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# SHORE EROSION

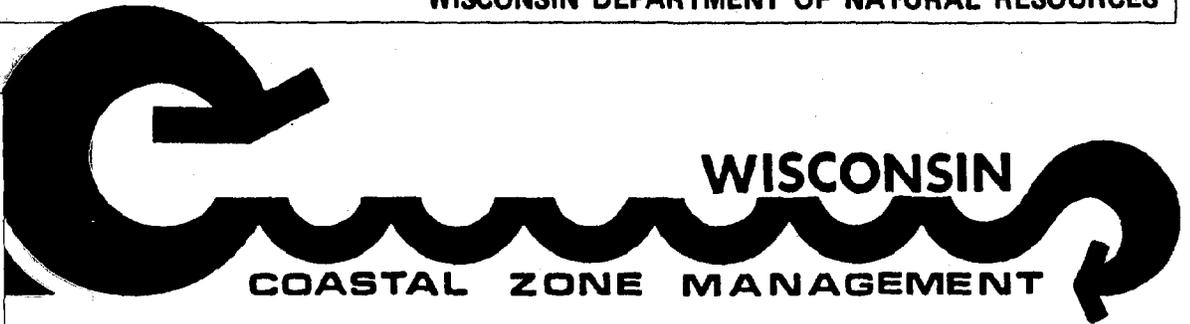
A STUDY PLAN / 1976

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COASTAL ZONE  
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WISCONSIN DEPARTMENT OF NATURAL RESOURCES

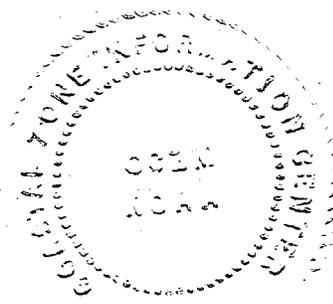
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COASTAL ZONE MANAGEMENT

SHORE EROSION STUDY  
COASTAL ZONE MANAGEMENT DEVELOPMENT PROGRAM

Department of Natural Resources  
State Planning Office  
December, 1975



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## SHORE EROSION STUDY

### I. Introduction and Setting

In recent years Wisconsin property owners and the state have suffered millions of dollars of losses because of the extensive erosion of the Lake Michigan and Lake Superior coasts. As long ago as 1951-2 it was estimated the value of shore property damages amounted to \$4,591,000 or \$9,275,000 at 1970 values.

Property damages are accelerated by the high water levels on the Great Lakes and have intensified the concern of Wisconsin citizens. This concern has been expressed during the last year at public hearings and meetings at Superior, Ashland, Green Bay, Manitowoc, Milwaukee and Kenosha, as it has been reflected by numerous reportings in the state's newspapers and on its television and radio stations. Local and County Governments and the Regional Planning Commissions have also been responsive to the concern of their constituencies over the shore erosion problem. The Red Clay Project being coordinated by the Northwestern Wisconsin Regional Planning Commission and the June 1, 1973 meeting of governmental officials convened by the Southeastern Wisconsin Regional Planning Commission are examples of this responsiveness.

In a broader context, Wisconsin has participated for over two years on a joint Federal Regional Council Great Lakes Basin Commission Task Force for Shoreland Damage Reduction. The purpose of this task force is to develop and implement a strategy, marshalling all State and Federal programs to reduce shore damages. Presently, the Task Force's efforts are directed toward bringing the existing Federal programs into focus on this issue.

The Shore Erosion Study forms an integral part of the Coastal Zone Management Development Program which is a cooperative effort of government agencies, institutions and interested groups in Wisconsin. The primary goal of the study is the development of alternative plans for the prevention and abatement of shore damage to private and public coastal property.

The foundations of the study were developed during the first year effort of the Coastal Zone Management Development Program with the planning, initiation and completion of basic data inventories by state agencies, institutions and the Regional Planning Commissions. The basic structure for public involvement in the study and a measure of the public concern for shore damage problems were also developed in the first year of the program. Additionally, a series of technical meetings initially defined informational needs and delineated the plans for the technical studies that will be required for the formulation of alternative plans related to shore erosion. The Shore Erosion Study is being conducted during the second and third years of the Coastal Zone Management Development Program.

The overall effort of the Shore Erosion Study can be divided into two major activities; 1. Public involvement and review, and 2. Technical studies. Regional and local perspectives are a vital part of the effort to formulate alternative plans that comprehensively and systematically address the shore erosion problem. A coordinated federal, state, regional and local effort is required for the success of the study.

### II. Public Involvement

The public involvement portion of the study is the key part of the study plan and is supportive of the need of local and regional agencies and private citizens to have access to basic information and data inventories, technical and non-technical background studies and alternative plans in order to fully participate in the development of a Wisconsin Coastal Zone Management Program. The shore erosion problem is a priority issue to many of Wisconsin's citizens because it is a highly visible problem and, because it is causing extensive damages to both public and private properties on Lake Michigan and Lake Superior.

In an effort to increase public awareness and understanding of the erosion problem efforts will be increased to provide information pamphlets, staff presentations to governmental and special interest groups, information programs, news releases, conferences and workshops. Specific informational materials related to the erosion problem completed by the Geological and Natural History Survey, and the University of Wisconsin Sea Grant Program will help strengthen public involvement in this study.

The major public involvement in the development of alternative shore erosion plans will be made through the Coastal Zone Coordinating and Advisory Council, the State Coastal Zone Advisory Committee and the Regional Coastal Zone Advisory Committees. The Regional Advisory Committees

can perform a vital role in this effort by providing appropriate perspectives and priorities of different interest groups, and different regional viewpoints. Presentations to the regional committees and local meetings will also provide a means for assuring public review of studies and suggested plans and determining that local issues are appropriately addressed.

Early efforts to plan this study began in the fall of 1974 with the convening of the first of a series of meetings of the Shore Erosion Policy Group under the auspices of the Coastal Zone Management Development Program. These meetings brought together for the first time a broad spectrum of Wisconsin's technical community. The group includes representatives of agencies, institutions and interested groups with a specific interest in shore erosion problems and the development of alternative plans directed toward those problems. Technical committees of the Shore Erosion Group were formed and charged to suggest specific information needs and to develop study plans for the acquisition of additional information. The major work elements of this study were developed from the initial reports of the technical committees of the Shore Erosion Group.

The information and alternative plans produced by the Shore Erosion Study will be distributed and presented to all of the public participation groups as they become available for review, discussion and amendment.

### III. Technical Studies

The technical studies will be built upon the evaluation of existing data inventories, the acquisition of appropriate existing data and the generation of new data required for the shore erosion study. The formulation of alternative plans will be based on the technical studies and the review of the plans by government and public decision makers through the Coastal Zone Coordinating and Advisory Council, the State Coastal Zone Advisory Committee and the Regional Coastal Zone Advisory Committees and local committees. The plans will provide an integrated coastal zone management plan addressing the shore erosion problem. This study reflects the outstanding cooperation and support of the Sea Grant Program. This study reflects the outstanding cooperation and support of the Sea Grant Program.

Some regional groups plan to do more detailed analysis of specific shore erosion problems in their areas than can presently be accommodated in the statewide emphasis of this study. The Shore Erosion Study will be coordinated with these regional efforts to avoid duplication.

#### A. Inventories of Existing Data

The inventory of existing physical information related to shore erosion is an important prerequisite of the study. The evaluation of the quantity and quality of the available data will allow the study to use, extend or supplement the information produced by previous efforts with a minimum of expensive duplication. In the first year of the Coastal Zone Management Development Program many of these data needs were anticipated and appropriate inventories were either planned, commenced or completed. A review of these inventories delineates the existing information base and focuses on those areas where additional data must be acquired.

##### 1. Bibliographic Inventories

- a. An annotated bibliography of geologic, hydrologic, soils, and climatologic material pertaining to the coastal counties was completed by the Geologic and Natural History Survey as part of the Coastal Zone Management Development Program. Supplemental information was also included pertaining to lake currents, lake levels, shoreline protection and shoreline management. This bibliography contains 448 citations and is indexed alphabetically by author for each subject area. The references were primarily drawn from the published and unpublished holdings of the University of Wisconsin, Geologic and Natural History Survey, U.S. Geological Survey, Sea Grant and other state and neighboring agencies and institutions.
- b. An annotated bibliography of topographic, geologic, hydrologic and bathymetric materials pertaining to the Lake Michigan shore of Southeast Wisconsin and adjacent areas was completed by the Department of Geological Science, University of Wisconsin - Milwaukee. This bibliography primarily references material from the holdings of the University of Wisconsin, U.S. Army Corps of Engineers, local governments and private engineering companies with special emphasis on coastal engineering information.

- c. Annotated bibliographies of vegetation and water quality materials of the coastal counties were also completed by the Department of Natural Resources as part of the Coastal Zone Management Development Program. These references were drawn from the published and unpublished holdings of the Department of Natural Resources, the University of Wisconsin, Sea Grant and other state and federal agencies.

Three additional efforts related to these bibliographic inventories are planned in the Shore Erosion Study; (a) the collation of the completed bibliographic inventories into a single document, (b) the extension of the bibliographic inventory of engineering materials, and the acquisition of coastal engineering data.

Efforts are being made to acquire all materials particularly appropriate to the Shore Erosion Study. Additional acquisitions will continue particularly of those materials containing primary data such as shore recession measurements.

## 2. Photographic Inventories

- a. The basic tool for analytical work along the shoreline is aerial photography. A preliminary inventory of coastal imagery was completed by the Department of Natural Resources as part of the Coastal Zone Management Development program. The inventory primarily covers aerial photographic holdings of government agencies and photogrammetric engineering companies for Wisconsin's coastal counties. A final inventory that includes corrections deletions and additions to the preliminary report has been completed.
- b. Acquisition has been made of photo indexes of all known aerial photography in the coastal counties. This material will allow acquisition of historical photography required for recession measurements, other inventories and study designs.
- c. Aerial photographs held by the Department of Transportation, the Department of Natural Resources, the U.S. Army Corps of Engineers, and the Southeastern Regional Planning Commission have been acquired as part of the Coastal Zone Management Development Program. These photographs are currently being used for photo interpretation studies of wildlife habitat, coastal erosion activity and shore protection structures.
- d. Acquisition has been arranged through contract with Chicago Aerial Survey and Park Aerial Survey for high altitude photographic coverage of the Bay Lake Regional Planning Commission and Northwest Wisconsin Regional Planning Commission Coastal Counties at a common scale and format to supplement similar coverage of the Southeastern Wisconsin Regional Planning Commission Counties. This photography will be used for mapping existing land use, wildlife habitat and other coastal characteristics.
- e. Acquisition has been made through the cooperation of Sea Grant and the Department of Natural Resources for low altitude aerial photographic coverage of the Lake Michigan and Lake Superior shorelines as part of the Coastal Zone Management Development Program. This is in stereo coverage and will be made available to the Regional Planning Commissions as well as used for detailed photo interpretation, measurement of coastal characteristics and other research purposes.

Additional acquisitions of historic aerial photographic coverage are planned for shore recession measurements, inventory of shore protection structures and other studies of shore characteristics. Sufficient photographic materials are now on hand to allow the commencement of these studies and the additional coverage can be ordered without delaying the program.

The acquisition of low altitude aerial photographic coverage detailed in paragraph (5) forms the initial requirement for a system of periodic monitoring of Wisconsin's shoreline.

## 3. Cartographic Inventories

- a. Land Resource Data Inventories of geologic, soils, water and related information were completed by the State Planning Office for the entire state. This series of inventories of mappable information was gathered from existing materials held by the state agencies and regional institutions.

- b. Acquisition of existing maps and charts was made by the Department of Natural Resources as part of the Coastal Zone Management Development Program. These materials include published and manuscript copies of U.S. Geological Survey topographic sheets, Lake Survey Charts of Lake Michigan and Lake Superior, cadastral and land cover maps, and additional maps from the University of Wisconsin Cartographic Lab, the Army Map Service and the National Ocean Survey. Clear film copies were also acquired of Highway Maps of the coastal counties from the Department of Transportation.
- c. Acquisition was made of a set of shoreline maps prepared by the U.S. Army Corps of Engineers for the Great Lakes Basin Commission. These maps are very similar, although larger scale, to the National Shoreline Inventory Maps.
- d. Acquisition is underway of a set of base maps, as used by the Regional Planning Commission, for the collection of erosion related information.
- e. An inventory and acquisition program was begun by the Department of Natural Resources of vertical and horizontal controls in the immediate shoreline areas as part of the Coastal Zone Management Development Program. These efforts included published materials of the Southeastern Wisconsin Regional Planning Commission, the U.S. Coast and Geodetic Survey and the U.S. Geological Survey. Additional materials will be obtained from the Department of Transportation, the Regional Planning Commissions and the County agencies.

Further cartographic inventories planned as part of the Shore Erosion Study include; (a) the collation and mapping of existing shore recession measurements, (b) the collation and mapping of shore typology and erodability from such existing sources as the National Shoreline Inventory and the Shore Damage Survey, (c) the collation and mapping of existing and historic shore protection structures, and (d) the collation and mapping of historic bathymetric changes in the nearshore area based on the field sheets held by the Lake Survey Center.

#### 4. Program Inventory

An inventory of current programs directly and indirectly related to shore erosion was completed by the Department of Natural Resources as part of the Coastal Zone Management Development Program. The majority of these programs are funded by the U.S. Army Corps of Engineers, Sea Grant, the University of Wisconsin or the Environmental Protection Agency.

#### B. Analytical Studies

The review of data inventories indicates that a substantial amount of data exists upon which a detailed analysis of the shore damage problem can be based. However, the inventories also disclose specific weaknesses and gaps in the available information. These data deficiencies must be corrected so that a solid foundation exists for the formulation of viable alternative plans. The following studies are designed to supply these informational needs within the limits of present funding.

##### 1. Shore Recession Measurement Study

The measurement of the amount of shore recession is the first step in identifying the severity of shore erosion, locating geological hazard areas and defining critical erosion reaches. Most of the existing shore recession measurements are more than twenty years old and therefore do not necessarily reflect present conditions. This study is designed to provide uniform measurements, principally from air photos of present shore erosion conditions. The study is divided into three phases; preliminary, reconnaissance and intensive.

- a. Phase One -Preliminary study was initiated through an agreement between Sea Grant Advisory Services and the Department of Natural Resources. This agreement provided for administration and funding by Sea Grant while the Department of Natural Resources furnished technical direction, instruments and materials through the Coastal Zone Management Development Program.

(1) Preliminary study based on interpretation of recent aerial photographs.

- (a) Locate and mark section, township and range lines on the air photos.
  - (b) Identify and tabulate active erosion areas.
  - (c) Identify and tabulate shore protection structures.
  - (2) Initial replicate measurements from fixed geographic locations to the bluff edge, toe of the bluff, and the water's edge of sequential air photos.
    - (a) Develop technical methods, coding, and a standard operating procedure for recession measurements.
    - (b) Determine feasibility of measuring accelerated erosion attributable to removal of bluff vegetation.
    - (c) Determine feasibility of measuring accelerated erosion attributable to high lake levels.
    - (d) Determine feasibility of correlating shore erosion with specific weather conditions.
  - b. Phase Two - Reconnaissance level recession measurement of entire Lake Michigan and Lake Superior coasts.
    - (1) Extension of initial recession measurements to areas identified as actively eroding.
      - (a) Training of additional interpreters for recession measurement.
      - (b) Coding of shore recession measurements and adaption of computer program for recession calculations.
    - (2) Extension of recession measurements to entire Lake Michigan and Lake Superior coasts.
      - (a) Collation and mapping of all shore recession measurements.
      - (b) Definition and delineation of severe erosion reaches and geological hazard areas.
  - c. Phase Three - Intensive shore recession measurement in areas of erosion hazard and erosion problem areas. This portion of the study coincides with the, "Study of Erosion Problem Areas," and is dependent on the definitions developed by that study.
    - (1) Additional shore recession measurements, at more closely spaced intervals, in areas defined as areas of erosion hazard or erosion problem areas. These measurements would follow the same technique used in phase two of this study.
    - (2) Mapping will be made of selected areas utilizing a plotter and stereoscopic photography. Stereopairs would be relatively oriented and model coordinates read in digital form in an arbitrary model space. With ground control, the arbitrary coordinates can then be transformed into an absolute ground coordinate system. This procedure would produce heights of bluffs, bluff slopes and contour map of the shore. The handling of sequential pairs of air photos by this method would produce estimates of the volume of sediment contributed to the lake system and detailed recession measurements.
2. Additional Study of Erosion Problem Areas

Critical erosion areas are defined as areas in which property of unusual cultural, economic or scientific value is in danger of being damaged or destroyed through the processes of coastal erosion. Details of this definition can be interpreted in many different ways, but for the purpose of fitting the study to the means available, a working definition will be developed and used as an improved basis for private and public consideration of possible shore protection structures and as an additional data base to aid future site-specific analyses. A definition of erosion problem areas will be developed through

a survey of public perception and an overlay technique using shore recession measurements together with inventories of land use being prepared or available through individual Regional Planning Commissions. Additional inventories of transportation facilities, public access, recreational facilities, historical sites, wildlife habitat and unique geological features will also be used in developing the definition and determining erosion problem areas.

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- a. Definition and delineation of erosion problem areas.
    - (1) Regional and local survey of public perception of erosion problem areas coordinated with the Regional Planning Commissions.
    - (2) Field reconnaissance to delineate erosion problem areas.
    - (3) Field estimate of the scope of engineering work required to provide structural protection of erosion problem areas.
    - (4) Mapping and evaluation of existing protective structures.
    - (5) Estimation of maximum safe slope angles and differentiation of stable and unstable slopes.
    - (6) Delineation of areas in which ground-water seepage appears to be a significant factor in slope stability and shore erosion.
  - b. Definition and delineation of natural hazard areas where a significant threat of precipitous slope failures could lead to injury or loss of life.
    - (1) Collation and mapping of natural hazards based on the survey of public perception and field observations.
    - (2) Notification of Regional Planning Commissions, local governments and residents.
  - c. Development of methods of converting descriptive field survey information into estimates of the actual costs for providing structural protection.
  - d. Extension of the Littoral Environmental Observation Program (LEO) so as to insure appropriate design information for protective structures in critical erosion areas.
  - e. Determination of additional data requirements and design of a study plan for intensive investigation of site-specific areas.

Although this study is aimed at erosion problem areas, future studies should examine other selected erosion areas, particularly those that may become a problem as a result of anticipated development.

### 3. Empirical Study of Shore Protection Structures

This study will utilize inventories of shore protection, navigation, and other structures together with an examination of the nearshore sediment budget to evaluate the effect of structures on erosion in the protected areas and in adjacent unprotected areas. This study is particularly necessary for the state's regulatory program and for analyzing the effectiveness of shore protection structures.

- a. Collation of inventories of shore protection structures.
- b. Sediment Budget Analysis
  - (1) Acquisition of bathymetric field sheets from the Lake Survey Center, Detroit, Michigan.
  - (2) Use of map differencing technique, subtraction of depth values of one chart from another where the isobaths cross, to produce a number field of depth changes in the near-shore zone.

- (3) Contouring and planimetering the map of depth changes to produce a volumetric measurement of significant erosion and deposition.
  - (4) Consideration of dredged volumes in the study area.
  - (5) Determination of sediment budget time trends from three sets of bathymetric data.
- c. Comparison and analysis of areas of significant erosion and deposition with the location of shore protection structures.
  - d. Comparison of areas of significant erosion and deposition with adjacent measurements of shore recession.
4. Empirical Study of Shore Erosion and High Lake Levels

This study was started through an agreement between Sea Grant Advisory Services and the Department of Natural Resources and is referred to in the Study of Shore Recession Measurements (par. B.1.a.). Under this agreement two methods are being examined to determine the feasibility of measuring the acceleration of shore erosion caused by high water levels on Lake Michigan and Lake Superior.

- a. The first method will attempt to compare shore recession measurements derived from aerial photographs taken during known periods of low water levels to those taken during periods of high lake levels.
- b. The second method will compare shore recession measurements derived from all usable aerial photography of a site to lake levels averaged for time periods comparable to those of the available aerial photography.

This study may fulfill an important need in the flood insurance program for comparative erosion information and for potential compensation for shore damages resulting from the Lake Levels Operating plans instituted by the International Joint Commission.

5. Analysis and Summary Statement on the Cost Effectiveness of Shore Protection Structural Alternatives.

This statement will be derived from other studies such as the study of erosion problem areas above, the Michigan Demonstration Program, the Shore Damage Surveys, other Corps of Engineer studies and the coastal engineering literature.

6. Survey and Analysis of Nonstructural Alternatives for Decreasing Shore Damages.

This study would analyze the advantages and disadvantages of existing and possible nonstructural alternatives that would reduce or at least minimize the damages to shore property produced by coastal erosion processes. This information would be of particular value in connection with the application of flood insurance to erosion.

- C. Development and Implementation of Long Term Data Acquisition Programs to Meet Future Needs.

In addition to the studies and analyses previously outlined, certain long-term data requirements can be anticipated and such studies need to be commenced early in the shore erosion study so that the information will be available when it is required. Much of these studies can be justified as it relates to the information needs of regulatory programs.

1. Development of a periodic shore profiling study. This study would build on the profiling presently underway as part of the Shore Damage Survey in Brown, Douglas and Racine Counties and also use profile information available from such other sources as the Beach Erosion Studies. This study would also include the sampling of bluff, beach and nearshore materials for particle size analysis and engineering tests. In addition soil borings would be made on the bluff to obtain undisturbed soil samples and allow monitoring of ground-water conditions within the bluff.

2. Expansion of the Littoral Environmental Observation Program (LEO) into the Lake Superior and Green Bay areas. Initial review and analysis of the first year results from the present seven stations on Lake Michigan indicate that they may be sufficient because of their consistency to provide design information along that coast. It also appears that it may be possible to hindcast wave height through the correlation of the existing stations with the Milwaukee weather station.

3. Establishment of a Monitoring and Evaluation Program for Shore Protection Structures.

This program would include periodic shore and nearshore profiling in areas adjacent to shore protection structures prior to their actual construction as well as a monitoring and evaluation periodically after their installation on the shore.

4. Establishment of a Program for Periodic Monitoring of the Shore through Low Altitude Aerial Photography.

This program would provide large scale stereoscopic photography of the shoreline for monitoring of shore erosion and shore protection structures.

#### IV. Key Related Studies in Progress

Most of the current research and studies related to shore erosion on Wisconsin's Lake Michigan and Lake Superior coasts has been funded by either the Sea Grant Program, the U.S. Army Corps of Engineers or the Coastal Zone Management Development Program. An inventory of these studies and related efforts are included in a separate report.

##### A. University of Wisconsin - Sea Grant

The Sea Grant College Program has become active in both research and public information programs dealing with erosion. The Shoreline Property and Resources subprogram has the goal of providing private citizens and local and state government with the information on which to base decisions about the development and management of coastal areas, particularly in terms of shore protection.

1. Shoreline Erosion in Lake Michigan - photoreconnaissance survey, mapping of shoreland descriptions, collection of bottom sediments, bluff profile monitoring.
2. Mechanics of Coastal Slumps - ground and photoreconnaissance survey, site survey of slumps in Southeastern Wisconsin, bluff profile monitoring on Lake Superior and Lake Michigan, surface sampling, borings, and ground water monitoring.
3. Computerized Shoreline Mapping from Aerial Photography - development of three techniques; (1) direct tracing of shorelines with a stereoscopic plotter, (2) Digitized shore geometry with a PG/2 stereoscopic plotter to determine shore recession or erosional volume, and (3) correlation technique using a scanning microdensitometer and computer search to locate landwater interfaces.
4. Remote Sensing in the Coastal Zone of Lake Michigan - study of thermal plumes from major power plants using an aerial thermal infra-red scanner and boat measurements of water temperature.

Sea Grant researchers have offered full cooperation with the Coastal Zone Management Development Program in addition to the initiation of shorter studies detailed earlier in this report.

##### B. U.S. Army Corps of Engineers

The Corps of Engineers has long played a major role in the federal concern with water and related lands and is currently involved in the entire field of water resources planning including commercial navigation, recreational boating, urban area problems, and shore and beach erosion protection.

1. Shore Damage Survey - Study of erosion and inundation damages related to the high lake levels of 1972-74, in Brown, Douglas and Racine Counties. The study is primarily based on a mailed shore damage questionnaire, and interviews with riparian property owners. Maps of land ownership and shore type, together with monumented bluff profiles and sediment

samples are also included in the survey. Approval of a second year effort in additional counties is anticipated. The survey is being conducted under a contract with the Department of Natural Resources by the University of Wisconsin - Milwaukee, Superior and Parkside.

2. Littoral Environment Observation Program (LEO) - Daily observations and measurements of wave characteristics, wind characteristics, foreshore slope and littoral drift current, including weekly beach profiles and a monthly foreshore sand sample. Training, supplies, instruments and data processing are handled by the Coastal Engineering Research Center and the Chicago District, Corps of Engineers. Observers are unpaid but employees of local government or the Department of Natural Resources. Eight stations are presently operating on Wisconsin's Lake Michigan coast.
3. Implementation Studies
  - a. Survey Studies - solicited from congressional representatives when local interests feel that a need exists for construction or improvement of a water resources project. Authority for a study is granted by either a Committee resolution or by a Congressional Act and the study assigned to the Corps for accomplishment. Completed surveys are submitted to Congress for action.
  - b. Studies Under Special Continuing Authorities
    - (1) Small Projects
      - (a) Small navigation projects (Section 107 of the 1960 River and Harbor Act)
      - (b) Small flood control projects (Section 205 of the 1948 Flood Control Act)
      - (c) Small beach erosion control projects (Section 103 of the River and Harbor Act of 1962)
    - (2) Prevention and mitigation of shore damage caused by existing federal navigation works (Section 111 of the River and harbor Act of 1968)
    - (3) Emergency bank protection (Section 14 of the Flood Control Act of 1946)
    - (4) Shore and bank protection (Sections 27 of the Water Resource Act of 1974) (an amendment to Section 14 of the Flood Control Act of 1946)
    - (5) Shoreline erosion control demonstration (Section 54 of the Water Resource Development Act of 1974)
4. Coordination Program (Section 22 of the Water Resources Development Act of 1974)

A preliminary proposal for funding of a state shore erosion program was submitted and discussed with representatives of the St. Paul and Chicago Districts and the North Central Division. It is understood that Section 22 funds are not to supplement existing Corps programs and are to be used for coordination of the Corps with state programs. Funding levels have since been lowered and support in FY 1976 is not anticipated.

C. Lake Levels Studies

1. University of Wisconsin - Water Resources Management Workshop - to critique the International Great Lakes Levels Board Report, a summer workshop was supported by the Coastal Zone Management Development Program. It is planned that the workshop with the support of state agencies and university staff will produce a source document to be used in the development of a state position. This document will be in the form of a working paper that will be reviewed and critiqued by the Coastal Zone Management Development staff and conveyed to the Coastal Zone Coordinating and Advisory Council for review and eventual transmittal to the Governor.
2. The University of Wisconsin, Institute of Environmental Studies, Lake Superior Project.

A study entitled "The Specific Role of Water Management in Lake Level Fluctuations with Special Reference to Lake Superior," was developed by the Lake Superior Project. Three strategies are to be followed: (1) A modeling effort; (2) Cost Effectiveness of Shoreline Structures; and (3) The Effects of Man's Artificial Structures.

This study is funded by the Rockefeller Foundation and involves the participation of scientists of the University of Michigan, The University of Toronto and the University of Minnesota-Duluth.

D. Demonstration - Research projects to abate nonpoint source Water pollution (Section 108 of the Water Pollution Control Act Amendments of 1972)

1. Washington County Project - general objectives

- a. Demonstrate the effectiveness of erosion and sediment control techniques through land treatment and water quality monitoring on small watersheds.
- b. Develop sediment control ordinance or other regulatory instrument and investigate sediment control regulation.
- c. Develop a model to implement a sediment control program using a regulatory procedure.
- d. Develop an educational program directed to implementation of sediment control regulations.
- e. Evaluate the feasibility of implementing regulatory erosion and sediment control programs in the Great Lakes Basin.

2. Red Clay Erosion - Sedimentation Program - specific goals

- a. Initiation and implementation of a program for erosion and sedimentation control in a basinwide long range program.
- b. Develop interstate institutional arrangements to implement the control program.
- c. Develop cost effectiveness analysis for a long term control strategy.
- d. Demonstration and evaluation of new techniques for reducing the rate of erosion and sedimentation.
- e. Promote proper land use consistent with the capabilities and limitations of the Red Clay soils.

Shore erosion demonstration projects have been initiated in Ashland County at Madison Beach and Madeline Island under this program.

E. Pollution from Land Use Activities Reference Group - PLUARG. The International Joint Commission, through the Great Lakes Water Quality Board, established the International Reference Group on Great Lakes Pollution from Land Use Activities to conduct studies of the impact of land use activities on the water quality of the Great Lakes Basin and to recommend remedial measures for maintaining or improving Great Lakes water quality. The study program consists of four major tasks.

1. Task A - the collection and assessment of management and research information, the critical analysis of recommendations.
2. Task B - preparation of a land use inventory and analysis of trends in land use patterns and practices.
3. Task C - detailed survey of selected watersheds to determine the sources of pollutants, their relative significance and the assessment of the degree of transmission of pollutants to the boundary waters.
4. Task D - the collection of supplementary information on the impacts of materials to the boundary waters, their effect on water quality and their significance in these waters in the future and under alternative management schemes.

Activity 1 of Task D is directed at shore erosion and the Department of Natural Resources has cooperated in obtaining surface samples for analysis by the Environmental Protection Agency as part of the Shore Damage Survey.

V. Formulation of Alternative Plans

The preceding inventories and studies form the foundation for the examination and formulation of alternative plans directed towards shore erosion problems. This final phase of the study will examine the structural alternatives and costs, the cost effectiveness of available shore protection structures and the available and possible nonstructural alternatives that would reduce or minimize the damages to shore property produced by coastal erosion. The study will also layout the implementation specifics under each alternative. Various combinations of structural and nonstructural alternatives will also be analyzed.

Upon completion the plan alternatives will be forwarded to the Regional Planning Commissions for review by their advisory bodies and to the Coastal Zone Coordinating and Advisory Council and the State Coastal Zone Advisory Committee. These groups will react, modify and help shape a state position relative to shore erosion.

VI. Administration

The Shore Erosion Administrative Committee will be responsible for guiding the study including its overall administration, the dissemination of information related to the study. The membership of the Administrative Committee includes: 1. M. Ostrom, Geological and Natural History Survey; 2. G. Hedden, Sea Grant Advisory Services; 3. G. Pirie, University of Wisconsin, Milwaukee; 4. S. Born, State Planning Office; 5. D. Mickelson, University of Wisconsin, Madison; 6. A. Miller, State Planning Office; 7. T. Lauf, Department of Natural Resources; and 8. P. Tychsen, University of Wisconsin, Superior.

The staff coordinator for the Shore Erosion Study is Charles Hess, Department of Natural Resources, and the study will be conducted at the Geological and Natural History Survey and the DNR.

The general objectives of the study will be developed by the Shore Erosion Group. The Group includes representatives of agencies, institutions and interested groups with a specific interest in shore erosion problems. Technical committees of the Group have been formed to suggest specific information needs and to develop study plans for the acquisition of further information. Most of the present work plan was developed from the initial reports of these technical committees. Additional committees will be formed as the need arises for further information and development of study designs.

1977

1976

1975

SHORE EROSION STUDY

INDEX OF EROSION RELATED PROGRAMS

COASTAL EROSION BIBLIOGRAPHY

INDEX OF COASTAL IMAGERY

MAP & CHART INDEX

Shore Damage Surveys

Beach Erosion Studies Corps of Engineers

Shoreline Studies -Sea Grant

Shore Structure Permit Files

Illinois Coastal Erosion Studies

Michigan Shore Demonstration Program

Related Coastal Zone Studies

RECESSION MEASUREMENT STUDY

SAND BUDGET STUDY

INVENTORY OF SHORE PROTECTION STRUCTURES

PUBLIC PERCEPTION SURVEY OF EROSION PROBLEM AREAS

DELINEATION OF EROSION PROBLEM AREAS

DELINEATION OF EROSION REACHES

FIELD SURVEY OF EROSION PROBLEM AREAS

ANALYSIS OF NONSTRUCTURAL ALTERNATIVES

ANALYSIS OF PROTECTIVE STRUCTURE ALTERNATIVES

ALTERNATIVE EROSION PLANS

SHORE EROSION PLAN Implementation & Funding

ADDITIONAL DATA NEEDS FOR ENGINEERING STUDIES

SHORE PROTECTION MONITORING PROGRAM

STUDY PLAN

RELATED PROGRAMS

ANALYTICAL STUDIES

INVENTORY

INFORMATION STUDIES

PLANNING-EVALUATION-SELECTION

### Wisconsin Shore Erosion Study Plan

COASTAL EDGE  
INFORMATION CENTER

