the shoreline, and the effect of land use and management techniques on the rate of erosion is diminished. Dividing the EHA into tiers along several boundaries provides flexibility by allowing for varying types of management strategies and degrees of restriction in each tier. For example, the immediate erosion-prone area might be delineated on the basis of the recession rate multiplied by a pre-determined number of years, and an inland impact zone might be designated bounded by property lines or another reasonable boundary. Having two zones would permit the use of restrictive regulations in the first, more seriously threatened tier in order to offer maximum protection from erosion damage. Further development might be prohibited altogether. The second, less endangered tier could be managed less restrictively while still recognizing the impact that the use of that area could have on the rate of erosion. Regulations might include provision for protecting vegetative ground cover or controlling surface water runoff. In addition, the second tier might well become part of the first tier as erosion progresses. Beginning to manage it now will set the stage for later, more restrictive management and, if properly done, will slow the erosion rate.

Illinois has followed this type of procedure in its coastal management program by establishing Hazard Areas and Impact Areas. Figure 3 illustrates this type of delineation. The Hazard Areas are defined as the landward extent of the 100 year bluff recession rate and also include the 100 year floodplain inundated by sheltered coastal waters.

Impact Area boundaries correspond to the Coastal Zone Boundary, which is generally the landward property line of properties directly adjacent to coastal waters. In each type of area the state and municipalities have differing and well-defined responsibilities. (Illinois Coastal Management Program: Preliminary Draft, pp. 88-89)



Eroding Bluff



Armored Shore

FIGURE 3

(Source: Illinois Coastal Zone Management Program: Preliminary Draft)

A further consideration, and one which presents some difficulties, is whether or not to periodically move the landward boundary as the shore erodes, maintaining a relatively constant depth at any point in

the district. This would require re-assessment at intervals to determine whether or not conditions had changed, better data had become available, or protective shoreline structures had either been built or had failed. Changing a boundary by a few feet or reviewing it every few years would be administratively cumbersome. Therefore, if periodic re-assessment is adopted, decisions about frequency and distance must be made and reasonable criteria set. And if a boundary is moved inland after such a review, questions will arise about how to treat the newly included area which may have existing uses that are restricted in the EHA. On the other hand, to never review the boundary is to ignore the fact that the shore is a dynamic environment, reacting to alterations in man-made and natural conditions. Consequently, it would be wise to re-assess both the shore situation and the EHA boundary at reasonable intervals, keeping in mind the administrative questions that will arise.

IV. EROSION HAZARD AREAS: MANAGEMENT

A. Selection of Management Strategies

Because the EHA is a flexible concept which can be applied to meet specific circumstances and needs, its purposes should be in keeping with the goals of each community. Specifying the purposes for establishing an EHA is as important when selecting appropriate management strategies as it is when delineating the boundaries of the area. If, for example, the local government rarely utilizes conditional use permits, it would make little sense to try to regulate land use in an EHA through a case-by-case permitting procedure. From a broader perspective, the community must determine whether or not to apply any use regulations to its EHA and, if so, what they will be. Having clearly-defined purposes for its EHA will provide the local government with a basis for later evaluation of the chosen management strategies and of the success or failure of the EHA to meet the needs of the community.

Management strategies for EHAs can be divided into two basic categories, regulatory and non-regulatory. Regulatory methods are those which are mandated by law or rule and which require that certain standards be complied with. Non-regulatory techniques are programs which rely on voluntary compliance to achieve their ends. Both regulatory and non-regulatory strategies can be applied effectively in undeveloped or developing areas. Highly developed areas present a special situation because it is difficult to impose restrictive regulations in an area already developed under other requirements. Non-regulatory strategies can, however, be utilized advantageously, and restrictions

may be placed on areas being redeveloped. In addition, various combinations of regulatory and non-regulatory techniques are possible whatever the stage of development.

B. Regulatory Strategies

The most common regulatory management strategies applicable to EHAs are: 1) zoning and subdivision ordinances; 2) building codes; 3) situation-specific ordinances. Each of these strategies has more than one possible application to EHA management.

1) Zoning and subdivision ordinances

Since the decision in Euclid v. Ambler Realty Co. (1926) zoning has been recognized as a fundamental land use management technique. Incorporated communities have the legal capability to effectively manage their coastal areas. The Wisconsin Statutes grant counties, municipalities, towns, and villages varying degrees of authority to regulate land use. In other states as well, general zoning ordinances may establish use districts as well as bulk, height, and placement of structures. Land subdivision ordinances generally require accurate surveying and mapping according to pre-determined standards, and they may prohibit the subdivision of land subject to extreme hazard conditions unless such danger can be overcome by use of compensating techniques like building setbacks or special construction methods. These powers are broad enough to govern land usage within EHAs. Because zoning can specify what uses will be permitted, designate where various activities may be conducted, and establish standards, it has been the traditionally preferred tool for regulating land use where hazard zones can be delineated. In Little Cottonwood Canyon, Utah, for example,

a natural hazards zoning ordinance was adopted in 1973, prohibiting construction of permanent structures in areas subject to hazards such as floods, landslides, and avalanches. (Land Use Management and Regulation in Hazardous Areas: A Research Assessment, p. 70)

An EHA might be incorporated into the zoning code as a particular use district similar to standard residential or commercial districts. Or it might be treated as an overlay district which would carry certain regulations in addition to those already existing in the district which is being overlaid. Floodplain districts and Planned Unit Developments operate on this principle. A variation on hazard district regulation through zoning is the idea of graduated use zones which impose more severe restrictions in more hazardous areas. Warrick, Rhode Island, identifies "areas of extreme hurricane danger" which have few permitted uses and "areas of hurricane danger" which allow a wide range of structures that meet first floor minimum elevation requirements. (Land Use Management and Regulation in Hazardous Areas: A Research Assessment, p.71)

In any of these cases, an EHA would be regulated according to the same administrative procedures which the local government has established for zoning and subdivision management. Only the specific requirements for EHA management would be different.

Examples of the regulatory strategies being used in Wisconsin counties and municipalities to accommodate special shoreland and coastal conditions illustrate possible EHA management techniques. Although these regulations are not linked to the establishment of EHAs, the principles are, nonetheless, transferable. In Marinette County a 150 foot setback (twice the usual shoreland setback) has

been established along several lakes and rigorous tree-cutting restrictions have been adopted. Racine County likewise has set tighter restrictions for setbacks and tree-cutting than are required by state shoreland and floodplain regulations. Its shoreland and floodplain provisions have been included in its comprehensive zoning ordinance, providing a simplified approach without duplication of regulations. (Capabilities of County Land Regulation Programs in the Wisconsin Coastal Area, pp. 12,17)

All of Wisconsin's 33 coastal cities have zoning ordinances, and only two villages do not have zoning codes, therefore, 96% of the incorporated shoreline has zoning. Twenty-five of the coastal municipalities have also adopted subdivision ordinances. Approximately one-half of the municipalities use non-districted rules like tree-cutting and landscaping regulations, required setbacks from navigable waters, or construction and filling restrictions. In addition to these typical applications of zoning and subdivision authority, several municipalities have enacted special types of use districts along the Great Lakes shoreline. Mequon, Whitefish Bay, and Shorewood have placed most of their coastal land into Lake Shore or Lake Estate districts, requiring larger than average lot sizes. Washburn has established Public and Semi-Public districts allowing the city to reserve those areas and their possible uses until the most appropriate uses of the land have been determined. Cudahy has a Park Land district and Bayside has a Nature Center district, each designed to protect unique natural areas. Sheboygan, Manitowoc, and Sister Bay have utilized their subdivision ordinances to specifically require dedication of shoreland for the purpose of providing access to the Great

Lakes. (Land Use and Coastal Management in Wisconsin Coastal Municipalities, pp. 29-31) These special applications of zoning and subdivision powers provide a precedent for districting to accommodate the special problems posed by erosion and serve as examples of the types of regulatory actions which may be taken under existing local government authority.

If the option of regulating land uses within an EHA through zoning and subdivision ordinances is chosen, the local government has several choices in deciding how stringently to restrict uses within the district. The range of choices includes, but is not limited to: a) prohibition of all human-related uses; b) limitation to open space or recreational uses; c) provision for conditional uses upon review; d) establishment of special criteria or performance standards.

a) Prohibition of all human-related uses

This alternative requires a careful evaluation of the shoreline situation and would not be feasible in an already developed area. It would be justified only in extreme circumstances when protection of the area from any human encroachment was necessary because of the existence of a unique or fragile resource. If this situation arose on privately owned property the local government would be well-advised to consider acquiring the land or its development rights in order to avoid the issue of taking without compensation.

b) Limitation to open space or recreational uses

This option might accomplish two ends, increasing the amount of public and private recreational land available to the residents of the community and protecting the area from the negative effects

of more intensive development. If the community chooses to acquire the land or the development rights to it, the EHA could be incorporated into the overall plan of development as part of the public parks and recreation system. And acting to limit use in this way will protect the area from the removal of vegetation and the surface water runoff that often accompany construction of buildings.

c) Provision for conditional uses upon review

Conditional uses are permitted only after a case-by-case review and approval by local government officials. The types of uses which are conditional for each use district are often listed in the zoning ordinance itself. Applying this procedure to management of an EHA would provide local officials with flexibility in determining whether or not conditions warrant a particular type of development in a certain area. An accurate assessment of the site specific erosion hazard can be made at the time of the permit application. Knowledge of both the water and land elements of the hazard will provide a basis for granting or refusing the permit. The conditions which must be met in order for a permit to be granted can likewise be determined. Questions about what the proposed use is and how it will be designed and located to mitigate the effects of the erosion hazard must be answered satisfactorily for the conditional use to be approved.

d) Establishment of special criteria or performance standards

In this alternative the EHA is treated like an overlay district rather than a separate zoning district. That it, the zoning classification of the area in question remains the same

as it was prior to the delineation of the EHA. However, new criteria are established for uses within the district, e.g., setbacks from the shoreline, construction or moveability standards for buildings, vegetation requirements, or other proof of the capability of the property owner to meet the protective and damage reduction intent of the EHA. The rationale behind establishing performance standards is to assure that certain minimal standards are met without dictating the exact methods for meeting them. The focus is on how the land functions rather than on what is placed on it. This approach provides for flexibility in the use and management of an EHA based on the financial and technical resources available to property owners and the ingenuity applied to meeting the standards.

Within this framework of regulation through zoning and subdivision ordinances, there are useful administrative tools. Both permit procedures and bonding requirements can be utilized to enforce ordinance provisions. In the first procedure a zoning permit may be required of any property owner who wants to develop or physically alter vacant land. The permit application could require the applicant to demonstrate that the development will not accelerate erosion. Another type of permit, the use or occupancy permit, could be required before any land or building is occupied. The combination of these permit systems allows site inspection and evaluation of the structure from beginning to completion assuring total compliance with the zoning ordinance. A second approach would be the requirement for compliance bonding whenever any type of special use permit is granted. The local government may demand that a bond be furnished which would be sufficient

to provide for correction of any erosion damages caused by non-compliance. (A Plan for Michigan's Shorelands, p.97)

2) Building Codes

If structures are to be permitted in erosion-prone areas, construction standards should be sufficient to protect the property owner and the general public from potential damage. Building and housing codes could be adapted to provide moveability standards for structures within EHAs. New structures would be required to meet standards which would allow a building to be moved more readily than one built with standard construction methods. Examples of the types of provisions which might be included are basement requirements, simple architectural designs, or materials and construction techniques which lend themselves to being moved. The state of Michigan incorporated this concept into its coastal management program, although to date no further work has been done to define the necessary standards. (Erosion, p.3) In Wisconsin it is possible for a community to petition the state regulatory authority for a variance to the State Building Code in order to accomodate local soil or climatic conditions. In presenting its arguments for an exception, the local government would have a stronger case if it could point to an established EHA as its regulatory framework for the variance. This situation may, however, be subject to change with the proposed adoption of a Uniform State Building Code which might preclude establishing local building requirements and moveability standards.

Depending on the actual wording of the building or housing code in question, it might be advisable to indicate clearly that these special moveability provisions apply only to structures within EHAs.

Unlike zoning provisions which often apply specifically to one zone, these codes usually apply to all structures in a community, whether or not they are in an erosion-prone area.

3) Situation-specific ordinances

Many coastal communities already have several ordinances which pertain to specific situations and could be refined to apply directly to an EHA. Both private and public development projects should be subject to these ordinances. Sanitary and well codes might be written to require particular safeguards which would assure that water and waste facilities are located and constructed in a way that removes them from an erosion threat. Filling, grading, and dredging regulations should be aimed at controlling unnatural erosion and sedimentation caused by soil exposed during the construction process. Specific provisions may be created which control removal of vegetation, require methods for alleviating surface water runoff, and address the problems of sediment control. Issuance of special permits would allow the local government to incorporate provisions covering the planting of temporary and permanent ground cover, the use of diversions, silting basins, or terraces to trap sediment and the exposing of bare ground. (A Plan for Michigan's Shorelands, p.100)

The city of Highland Park, Illinois, has proposed a comprehensive ordinance covering a number of these problems in all properties within 100 lineal feet of the top edge of a steep slope. It requires detailed examinations of soil types and sub-surface hydrology, sets standards for grading which minimize alteration of the land and include an earth-moving schedule designed to limit the amount of time soil is exposed, provides for revegetation with native plants, and prohibits earth-

moving activities within certain distances from ravine and bluff bottoms. This ordinance is intended to minimize negative impacts on people and property and lessen the social and economic costs associated with construction in areas subject to erosion. (Draft: Bluff and Ravine Steep Slope Ordinance)

C. Non-Regulatory Strategies

In addition to regulatory methods, there are several non-regulatory management strategies which can be applied to reduce the damages within an EHA. These techniques rely on incentives for participation and individual citizen concern to be effective. Among the most common strategies are: 1) educational programs and hazard information systems; 2) voluntary associations; 3) tax incentive programs.

1) Educational programs and hazard information systems

Establishing an EHA provides a basis for the local government to identify the erosion-related problems of the area and to disseminate this information to concerned citizens. The inclusion of an EHA on an official map, in a zoning ordinance, or in a comprehensive plan acknowledges the existence of erosion-induced dangers and brings them to the attention of anyone who has access to these documents. Although limited in scope, this in itself serves an educational function. Beyond this, however, the local government may utilize the technical data gathered in the delineation process to institute a formal educational effort through schools, community and civic groups, special forums or public meetings, or government offices which deal with land use and property transfers.

Taking this one step further, the local government may create a

hazard information system to identify parcels of land which are unbuildable or seriously endangered because of severe erosion. The system would be especially beneficial to potential shore property buyers and could be operated through mortgage lenders, real estate agents, or local officials involved in recording the transfer of property. Its purpose would be primarily to notify an unwary buyer that there are serious erosion problems on the property being sold and that there may be restrictions on the use of that property. In addition, the lending institutions would have important information which could affect their willingness to grant mortgages for such properties. The state of Michigan intends to promote this type of program on a voluntary basis through banks and lending institutions and reports a favorable initial response from buyers and lenders. (Telephone conversation, Chris Shafer, Michigan Department of Natural Resources, July 28, 1978)

The hazard information system could also be adapted to benefit shore property owners who lack information about the type and severity of hazard they are facing. Based on the technical data gathered to delineate the EHA, the local government could provide detailed information about the condition of shoreline reaches, their recession rates, the relative stability or instability of bluffs, and the overall soil and water conditions. These data would assist the property owner in making informed decisions about the best way to deal with erosion-related problems.

2) Voluntary associations

It is not unusual for citizens who perceive a common problem and who feel that they would benefit from a joint effort to solve it to

form a voluntary association for that purpose. It would be feasible for the residents of an EHA to do this based on their common concern about erosion damage. While voluntary organizations find it difficult to raise money for large budgets, an EHA association could focus on lobbying to influence public agencies to undertake particular management functions, monitoring the shoreline situation, promoting a hazard information system, and educating the public to the seriousness of erosion-related problems. If a situation arose which required the expenditure of large amounts of money, the association could petition the local government for a special assessment in order to finance the needed program. Consequently, by delineating an EHA and thereby drawing attention to its problems, a local government may provide the incentive for citizen action.

3) Tax incentive programs

The power of taxation can both encourage compatible uses and discourage incompatible uses within an EHA. It may even be utilized to discourage development altogether. More than one half of the states have enacted some form of differential taxation or use value assessment on real property. On the local level, this permits assessment of certain properties according to the value of the current use rather than according to market value. This type of assessment could be especially useful if the restrictions placed on an EHA had the effect of lowering property values. Variations on this technique include a provision for levying a penalty tax if the land is later converted to another use or an agreement between the government and landowner that restricts land uses for a designated period of time. (Land Use Management and Regulation in Hazardous Areas: A Research Assessment,

p.77) A tax incentive program is likely to be most effective as a supplement to regulatory strategies which restrict property owners in their use of the land.

D. Administration of an EHA

The continuing administration of EHA management strategies would logically be handled by the appropriate local government authorities, e.g., the officials and staff of the planning, zoning, or community development departments. The decision concerning who will administer will depend in part on which regulatory and non-regulatory methods are implemented and in part on what agency has the necessary authority. Generally, the department or commission charged with the responsibility for overseeing land use regulation would have the option of directly administering the EHA or establishing an agreement with another agency for technical assistance and/or recommendations. In the former case, there would be little or no change, only added duties. In the latter situation, several alternatives are possible: 1) establishing an erosion control review board; 2) contracting for technical assistance from a governmental or private agency; 3) forming a technical advisory committee of interested citizens and local experts.

1) An erosion control review board could have the responsibility of reviewing building project plans, informing neighboring landowners of the plans for such projects, and informally clearing projects with affected interests like the state agencies concerned with overseeing shoreline regulation. It would not possess any regulatory authority of its own, but it could relieve the additional burden of assessing projects and making recommendations within the EHA for the staff of

the local planning and development agency. (Some Non-Structural Alternatives for the Reduction of Shore Damages, p.7)

2) Contracting for technical assistance to aid in decision-making is a viable alternative when staffing and/or finances do not permit an agency to do its own research or when another organization is already capable of doing the necessary work. In Racine County, the Planning Department and SCS have a cooperative arrangement whereby the SCS agent examines the proposed site of new construction or remodeling along the shoreline and advises the Planning Department of any soil or water problems that would be created by the activity. The Planning Department can then take whatever action is necessary to protect the shoreline from increased erosion. This type of arrangement could be made between different agencies, depending on local circumstances and informational needs.

3) A technical advisory committee of interested citizens and local and regional erosion-sensitive experts could also play an important role in advising on EHA administration. Its broad base of pooled knowledge would be a valuable resource and could bring in expertise from many sources, public and private, local and regional or state. Again, Racine County has employed this method to further its coastal planning efforts.

These various methods of administering an EHA could be used separately or in combination, depending on the needs of the coastal community. Other approaches are possible as well, reflecting the unique resources of every community, and experimentation and cooperation should be encouraged. The officials and citizens closest to the problems of shoreline erosion will have a vested interest in

solving them and will have a positive contribution to make toward that effort.

V. CONCLUSION

Shore erosion presents serious and often unique management problems because of its episodic, yet continuous, nature. Delineating and managing Erosion Hazard Areas (EHAs) offers coastal communities a preventive approach to lessening the effects of shoreline erosion without requiring any legal or institutional changes. It stresses avoiding actions which create situations that will prove hazardous to people and their property. As an alternative to structural solutions to erosion-related problems, EHAs provide a range of options for preventing or reducing erosion damages. These management possibilities include regulatory and non-regulatory strategies which can be adopted separately or in combination and adapted to meet local needs. The emphasis is on providing flexibility for local units of government to utilize existing authorities and seek creative approaches to reducing the damages caused by shore erosion.

APPENDICES

APPENDIX A

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APPENDIX B

TECHNICAL AND MANAGEMENT INFORMATION SOURCES

AGENCIES

WISCONSIN

Coastal Management Program
B130, 1 West Wilson Street
Madison, WI 53702
(608) 266-8952

Bay-Lake Regional Planning Commission
Suite 450, Social Ecology Building
University of Wisconsin-Green Bay
Green Bay, WI 53402
(414) 465-2135

Department of Natural Resources
Office of Planning and Analysis
4610 University Avenue
Madison, WI 53705
(608) 266-2121

Department of Natural Resources
Bureau of Water Regulation and Zoning
4610 University Avenue
Madison, WI 53705
(608) 266-8030

Department of Transportation
Engineering Services
5B, 4802 Sheboygan Avenue
P.O. Box 7916
Madison, WI 53707
(608) 266-0074

Geological and Natural History Survey
1815 University Avenue
Madison, WI 53706
(608) 262-1705

Northwest Regional Planning Commission
302½ Walnut Street
Spooner, WI 54801
(715) 635-2197

APPENDIX B, CONT.

TECHNICAL AND MANAGEMENT INFORMATION SOURCES

AGENCIES

Sea Grant College Program, University of Wisconsin
Marine Studies Center
1815 University Avenue
Madison, WI 53706
(608) 263-5133/263-2488

Southeastern Wisconsin Regional Planning Commission
916 N. East Avenue
Waukesha, WI 53186
(414) 547-6721

UNITED STATES

Agricultural Stabilization and Conservation Service
Wisconsin Office
4601 Hammersley Road
Madison, WI 53711
(608) 252-5301

Army Corps of Engineers
Chicago District Office
219 South Dearborn
Chicago, IL 60604
(312) 353-6405

Army Corps of Engineers
St. Paul District Office
1135 US Post Office and Customs House
St. Paul, MN 55101

Geological Survey
Wisconsin Office
Water Resources Division
1815 University Avenue
Madison, WI 53706
(608) 262-2488

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APPENDIX C

GLOSSARY

Accession:	a linear addition of shoreland by natural deposition
Accretion:	a volumetric addition of shoreland by natural deposition
Erosion:	the set of processes by which more shore material is removed than deposited; volumetric reduction of shoreland by natural processes
Erosion Hazard Area:	a specifically delineated geographic area along the shoreline which is subject to the effects of erosion
Loading (bluff):	the addition of material to either the bluff top or bluff face which decreases the stability of the bluff in an engineering analysis
Preventive alternatives:	non-structural techniques intended to reduce erosion damages through shoreline management and guided land use
Recession:	a linear measure of the reduction of shoreland by natural processes
Recession rate:	the average rate of continued landward movement of the bluff or shoreline over a specified time
Remedial alternatives:	structural measures designed to slow or halt erosion processes
Setback:	a distance measured perpendicular to the shoreline from a pre-determined position, within which construction is regulated or prohibited