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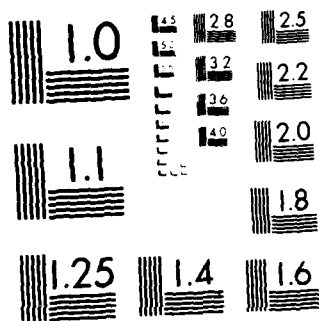
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PORT WING
BAYFIELD COUNTY, WISCONSIN

PRECONSTRUCTION REPORT

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ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

MARCH 1978

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The Shoreline Erosion Control Demonstration Act of 1974 provides that a 5-year program be developed to demonstrate and disseminate information about low-cost means to prevent and control shoreline erosion. A site near Port Wing, Wisconsin was selected as one of the demonstration projects, and is the only site on Lake Superior. The study involves about 1,000 feet of the Lake Superior shoreline in Bayfield County, Wisconsin. An investigation was made on the damaged shoreline, low-cost measures for protection the shore, several types of structures for construction were selected, and coordination with interested agencies and the public was maintained.					
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BAYFIELD COUNTY, WISCONSIN

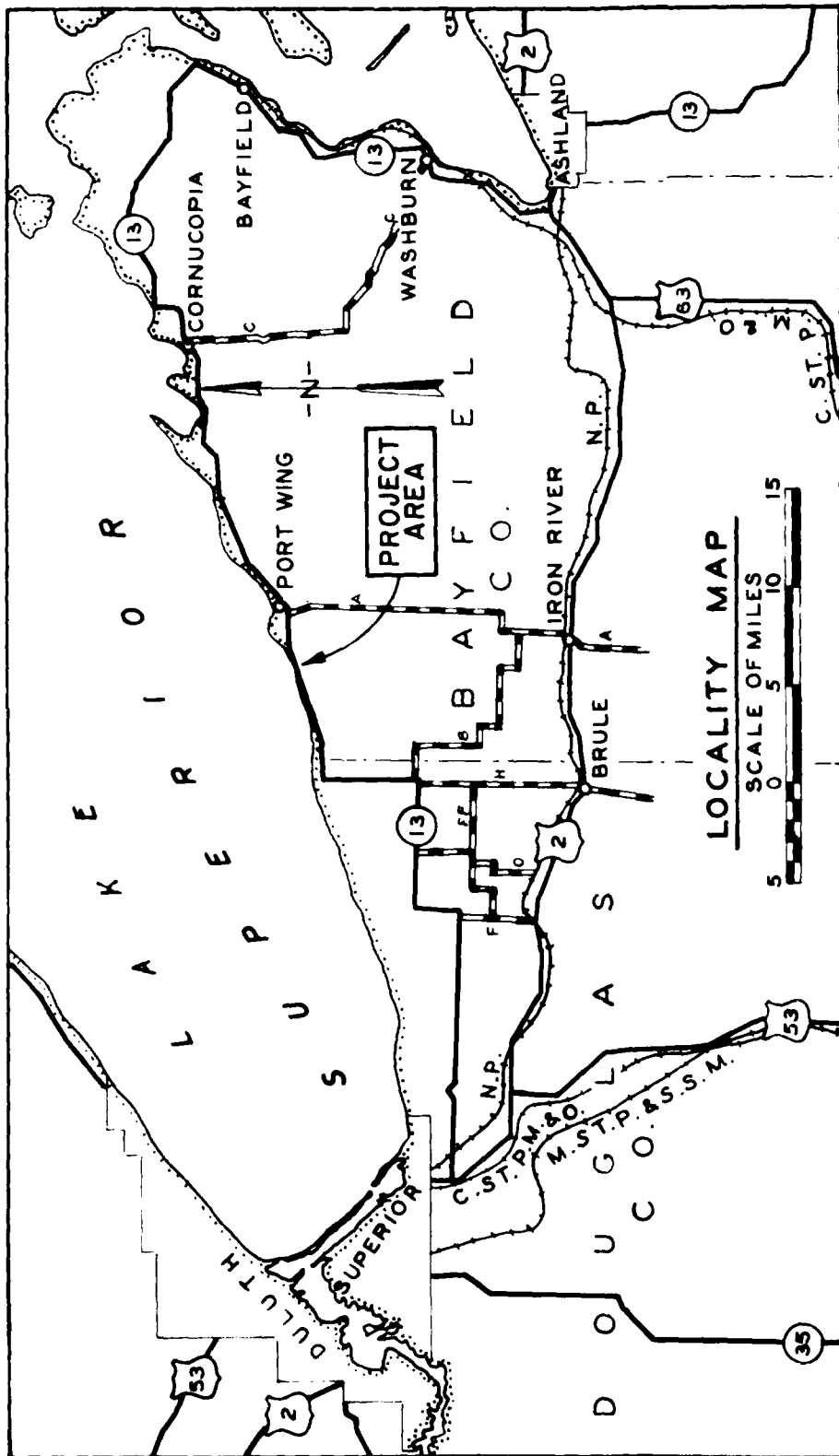
PRECONSTRUCTION REPORT

THE STUDY AND REPORT

PURPOSE AND AUTHORITY

In response to increased concern for the loss of public and private lands due to shoreline erosion and the resulting environmental and economic damage, Congress authorized Section 54 of the Water Resources Development Act of 1974, Public Law 93-251. This section, also known as the Shoreline Erosion Control Demonstration Act of 1974, provides that a 5-year program be developed to demonstrate and disseminate information about low-cost means to prevent and control shoreline erosion. It further directs that the Chief of Engineers shall establish a Shoreline Erosion Advisory Panel to advise him in carrying out the provisions of this section and that, among other coastal locations specified, demonstration projects shall be undertaken at no less than two sites on the shoreline of the Great Lakes.

The Shoreline Erosion Advisory Panel investigated many sites that met the criteria established and made its recommendation to the Chief of Engineers. He selected 10 sites from those recommended by the panel. A site near Port Wing, Wisconsin, shown on the following figure, was one of those selected and is the only site on Lake Superior.



LOCALITY MAP

SCALE OF MILES
0 5 10 15

LAKE SUPERIOR
SHORELINE EROSION CONTROL DEMONSTRATION PROJECT
STATE TRUNK HIGHWAY 13
NEAR PORT WING, WISCONSIN
LOCATION MAP

SCOPE OF THE STUDY

This study involves about 1,000 feet of the Lake Superior shoreline in Bayfield County, Wisconsin, as shown on plate 1. In view of the project purpose, an investigation was made of the damaged shoreline, low-cost measures for protecting the shore were considered, several types of structures for construction were selected, and coordination with interested agencies and the public was maintained. The studies were made in the depth and detail necessary to determine selected structures, costs, land requirements, and local cooperation needs and in sufficient detail to begin plans and specifications upon approval of this report.

STUDY PARTICIPANTS AND COORDINATION

The St. Paul District, Corps of Engineers is responsible for conducting and coordinating the study. Coordination began with the State of Wisconsin in December 1976 after the Port Wing site was selected. The Wisconsin Department of Transportation, Division of Highways is the lead agency for the State. Several meetings were held with representatives of the Division of Highways to discuss local cooperation requirements, project features, methods of State involvement toward its share of the construction costs, and vegetation measures to be considered. Coordination has also been maintained with members of the Shoreline Erosion Advisory Panel, representatives of the Soil Conservation Service and Coastal Engineering Research Center, other interested Federal and State agencies, and the public. Correspondence from coordination activities is in appendix 1.

THE REPORT

The report is organized into a main report and three appendixes. The main report presents the overall study, describes the project area, summarizes project costs, and presents the recommendations for the selected demonstration measures. Appendix 1 contains pertinent correspondence and documents used in connection with the study. Necessary design information is in appendix 2. Appendix 3 contains a draft copy of the cooperative agreement with the State of Wisconsin.

PRIOR STUDIES AND REPORTS

The following reports on shoreline erosion for the Port Wing area have been prepared:

a. Section 14, Emergency Bank Protection, Lake Superior at State Trunk Highway 13, Bayfield County, Wisconsin, 27 January 1976. - This report was prepared by the St. Paul District to determine the feasibility of protecting Highway 13 from damage.

b. Soil Engineering Report - Design Investigation, 10 December 1976. - This report was prepared by the Wisconsin Department of Transportation, Division of Highways, District 8.

RESOURCES OF THE STUDY AREA

The site selected for the demonstration project is on the southern shore of Lake Superior along Highway 13 in Bayfield County approximately 23 miles east of Superior, Wisconsin, and 6 miles west of Port Wing.

The shoreline of Lake Superior is a composite of beaches, boggy areas, and upland forests which provide habitat for a variety of fish and wildlife species. The primary forest stands in the Port Wing area consist of pine, red maple, trembling aspen, sugar maple, yellow birch, basswood, balsam fir, spruce, and white cedar. The project site has previously been cleared and only a few trees and evergreen shrubs remain in the area.

Approximately 50 species of mammals occupy the forested areas of Port Wing. Among the more common are white-tailed deer, black bears, coyotes, foxes, skunks, porcupines, squirrels, mice, weasels, beaver, snowshoe hare, otter, mink, and muskrat. Several bird species nest in the shrubs and trees. Waterfowl and shorebirds such as gulls, terns, herons, bitterns, rails, coots, and grebes occupy the shallow, marshy areas of the Lake Superior shoreline. These areas are vegetated with a variety of aquatic and emergent plants such as cattails, sedges, willow, elder, and rush.

A variety of fish species is found in the near shore or harbor areas of Lake Superior. The assemblage of fish is generally comprised of stenothermal "cold water" species such as whitefish and trout. Also present are species typically found in warmer water (walleye, yellow perch, and northern pike).

The mammals and fish species are not specific to the project area, but rather are in the general area and may on occasion be near or passing through the specific site.

An archeological study of the area has been made and no historical or archeological sites were identified. Therefore, construction of the shoreline demonstration project is not anticipated to have adverse effects on these values within the project area.

PROBLEMS AND NEEDS

GENERAL

Highway 13 is the South Shore Scenic Drive of Lake Superior between Superior and Ashland, Wisconsin, and provides an access to the Apostle Islands National Lakeshore area. The 1974 average daily traffic count was 500 vehicles. The projected 1995 daily traffic count is 900 vehicles. The demonstration site is shown on the U.S. Geological Survey 15-minute quadrangles, Brule and Port Wing, Wisconsin, at a scale of 1:62,500, based on 1959 photography.

PROBLEM IDENTIFICATION

The demonstration site fronts Lake Superior in a northwest direction and is exposed to storms from the west to northeast sectors. The site is located on red lacustrine clay deposits of glacial Lake Superior. These deposits are prevalent along the entire south shore of the lake in Wisconsin and are highly erodible. A substantial annual loss of bluff and shoreline occurs along the entire Wisconsin south shore.

In June 1975, the study site was first inspected by representatives of the Corps of Engineers and the Wisconsin Department of Transportation. That inspection revealed extensive bank erosion and slope failures along approximately 1,000 lineal feet of shoreline. At the most critical point, the bank top had retreated to within 39 feet of the highway center line (about 22 feet from the shoulder). According to a report prepared by the Wisconsin Department of Transportation, the top and toe of the bank at the site had retreated about 50 and 26 feet, respectively, from 1962 to 1974.

The site has subsequently been inspected on several occasions by members of the Shoreline Erosion Advisory Panel and representatives of the Coastal Engineering Research Center, Corps of Engineers, and State of Wisconsin. The latest topographic surveys (November 1977) show that the bank has retreated to within 32 feet of the highway center line, a loss of 7 additional feet since 1974.

Within the 1,000-foot reach, erosion is threatening to destroy the highway. A demonstration project at this location will provide several benefits and fulfill several purposes. It not only will demonstrate low-cost shoreline protective measures but will make the site readily accessible for inspection by many people who may benefit from constructing similar features along their eroding property. The project will also provide some protection for the highway. If the protective measures are not effective, the Department of Transportation will have to relocate the highway.

EXISTING CONDITIONS

GENERAL

Each year the water surface elevation of Lake Superior is subject to seasonal rise and fall, but the amount fluctuates from year to year. From 1860 to 1978, records at Duluth, Minnesota, show the greatest annual fluctuation, based on the highest and lowest monthly means for a particular year, was 2.67 feet in 1869. In addition to the annual fluctuation, variations for short periods are caused by differential atmospheric pressures and by the tractive force of wind on the water surface. Changes of this type can be more than 2 feet but seldom exceed 1 foot above or below the normal level.

The discharge of water from Lake Superior to the lower lakes has been regulated since 1921 by control structures on the St. Marys River at Sault Ste. Marie, Michigan. These control structures have been operated under the direction of the International Joint Commission to maintain the mean monthly level of the lake as closely as possible between elevations 600.5 and 602.0 feet IGLD (International Great Lakes Datum) 1955. See appendix 2 for more detailed information on lake levels.

WAVE CLIMATE AND SHORE CONDITIONS

The south shore of Lake Superior in the reach from Superior to the Apostle Islands region varies in its backshore character from marsh and dunes to moderately high erodible bluffs of red clay. The foreshore from Superior to the project site is primarily sandy and has an average slope of 1:75. This shallow slope helps to lessen the severity of larger waves, causing them to break well seaward of the shoreline. Smaller waves can and do reach the toe of the low bluff where the depth for the design conditions will reach 6.0 feet.

INVESTIGATIONS

Field investigations made in connection with this study consisted of selected soil borings and tests and topographic and bathymetric surveys as required. A base line was established on the center line of Highway 13 as shown on plate 2. The base line has been tied into the State coordinate system. Cross sections of the bank and shoreline were obtained at 33 locations parallel to each other and generally perpendicular to the shoreline. Between stations 173+93 and 187+98.35 the sections are 50 feet apart.

Bathymetric sections to a minimum 12-foot depth were taken at 18 locations as an extension to the topographic range line at the same station. Between stations 174+94.33 and 187+98.35, the sections are 100 feet apart. The plotted sections are shown on plates 3 and 4 and are representative of all the sections taken.

The boring locations and logs are shown on plates 1 and 5, respectively. Borings indicate sandstone bedrock exists at about elevation 596 IGLD. Materials above the bedrock consist of brown, gray, and red clays, with small amounts of sand along the shoreline.

The littoral environmental observations (LEO) have not been started at the site. A LEO program is being established and will start when the ice leaves the area. One location will be established for the observations at the left profile line.

PLAN FORMULATION

The formulation and evaluation of the protective measures to be considered are of necessity within an appropriate set of criteria. Such criteria, both technical and economic, and also intangible considerations permit the development and selection of a system of devices which may respond to the problems and needs of the area in addition to meeting the objectives of section 54 - to demonstrate low-cost means to prevent and control shoreline erosion.

TECHNICAL CRITERIA

The following technical criteria were considered:

- a. Protection should be provided against the lake level generated by the 10-year storm. Studies indicate that a design water surface level of 602.9 IGLD and a design wave of $H_s = 5.2$ feet, $H_b = 4.8$ feet, and $T = 6.2$ seconds would be applied at the toe of the structure (see appendix 2).

b. Protective works should be designed to prevent overtopping by the design storm. Maximum runup values vary from 4.6 to 11.1 feet according to the type and slope of the structure. These values are reduced to make possible an economic limit to the height of the structure compatible with the demonstration program.

c. Wave heights considered should be those expected to occur with the storm that would produce 1-foot short-term rise on the lake.

d. Protective structures should not increase erosion along the adjacent shoreline.

ECONOMIC CRITERIA

The purpose of the project, as stated in the authorizing documents, is to provide low-cost measures to demonstrate erosion control. Therefore, economic considerations are concerned with minimizing the cost per lineal foot of the devices to be constructed.

ENVIRONMENTAL AND OTHER CRITERIA

The following environmental criteria and intangibles were considered:

a. The plan should be formulated with the goal of making a significant contribution to preserving, maintaining, restoring, and enhancing the natural resources of the project area.

b. Maximum effort should be made to avoid harmful environmental effects.

c. Public health, safety, and social well-being should be considered.

d. Structures provided for demonstration purposes should be different from those used in other selected demonstration sites to provide maximum consideration of a number of devices and methods.

ALTERNATIVES CONSIDERED

As part of the guidance provided by the Shoreline Erosion Advisory Panel for the Port Wing site, revetments to include dewatering and sloping were suggested as a possible means of providing low-cost shore protection. In addition, the need for filter cloth in conjunction with concrete blocks was identified.

Several general revetment-type structures which were considered but rejected after further investigation included concrete building blocks of various sizes and types, acrylic sand pillows, large bags of high-strength synthetic fiber filled with concrete slurry to form molded blocks, concrete posts, steel bins, machine-produced tongue and groove concrete blocks, solid concrete blocks fastened together with epoxy, concrete and polyethylene parking blocks, and precast concrete sheet pile. They were dropped from consideration for one or more of the following reasons.

- a. Only temporary protection would be provided.
- b. Production or materials would have high cost.
- c. Excessive labor would be required for installation.
- d. Flotation or anchoring problems would occur.
- e. Materials are not readily available.
- f. Previous testing performance or experience was unsatisfactory.
- g. Geologic or soil conditions prohibit their use.

THE SELECTED PLAN

The selection of the plan to develop, demonstrate, and disseminate information about low-cost measures to prevent and control shoreline erosion involved the comparison of the various alternatives that met the preceding criteria. Environmental effects and comments from the Wisconsin Department of Transportation were considered.

PLAN DESCRIPTION

The selected plan is shown on plate 1. It will protect about 1,030 feet of eroding shoreline and provide a stable upper bank. The following structures will be used:

a. Steel H-piles set vertically into the sandstone bedrock on 6-foot spacing with railroad ties placed and secured between the piles. Granular backfill will be placed behind the railroad tie wall. The structure will be 200 feet long with a top elevation of 610.0 IGLD, 1955 (611.2 msl, 1929).

b. Scrap tires filled with sand and backfilled with granular material. The structure will be 150 feet long with a top elevation of 607.0 IGLD, 1955 (608.2 msl, 1929).

c. Concrete blocks laid on granular material at a top elevation of 607.0 IGLD, 1955 (608.2 msl, 1929).

(1) 16- by 24-inch cobblestones (also called concrete turf and soil reinforcement grids, grass pavers, or Turf-blocks). The cobblestones will be laid on a 1 vertical on 3 horizontal slope for a distance of 150 feet.

(2) 8- by 16-inch concrete control blocks for a length of 100 feet. The blocks will be laid on a 1V on 3H slope with the cells vertical. The control blocks have an interlocking feature which holds the blocks in position in one direction. The cells will be filled with topsoil and seeded.

(3) 12- by 16-inch concrete control blocks. These blocks will be placed in the same manner as the 8- by 16-inch blocks for a length of 100 feet.

The structures considered most effective will be placed in the area where protection is critical to the stability of the highway. Granular fill and a plastic filter cloth will be placed behind or under each protective structure at the lower portion of the bank to prevent loss of foundation material. The toe of each structure will be keyed into the lake bottom. The remaining upper portion of the bank will be shaped to provide a slope of 1 vertical on 5 horizontal from the structure to the existing ground. The graded slope will be topsoiled and seeded.

At each end of the protection and between each demonstration structure, standard riprap sections will be used to prevent possible failure of the structures due to flanking and to prevent the failure of one structure from influencing the adjacent structure. The rock will be graded from 120 to 2,000 pounds. Riprap sections will vary from 50 to 70 feet in length and will be about 3.2 feet thick with a top elevation of 607 IGLD, 1955 (608.2 msl, 1929).

PLAN ACCOMPLISHMENTS

Construction of the plan will satisfy the primary study purpose - to develop, monitor, and disseminate information on a shoreline erosion control demonstration program. The plan may also prolong the useful life of Highway 13 and reduce the loss of bank material to the lake.

EFFECT OF THE PLAN ON THE ENVIRONMENT

The protective structures will have beneficial effects on the environment by reducing the amount of land being lost annually to the lake. However, the red clay along the south shore of Lake Superior is highly erodible and, after a storm, the effect of the suspended particles can be seen in the lake several thousand feet from shore. Curtailment of the erosion at the demonstration site would have an insignificant effect on this plume or on overall water quality.

DESIGN

The details of the revetment structures are shown on plates 6 and 7. The size and location of the structures were based on existing information concerning wave height, period, and direction; slope topography, and bathymetry of the area; and construction cost. The consideration given for design standards is consistent with the Coastal Engineering Research Center Shore Protection Manual.

The structural stability of the wall and H-piles was investigated using an active earth coefficient of 0.33 for computing forces against the wall and a passive coefficient of 2.10 for determining passive pressures on the H-piling. The passive coefficient includes a factor of safety of 2.0. The resulting design consists of eight BP 32 H-piles 30 feet long at 6 feet on center with 6- by 8-inch timbers placed in the H-pile flanges.

The scrap tire structure was designed using the guidance in a report entitled "Scrap Tire Revetment" published by Carroll Engineering, Inc., Baltimore, Maryland. The design is based on the concept presented in the report and modified to better suit conditions at the project site.

The concrete cobblestones are manufactured under the trademark "Monoslabs" and are distributed by Grass Pavers, Ltd., Royal Oak, Michigan. Similar products are manufactured under other names by other companies. The structure was designed using available literature and experience.

The concrete control block structures are basically trial designs using the interlocking feature of the blocks to provide a dependable structure. Two sizes of blocks were used to better evaluate the effect that block size would have on performance.

The upper portion of the slope will be flattened to 1 vertical on 5 horizontal. Based on soils information and previous experience, a stable slope will be provided. Material excavated from the existing bank will be used as needed to fill low areas. Excess excavated material will be disposed of off site.

The riprap sections were designed in conformance with procedures recommended by the Coastal Engineering Research Center Shore Protection Manual for graded riprap.

VEGETATION

Vegetation will be used on the graded slope above the structural measures. Planting will be done immediately after the structures are completed. The Soil Conservation Service and Wisconsin Department of Transportation have concurred that the vegetative cover used should meet the requirements of Sections 625 through 631, Wisconsin Department of Transportation, Standard Specifications, Road and Bridge Construction, Edition of 1975.

Two seed mixtures will be used in conjunction with each other in accordance with Section 630 cited above. The mixtures will be composed of seeds of the purity, germination, and proportions (by weight) as given in the following table.

Seeds and mixtures to be used for vegetative cover				
Species	Seeds		Mixture	
	Percent purity	Percent germination	Percent in No. 3	Percent in No. 5
Kentucky 31 fescue	97	85	65	-
21# Kentucky bluegrass	85	80	10	-
Creeping red fescue	97	80	15	-
Red top	92	85	5	-
Perennial ryegrass	95	90	5	-
Empire birdsfoot trefoil	95	80	-	35
Crownvetch	95	70	-	65

CONSTRUCTION

The estimated time of construction is less than 1 year. During construction, only the areas needed for construction and disposal of excavated material would be cleared. All efforts would be made to disturb as little natural cover as possible and to minimize the time that the area would be without vegetative cover.

To abate and control pollution caused by the construction, the contractor and any subcontractors would be required to comply with all applicable Federal, State, and local laws and regulations.

OPERATION AND MAINTENANCE

Operation and maintenance of the structures would be a Federal responsibility and would be accomplished in accordance with Federal regulations until the demonstration program ends. At that time, the structures will be turned over to the control of the local sponsor (the State of Wisconsin) for continued maintenance or disposal.

During the demonstration program, maintenance will be limited to the level expected to be performed by a homeowner using one of the protective measures. This is believed to be in line with determining the effectiveness of various measures. If damage is so extensive that a

homeowner would probably not try to correct the problem and the failure of a structure could adversely affect the performance of an adjacent structure, repairs or corrective action will be made.

No significant problems are anticipated in the operation and maintenance of the selected plan and annual costs are expected to be minimal unless severe damage or failure occurs.

ESTIMATED COSTS

The estimated construction costs for the selected plan are given in the following table.

Summary of first costs				
Item	Unit	Quantity	Unit cost	Total cost
<u>Construction costs</u>				
<u>H-piles and railroad ties</u>				
Granular fill	CY	520	\$6.00	\$3,120
Random fill	CY	2,570	1.50	3,855
Topsoil	CY	30	3.50	105
Stripping	CY	190	3.00	570
Excavation at structure	CY	220	3.00	660
Excavation of upper bank	CY	100	2.00	200
Riprap	CY	140	25.00	3,500
Plastic filter cloth	SF	2,400	0.35	840
Seeding upper bank	SF	19,600	0.02	392
H-piles 8BP-36	Ea	35	11.00	385
Railroad ties, 6-foot	Ea	578	10.00	5,780
Steel cap	LF	200	10.00	2,000
Contingencies				<u>4,593</u>
Total H-piles and railroad ties				26,000

Summary of first costs (cont)

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit cost</u>	<u>Total cost</u>
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Construction costs (cont)

Scrap tires

Granular fill	CY	100	\$6.00	\$600
Granular fill for tires	CY	200	4.00	800
Random fill	CY	210	1.50	315
Topsoil	CY	10	3.50	35
Stripping	CY	30	3.00	90
Excavation at structure	CY	470	3.00	1,410
Excavation of upper bank	CY	1,910	2.00	3,820
Plastic filter cloth	SF	3,600	0.35	1,260
Seeding upper bank	SF	17,250	0.02	345
Tires	Ea	2,600	1.00	2,600
Stainless steel connectors	Ea	2,500	1.25	3,125
Anchors, 4-foot	Ea	32	2.00	64
Anchors, 9-foot	Ea	16	4.50	72
Contingencies				<u>2,964</u>

Total scrap tires 17,500

12-inch concrete blocks

Granular fill	CY	110	6.00	660
Random fill	CY	20	1.50	30
Topsoil	CY	40	3.50	140
Stripping	CY	10	3.00	30
Excavation at structure	CY	120	3.00	360
Excavation of upper bank	CY	1,940	2.00	3,880
Plastic filter cloth	SF	3,100	0.35	1,085
Seeding upper bank	SF	11,700	0.02	234
Seeding structure	SF	1,400	0.02	28
Concrete blocks, 12-inch	Ea	2,250	1.25	2,813
Contingencies				<u>2,240</u>

Total 12-inch concrete blocks 11,500

8-inch concrete blocks

Granular fill	CY	140	6.00	840
Random fill	CY	30	1.50	45
Topsoil	CY	40	3.50	140
Stripping	CY	10	3.00	30
Excavation at structure	CY	120	3.00	360
Excavation of upper bank	CY	1,470	2.00	2,940

Summary of first costs (cont)

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit cost</u>	<u>Total cost</u>
<u>Construction costs (cont)</u>				
<u>8-inch concrete blocks (cont)</u>				
Plastic filter cloth	SF	3,100	\$0.35	\$1,085
Seeding upper bank	SF	11,700	0.02	234
Seeding structure	SF	1,400	0.02	28
Concrete blocks, 8-inch	Ea	3,375	1.00	3,375
Contingencies				<u>1,923</u>
Total 8-inch concrete blocks				11,000
<u>Concrete cobblestone</u>				
Granular fill	CY	260	6.00	1,560
Random fill	CY	90	1.50	135
Topsoil	CY	20	3.50	70
Excavation at structure	CY	190	3.00	570
Excavation of upper bank	CY	2,400	2.00	4,800
Plastic filter cloth	SF	4,650	0.35	1,628
Seeding upper bank	SF	17,250	0.02	345
Seeding structure	SF	3,300	0.02	66
Cobblestones	Ea	1,725	3.80	6,555
Contingencies				<u>3,271</u>
Total concrete cobblestone				19,000
<u>Riprap</u>				
Granular fill	CY	240	6.00	1,440
Random fill	CY	980	1.50	1,470
Stripping	CY	100	3.00	300
Excavation at structure	CY	500	3.00	1,500
Excavation of upper bank	CY	3,050	2.00	6,100
Riprap	CY	1,100	25.00	27,500
Plastic filter cloth	SF	10,460	0.35	3,661
Seeding upper bank	SF	35,300	0.02	706
Contingencies				<u>8,823</u>
Total riprap				51,500
Total construction costs				136,500
<u>Supervision and administration</u>				
Inspection				6,000
Overhead				<u>2,500</u>
Total supervision and administration				8,500
Total first costs				<u>145,000</u>

DIVISION OF PLAN RESPONSIBILITIES

This section presents information on the various Federal and non-Federal responsibilities for implementing the selected plan.

COST ALLOCATION AND APPORTIONMENT

The authorizing document provides that the local sponsor, in the case of a demonstration site located on private or non-Federal public lands, shall pay at least 25 percent of the construction cost and assume operation and maintenance costs upon completion of the project. In addition, the sponsor shall provide all necessary lands, easements, and rights-of-way and the cost thereof shall not be considered toward the required share of the construction cost.

The State of Wisconsin, in its capacity as sponsor, has agreed to provide services during the project duration as a supplement to the cash contribution to compensate for its construction share. The estimated total cost of construction is \$145,000 and is shown in the preceding table. The estimated State share is \$36,250.

FEDERAL RESPONSIBILITIES

After approval of this plan and upon receipt of the non-Federal assurances of local cooperation and the necessary funding, the United States would design and prepare detailed plans, award the necessary construction contracts, and supervise the construction. When construction is completed the United States would monitor the project and provide needed maintenance until the project is ended and transferred to the local sponsor.

NON-FEDERAL RESPONSIBILITIES

The non-Federal sponsor, the State of Wisconsin, has given satisfactory assurances that, if the Government starts construction of this project substantially in accordance with the plans in this report and with Federal legislation authorizing the project, it will:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction, operation, maintenance, repair, monitoring, and demonstration of the project, as defined by the Chief of Engineers or his designee.

b. Pay or contribute in services and cash 25 percent of the total first cost of construction of the project presently estimated to be \$145,000. Such construction costs shall be computed in accordance with the schedule set out in exhibit A of the agreement with the State.

c. Assume all costs of operation, maintenance, and repairs of the project upon its completion. "Completion of the project" is defined as that date on which the Government has terminated its responsibilities for construction, operation, evaluation, and demonstration of the project and transferred all of its jurisdiction and control over the project to the State. Based upon current authorized and continued Federal funding, the completion date is expected to be 30 September 1980 unless extended by subsequent congressional authority.

d. Hold and save the United States free from all damages arising out of the State's obligations as set forth in the agreement. However, the State shall not be responsible for damages due to the fault or negligence of the United States or its contractors in the construction, operation, maintenance, repair, monitoring, and demonstration of the project.

e. Permit public access to, and continue public use of, the shoreline to be protected by the project. Such public access shall be made available at no fee, either on an open basis or by schedule, during the life of the Port Wing Demonstration Project.

f. Comply with Sections 210 and 305 of the Uniform Relocation Assistance and Land Acquisition Policies Act of 1970 approved 2 January 1971 (Public Law 91-646).

g. Furnish an assurance that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000 d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto published in Part 300 of Title 32, Code of Federal Regulations.

PLAN IMPLEMENTATION

The following steps will be taken after this report is submitted:

a. An environmental assessment and negative declaration will be circulated to all interested agencies and individuals. If comments on the assessment reveal significant adverse environmental effects or if sufficient public opposition is indicated, an environmental impact statement will be prepared and circulated.

b. This report will be reviewed by North Central Division in Chicago, Illinois, and the Chief of Engineers in Washington, D.C.

c. The Chief of Engineers will authorize construction of the project.

d. Congress will be notified of project authorization. (The date that Congress is notified is the effective date of project authorization.)

e. Plans and specifications including detailed engineering cost estimates will be prepared.

f. The agreement with the sponsor, the State of Wisconsin, will be processed and signed.

g. The project will be advertised for bids.

h. The contract will be awarded.

i. The project will be constructed and monitoring will begin.

j. The project will be turned over to the State of Wisconsin which will assume responsibility for operation and maintenance.

It is not possible to accurately estimate a schedule for the above steps because of variables in the reviewing and funding process. However, the following time objectives have been established:

a. April 1978 - Report approval from the Chief of Engineers.

b. May 1978 - Completion of plans and specifications.

c. June 1978 - Advertise for construction.

d. July 1978 - Contract awarded.

e. August-September 1978 - Construction of the project.

f. October 1978-September 1980 - Monitor project.

VIEWS OF NON-FEDERAL INTERESTS

The project plans were coordinated with various State, local, and nongovernmental interests. Statements by those interests are contained in appendix 1.

REVIEW BY OTHER FEDERAL AGENCIES

Letters and comments received from other Federal agencies are also contained in appendix 1.

PROJECT MONITORING PROGRAM

GENERAL

The project for Port Wing is scheduled for installation in 1978 and will be followed by a monitoring program ending in September 1980. The monitoring program consists of certain physical observations to be accomplished before, during, and after construction. Data to be obtained involve the base conditions without any structures in place, conditions during construction, and the behavior of the test site and the structures following completion of construction. The estimated cost of the monitoring program is shown in the following table.

Estimated monitoring cost

Item	Cost			Total
	FY 78	FY 79	FY 80	
Surveys (topographic and bathymetric)	\$9,000	\$14,300	\$15,700	\$43,000
LEO observations	2,700	4,000	4,000	12,000
Sand samples	700	800	900	2,400
Visual inspections: visits, write-ups, and ground photography	3,200	5,000	5,200	15,000
Aerial photography	2,800	3,100	3,400	9,300
Data reduction and analyses (typing, ADP cards, drafting)(1)	1,400	2,300	2,500	6,900
Evaluative reports and correspondence	1,000	3,000	5,000	10,000
Total	20,800	32,500	36,700	98,600

(1) These costs do not include charges for the Coastal Engineering Research Center to perform final analysis.

WAVE DATA

No wave gages are located in the area. The cost of installing the necessary equipment was not considered warranted for the limited data to be acquired.

LEO OBSERVATIONS

Littoral environment observations (LEO) will be made at the project site on a twice daily basis. These observations will include the wave characteristics, surf zone, wind speed and direction, foreshore slopes, longshore current, ripcurrents, beach cusps, and water level variations. LEO observations will be suspended each year when the lake freezes.

TOPOGRAPHIC AND BATHYMETRIC SURVEYS

Surveys were made before project construction and will be made during construction and following construction until project termination. Surveys would be accomplished three times a year during the spring, summer, and fall quarters. Surveys would not be done during the winter due to snow cover and lake freeze-up.

VISUAL INSPECTIONS

The functional performance of the structure and the effect on the adjacent area would be observed monthly and a standard report form prepared. Ground level photographs would be taken during the monthly inspection to further document structural and vegetative changes.

AERIAL PHOTOGRAPHY

Vertical color and color infrared photographs would be obtained three times a year in April, July, and October during the demonstration period. Photos would not be taken during the winter due to the snow cover. The photography scale would be 1 inch = 200 feet (1:2,400)

with 60-percent overlap, 9- by 9-inch prints. Approximately 1 mile of shoreline will be covered with each flight.

DATA REDUCTION AND ANALYSIS

To establish a standard base that all demonstration projects can be measured against is the responsibility of the Chief of Engineers and the Coastal Engineering Research Center. The District office will support this effort by establishing and maintaining the system of data collection. A program is required to reduce, collate, and analyze the data as they become available. This would be accomplished the month following the aerial photography and the topographic and bathymetric surveys.

ENVIRONMENTAL ASSESSMENT

An environmental assessment has been prepared for this project. The environmental review process indicated that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, an environmental impact statement will not be prepared. A negative declaration was prepared and is being coordinated in accordance with ER 1105-2-507 (4)(b)(2).

RECOMMENDATIONS

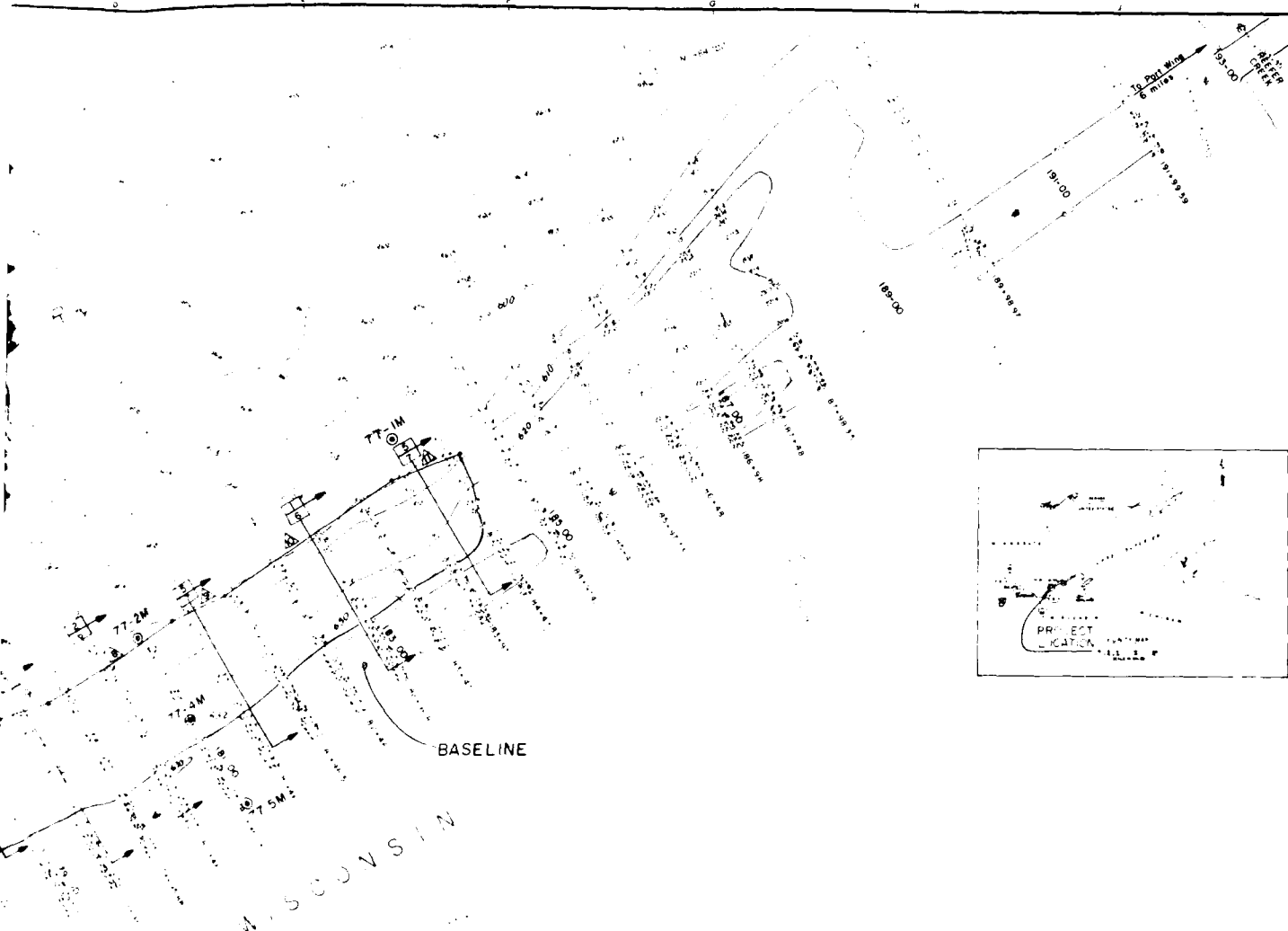
It is recommended that a project under the authority of section 54 of the Water Resources Development Act of 1974 be approved in accordance with the plan described in this report, subject to such modifications as in the discretion of the Chief of Engineers may be advisable.

Non-Federal interests will be responsible for fulfilling the requirements of the local sponsor as outlined in this report to include the payment in cash and/or services equivalent to 25 percent of the total first cost of construction.

The remaining 75 percent of the total first cost of construction, the operation and maintenance of the project, and the monitoring until project completion are a Federal responsibility.

The total first cost of construction is estimated to be \$145,000. The cost of the monitoring program is estimated to be \$20,800 in fiscal year 1978, \$32,500 in fiscal year 1979, and \$36,700 in fiscal year 1980.

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer



For all data on the U.S. Coast of Transportation No. 977
 the vertical curve are adjusted to U.S.G.S. 1929 datum
 and the horizontal curve are adjusted to 1960-1955
 bearings are shown in degrees
 angles are shown in degrees and minutes
 and seconds as shown on the plan

CONTROL LINE DATA				
REACH	STATION	OFFSET	LENGTH	TYPE OF PROTECTION
▲	174+48	259	50.446	R-PRAP
▲	174+97	247	50.614	CONCRETE
▲	176+45	218	50.249	R-PRAP
▲	176+95	213	100.020	CONCRETE CONTROL BLOCKS
▲	177+93	193	49.244	R-PRAP
▲	178+41	182	100.285	CONCRETE CONTROL BLOCKS
▲	179+40	168	50.000	R-PRAP
▲	179+88	152	50.163	SCRAP TIRES
▲	181+38	145	58.052	R-PRAP
▲	181+95	134	200.003	H-PILES & RAILROAD TIES
▲	183+95	133	70.342	R-PRAP
▲	184+63	115		

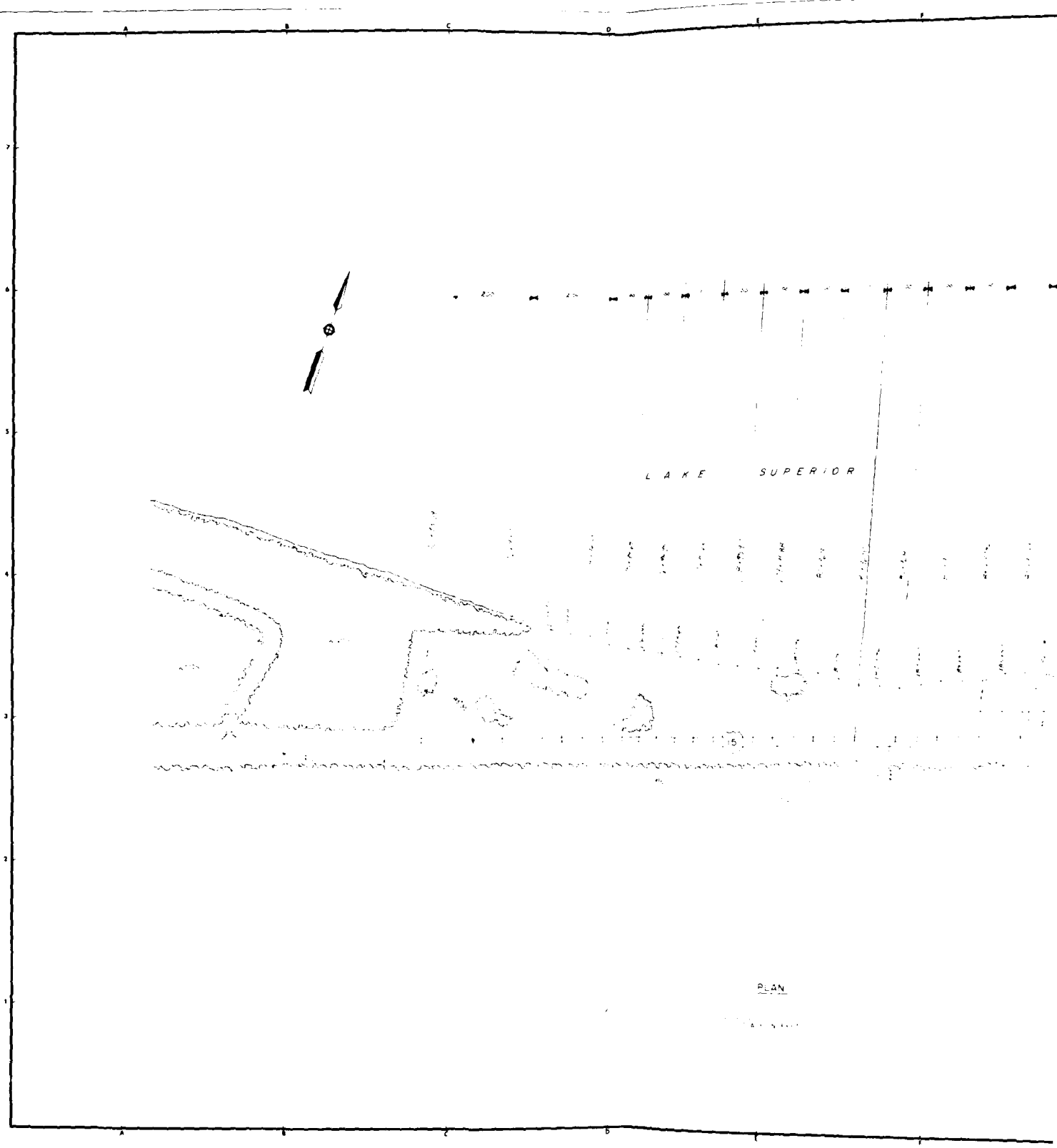
IDENTIFICATION
 SECTION 4.4 SECTION NUMBER

PLATE NUMBER WHERE
 SECTION IS SHOWN IN
 PLAN
 OR
 PLATE NUMBER WHERE
 SECTION IS DRAWN

TYPICAL SECTION FOR
 REACHES SHOWN INDICATE
 TYPICAL CROSS SECTION
 GROUND SURFACES VARY
 WITHIN REACHES SHOWN



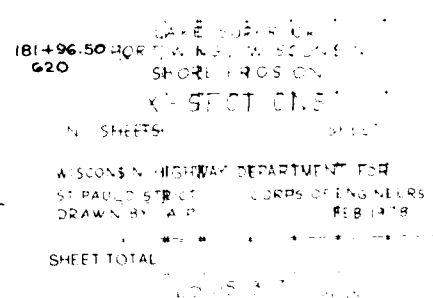
SYMBOL	DESCRIPTION	DATE	APPROVED
DEPARTMENT OF THE ARMY 1 ST AVIA DISTRICT CORPS OF ENGINEERS ST. PAUL, MINNESOTA			
LAKE SUPERIOR SHORELINE EROSION CONTROL DEMONSTRATION PROJECT STATE TRUNK HIGHWAY 13 NEAR PORT WING, WISCONSIN PLAN, CONTROL & VICINITY MAP			
DESIGNED BY	D.L.P.		
DRAWN BY	AP		
SUBMITTED BY	L.D.		
APPROVED BY	LT - MAJOR		
DATE		MARCH 1976	
DRAWING NUMBER		LSII-R-61/2	
SHEET		OF	



• 2 2 2 •

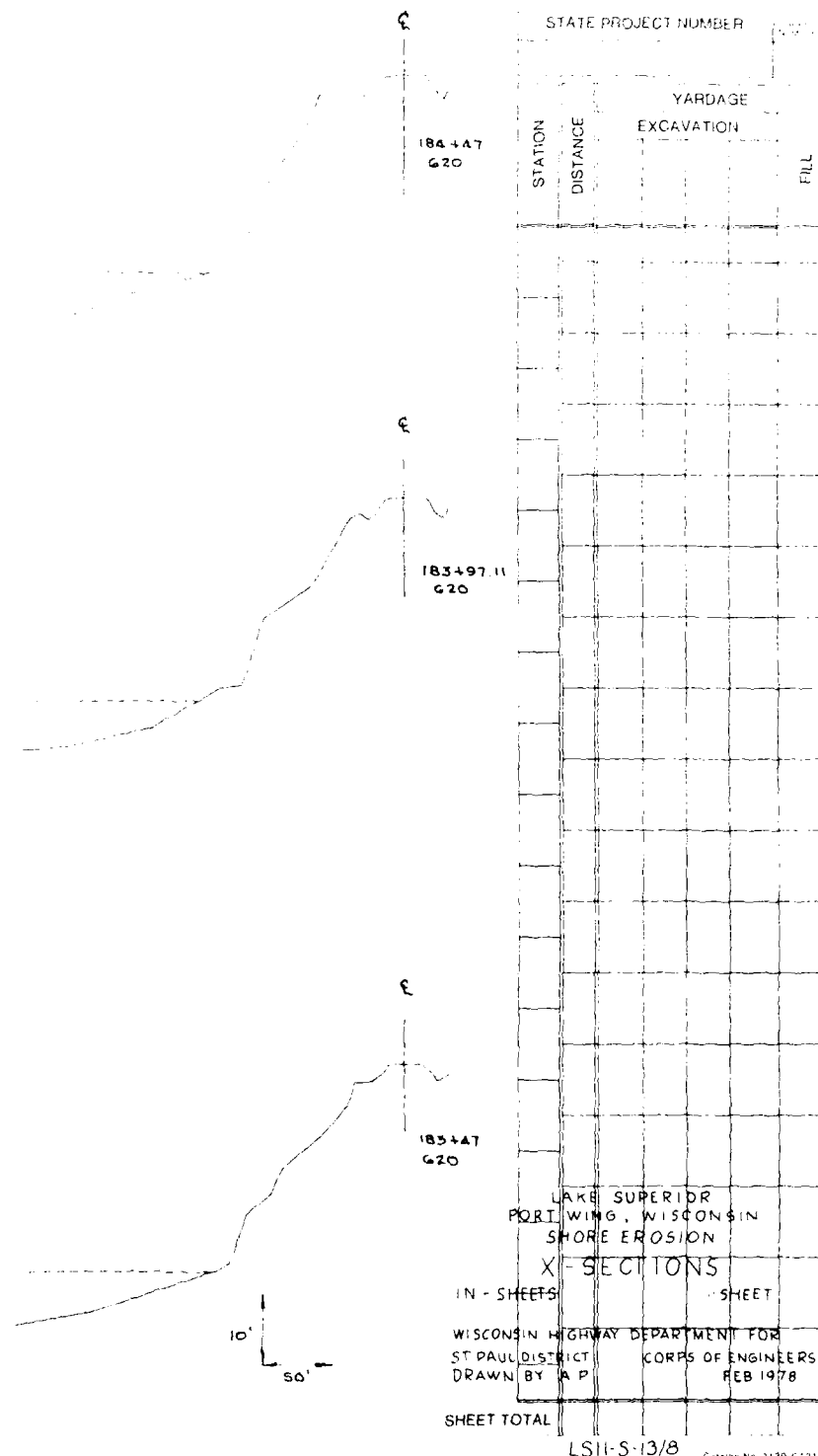
[illegible]

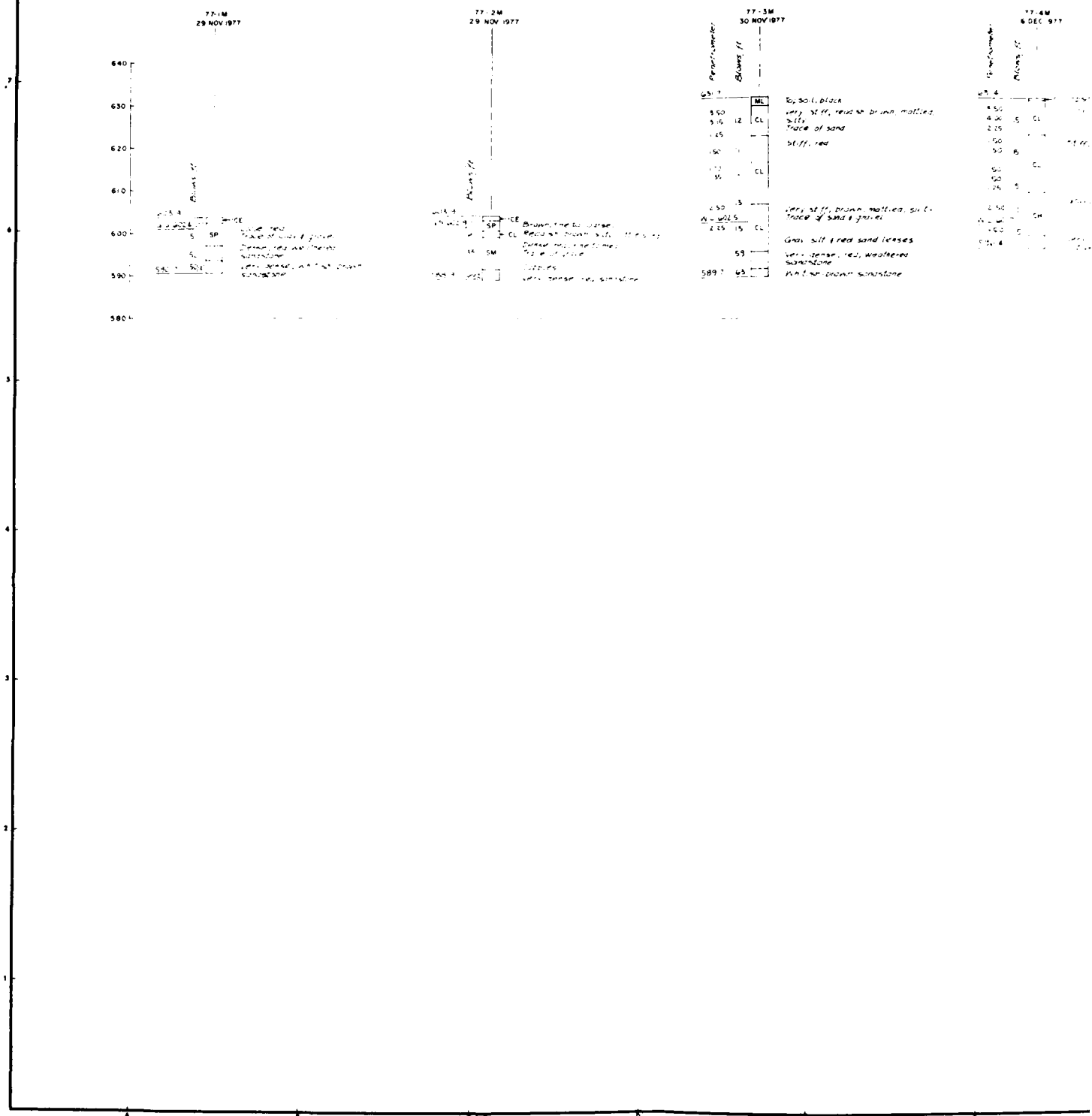
Continuation of Report on the Survey of the
Field Notes - Block 1, No. 1
Surveys done by Wisconsin Dept. of Nat.



Location of X Section on Dwas. 15005-1026-003
Data notes: 15005-1026-003
Surveys done by Wisc Hwy Dept Nov 77

Location of X Section on Dwg. LSII-S-10/2 & 10/3
 Field notes - - - - - BOOK LSII-S-1
 Surveys done by Wisc Hwy Dept Nov 77





77-5M
30 NOV 1977

77-4M
8 DEC 1977

77-5M
1 DEC 1977

77-5M
30 NOV 1977

77-4M
8 DEC 1977

77-5M
1 DEC 1977

77-5M
30 NOV 1977

77-4M
8 DEC 1977

77-5M
1 DEC 1977

640
630
620
610
600
590
580

BORING LEGEND

DESCRIPTION

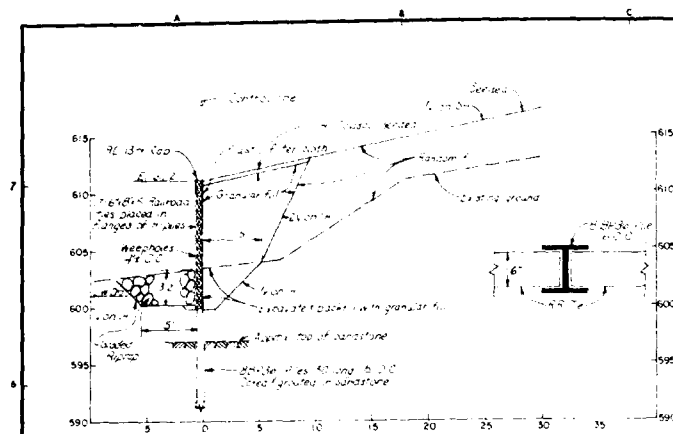
SP Poorly graded sands, little or no fines.
SM Silty sands.
ML Inorganic silts, liquid limit less than 50.
CL Inorganic clays, low to medium plasticity, LL less than 50.
CH Inorganic clays, high plasticity, liquid limit greater than 50.
WL Water level of date of boring.
77-1M Machine boring.

BORING NOTES

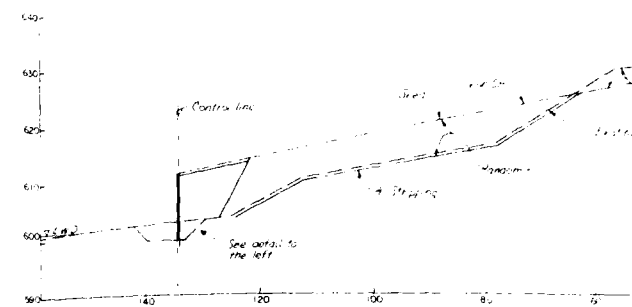
- GENERAL** The legend represents only the basic soils. To complete the classification pertinent information is added to the right of the boring log.
- 2. PENETROMETER** The unconfined strength value shown in tons per square foot is shown to the left of the boring log. The values were obtained from undisturbed samples using a 40, 100 pound Penetrometer.
- 3. BLOW COUNT** Blow counts are shown to the left of the boring logs and are the number of blows necessary to drive a 14" x 2" sampler a distance of 18" unless otherwise noted using a 40 lb hammer and 80" drop.
- 4. ELEVATIONS** All elevations are referred to U.S. M.S.L. 1929 datum.



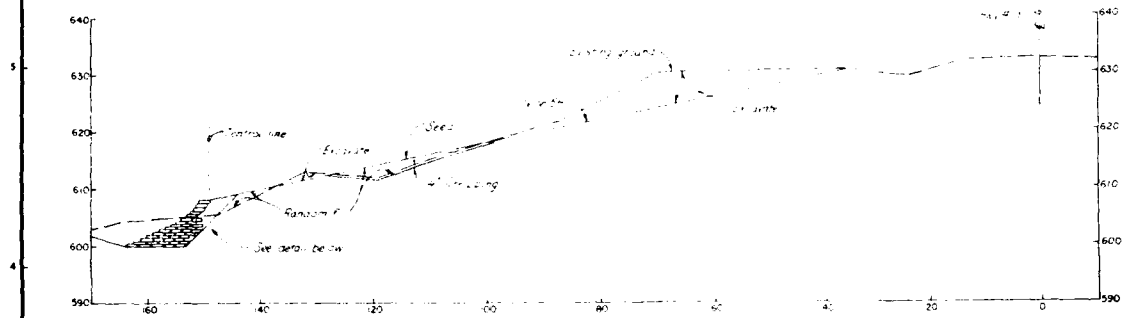
SYMBOL	DESCRIPTION	DATE	APPROVAL
DEPARTMENT OF THE ARMY ST PAUL DISTRICT CORPS OF ENGINEERS ST PAUL, MINNESOTA LAKE SUPERIOR SHORELINE EROSION CONTROL DEMONSTRATION PROJECT STATE TRUNK HIGHWAY 13 NEAR PORT WING, WISCONSIN BORING LOGS			
DESIGNED BY	D. L. P.	DATE	MARCH, 1978
DRAWN BY	A. B.	AS SHOWN	
CHECKED BY	L. D.	DRAWING NUMBER	LS11-R-61/6
SUBMITTED BY		SHEET	OF
APPROVED			



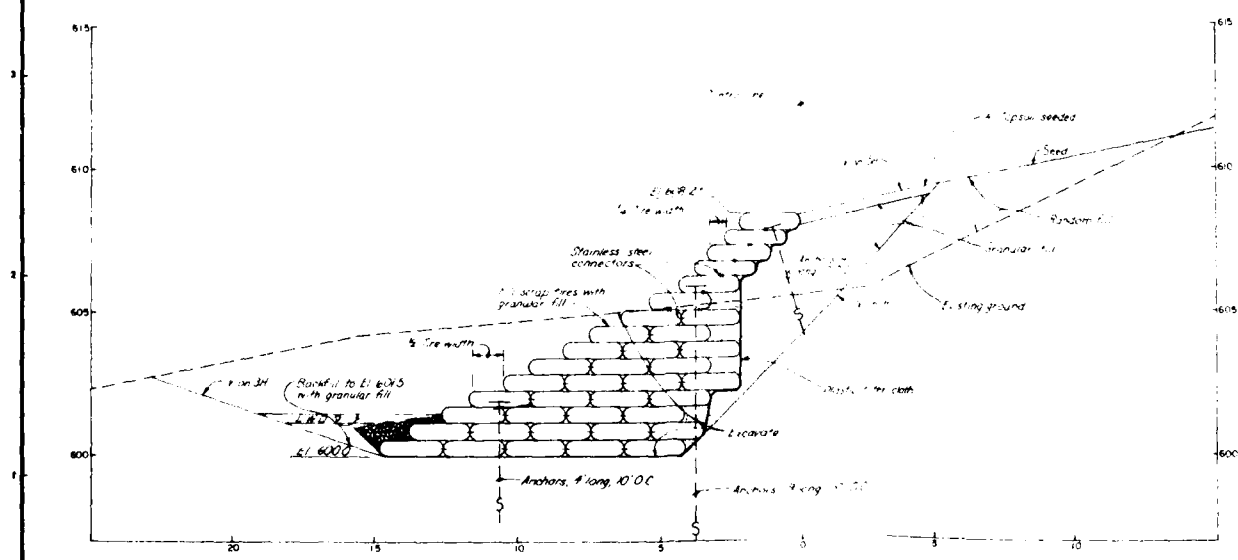
RAILROAD TIE - PILE DETAIL



H-PILE AND RAILROAD TIE CROSS SECTION



SCRAP TIRE STRUCTURE SECTION 2-1



SCRAP TIRE DETAIL



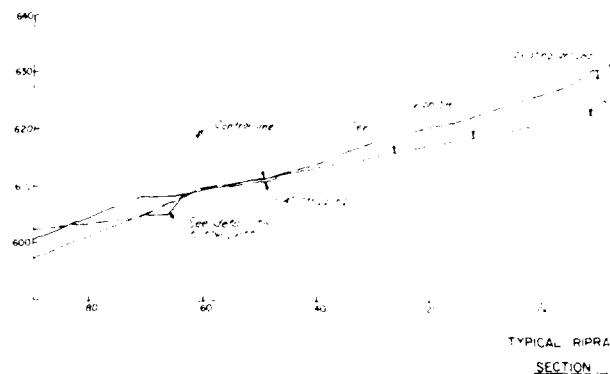
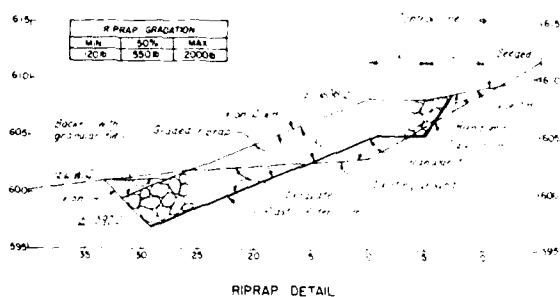
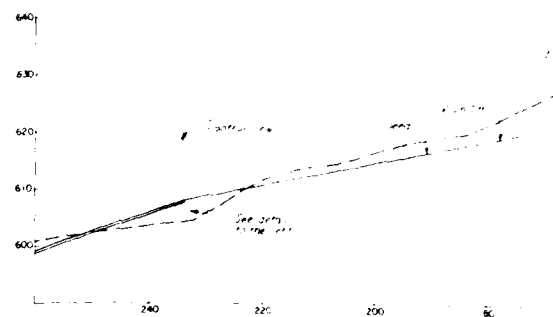
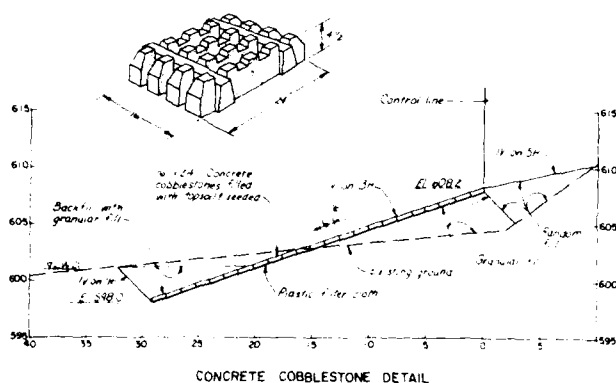
SECTION 3



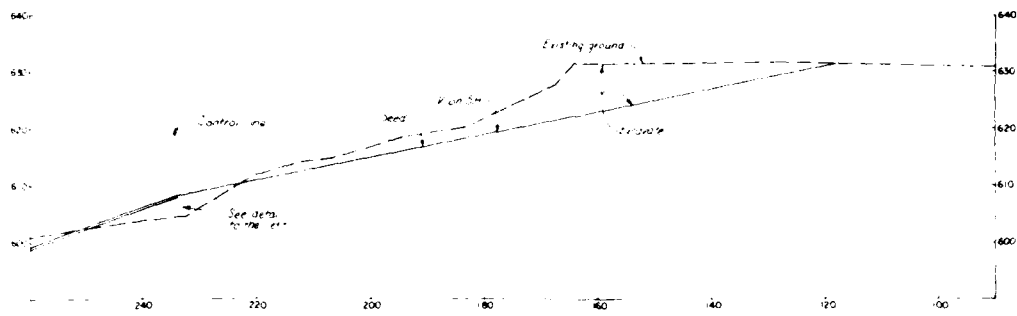
Note
 Elevations shown are adjusted to
 1929 datum



DRAWING NO. _____ DATE _____
 APPROVED BY _____
 CHECKED BY _____
 DESIGNED BY _____
 DATE _____
 DRAWN BY _____
 DATE _____
 PROJECT NO. _____
 PROJECT NAME _____
 PROJECT LOCATION _____
 PROJECT DESCRIPTION _____
 PROJECT STATUS _____
 PROJECT OWNER _____
 PROJECT MANAGER _____
 PROJECT ENGINEER _____
 PROJECT ARCHITECT _____
 PROJECT CONSULTANT _____
 PROJECT CONTRACTOR _____
 PROJECT SUBCONTRACTOR _____
 PROJECT SUBSIDIARY _____
 PROJECT DIVISION _____
 PROJECT DEPARTMENT _____
 PROJECT SECTION _____
 PROJECT SUBSECTION _____
 PROJECT DRAWING NO. _____
 PROJECT DRAWING DATE _____
 PROJECT DRAWING SCALE _____
 PROJECT DRAWING STATUS _____
 PROJECT DRAWING OWNER _____
 PROJECT DRAWING MANAGER _____
 PROJECT DRAWING ENGINEER _____
 PROJECT DRAWING ARCHITECT _____
 PROJECT DRAWING CONSULTANT _____
 PROJECT DRAWING CONTRACTOR _____
 PROJECT DRAWING SUBCONTRACTOR _____
 PROJECT DRAWING SUBSIDIARY _____
 PROJECT DRAWING DIVISION _____
 PROJECT DRAWING DEPARTMENT _____
 PROJECT DRAWING SECTION _____
 PROJECT DRAWING SUBSECTION _____



1. 2000
 2. 2000
 3. 2000



CONCRETE COBBLESTONE STRUCTURE

SECTION 4
1



TYPICAL RIPRAP SECTION

SECTION 5
1

Notes:
1. Riprap shall be placed in a 1:1 sand fill.
2. Riprap shall be placed in a 1:1 sand fill.



DESIGNED BY	DESCRIPTION	DATE	APPROVED
REVIEWED BY	LAKE SUPERIOR		
DESIGNED BY	SHORELINE EROSION CONTROL		
REVIEWED BY	NEAR PORT WING, WISCONSIN		
DESIGNED BY	DEMONSTRATION PROJECT		
REVIEWED BY	TYPICAL SECTIONS		
DESIGNED BY	DATE	MARCH 1978	
REVIEWED BY	AS SHOWN		
DESIGNED BY	DRAWING NUMBER	LSII-R-61/8	
REVIEWED BY	SHEET	OF	

APPENDIX 1

PERTINENT CORRESPONDENCE

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LETTER FROM THE U.S. GEOLOGICAL SURVEY, 15 FEBRUARY 1978	1-3
LETTER FROM THE NORTHWEST REGIONAL PLANNING COMMISSION, 16 FEBRUARY 1978	1-4
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RICHARD A. ERNEY, DIRECTOR

February 8, 1978

Colonel Forrest T. Gay, III
District Engineer
St. Paul District, Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

SHSW 0090-78
RE: NCSED-PB
Shoreline erosion project

Dear Colonel Gay:

We have examined the information you submitted concerning the shoreline erosion control project near Port Wing in Bayfield County, Wisconsin.

Our comments on the effect that this project might have on historical or archeological resources will have to await our review of the results of the cultural resources reconnaissance survey undertaken in the summer of 1977.

For your records, please note that Richard A. Erney is now Director of the State Historical Society of Wisconsin and State Historic Preservation Officer. If we can be of any further assistance, please contact Mr. Richard W. Dexter (608/262-2732) in the Historic Preservation Division.

Sincerely,

Richard A. Erney
State Historic Preservation Officer

By Jeff Dean
State Preservation Planner

RAE:rdc

Appendix 1
1-1



MUSEUMS DIVISION

Accredited by the American Association of Museums

February 13, 1978

Colonel Forrest T. Gay III
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Re: Section 54
Shoreline Erosion Control
S.T.H. 13 Bayfield Co.

Dear Colonel Gay:

There are no known archaeological sites in the above mentioned project (T49N, R9W - Section 4). We will be conducting an archaeological survey of the proposed new highway right-of-way later this year and will report to you should and material of archaeological significance be discovered.

Sincerely,

John T. Penman
Highway Archaeologist

JTP:jf

cc: Jon Novick
Department of Transportation

Appendix 1
1-2

THE STATE HISTORICAL SOCIETY OF WISCONSIN

816 STATE STREET - MADISON, WISCONSIN 53706 RICHARD A. ERNEY, DIRECTOR



United States Department of the Interior

GEOLOGICAL SURVEY

Water Resources Division
1815 University Avenue
Madison, Wisconsin 53706

February 15, 1978
(Att.: NCSED-PB)

Forrest T. Gay
Colonel, Corps of Engineers
District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

Thank you for allowing us to review your preliminary report,
"Section 54, Shoreline Erosion Control Demonstration Project, Lake
Superior at State Trunk Highway 13 near Port Wing, Bayfield County,
Wisconsin".

We have no significant comments to offer in regard to the proposed
project or the report. The report has been kept for our files.

Sincerely,

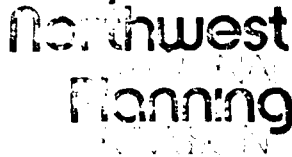
J. H. Green

Assistant District Chief

JHG/bjh



Appendix 1
1-3



an economic development district

EXECUTIVE COMMITTEE

CHAIRMAN
Charles J. Jander
VICE CHAIRMAN
Robert K. Kuntz
SEC. Y. TREASURER
Marion H. H. H.
EXECUTIVE DIRECTOR
John E. Post

• **ASHLAND COUNTY**
Robert J. Jander
• **BAYFIELD COUNTY**
Robert J. Jander
• **BURNETT COUNTY**
Robert J. Jander
• **DOUGLAS COUNTY**
Robert J. Jander
• **IRON COUNTY**
Robert J. Jander
• **PRICE COUNTY**
Robert J. Jander
• **RUSK COUNTY**
Robert J. Jander
• **SAWYER COUNTY**
Robert J. Jander
• **TAYLOR COUNTY**
Robert J. Jander
• **WASHBURN COUNTY**
Robert J. Jander

• **INDIAN RESERVATIONS**
Robert J. Jander

February 16, 1978

Colonel Forrest Gay, III
Corps of Engineers
130 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

SUBJECT: Section 54, Shoreline Erosion Control Demonstration Project, Lake Superior at State Trunk Highway 13 near Port Wing, Bayfield County, Wisconsin

Dear Colonel Gay:

The staff of the Northwest Regional Planning Commission has reviewed the project document and wishes to make the following comments:

1. The Northwest Regional Planning Commission supports the proposed project and offers any technical assistance that it may provide for the prompt completion of the project.
2. The Red Clay Project has taken an unofficial position of support for the project, since the Corps of Engineers did not request a review of the proposed project by the Red Clay Project.
3. The Northwest Regional Planning Commission suggests that some level of cooperation be undertaken between the Corps of Engineers and the Red Clay Project to provide for a free exchange of technical information. In addition, we would suggest that a future monitoring plan be developed by the Corps of Engineers to include monitoring of the Red Clay Project shoreline activities at Madeline Island and Madigan Beach in Ashland County after Red Clay Project termination.

If you have any questions, please feel free to call.

Sincerely,

John E. Post
John E. Post
Executive Director

JEH:ml

Appendix 1
1-4



United States Department of the Interior

BUREAU OF OUTDOOR RECREATION

LAKE CENTRAL REGION

FEDERAL BUILDING

ANN ARBOR, MICHIGAN 48107

ON FILE DEER TO:

D6427GL

Lake Superior

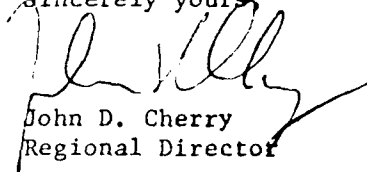
February 17, 1978

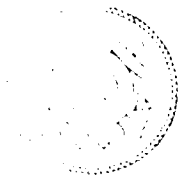
Colonel Forrest T. Gay III
District Engineer
U.S. Army Corps of Engineers,
St. Paul District
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

We have reviewed your preliminary report entitled "Section 54,
Shoreline Erosion Control Demonstration Project, Lake Superior at
State Trunk Highway 13 near Port Wing, Bayfield County, Wisconsin,"
and have no comments to offer at this time. There are no recrea-
tion projects involving Land and Water Conservation Fund monies in
this immediate area.

Sincerely yours


John D. Cherry
Regional Director



DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER (ecv)
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199
Phone: (216) 522-3934

11014

23 February 1978

Department of the Army
St. Paul District Corps of Engineers
Attn: Colonel Forrest T. GAY, III
District Engineer
1135 E. S. Post Office & Custom House
St. Paul, Minnesota 55101

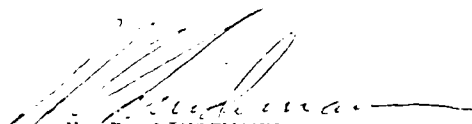
Sir Colonel GAY:

Your Shoreline Erosion Control Demonstration Project on the southern
shore of Lake Superior is of major interest to us. We routinely
encounter erosion problems in our marine projects.

We do not have any specific comments on your preliminary report but
have reviewed it with interest.

We would like to continue to receive all information on the project as
it develops. Some of our engineers are interested in visiting the
demonstration site at appropriate times to gather first hand knowledge
and experience.

Your consideration in this matter is greatly appreciated.


H. E. LINDEMANN
Chief of Staff



UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

FEB 14 1978

Colonel Forrest T. Gay, III
District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

We appreciate your letter of February 3, 1978 in which you discussed the Shore Erosion Demonstration Project, Lake Superior at State Trunk Highway 13 near Port Wing, Bayfield County, Wisconsin. We have reviewed the attached preliminary and reconnaissance report and have only minor comments.

Our Agency has worked with State and local agencies to develop an erosion control program for the red clay counties of Wisconsin. In order to assist us in our erosion control program, we request that a long-term monitoring program be coordinated with our Red Clay Project.

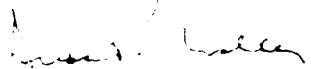
In the past year, a similar erosion control project was initiated along the Ashland County Shoreline. Longard tubes, sand filled plastic tubes, were placed on Madigan Beach for shoreline protection and a sampling evaluation program was established. If a monitoring program is initiated at this site, we recommend that the water be sampled for heavy metals, oil, and 100 or other elements present in the tires which may leach out.

From the map, it appeared the area of severe erosion is sparsely vegetated. The shoreline to the east and west does not have the erosion problem. These areas of shoreline are also heavily wooded. Consideration should be given in the revegetation program to use of native tree species to add soil stability.

-2-

We appreciate the opportunity to review this shore erosion demonstration program. If you have any questions in regard to our comments, please contact Mr. William D. Franz at 353-2307 or Mr. Carl Wilson at 353-2165. Mr. Wilson is the Red Clay Project officer for our Agency.

Sincerely,



Susan P. Walker, Chief
Environmental Impact Review Staff
Office of Federal Activities

APPENDIX 2

TECHNICAL DESIGN DATA

APPENDIX 2

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APPENDIX 2

LAKE LEVELS

Each year, the water surface elevation of Lake Superior is subject to a consistent seasonal rise and fall. The lake level usually reaches its lowest stage in March at about the close of winter and attains its highest stage during the late summer, usually in September. The amount of this annual fluctuation varies irregularly from year to year. Records at Duluth, Minnesota, from 1860 to 1978 indicate that the greatest annual fluctuation, based on the highest and lowest monthly means for a particular year, was 2.67 feet in 1869. The lowest annual fluctuation was 0.41 foot in 1929. For the period 1900 to 1970, the average fluctuation was 1.10 feet with the low in March and the high in September.

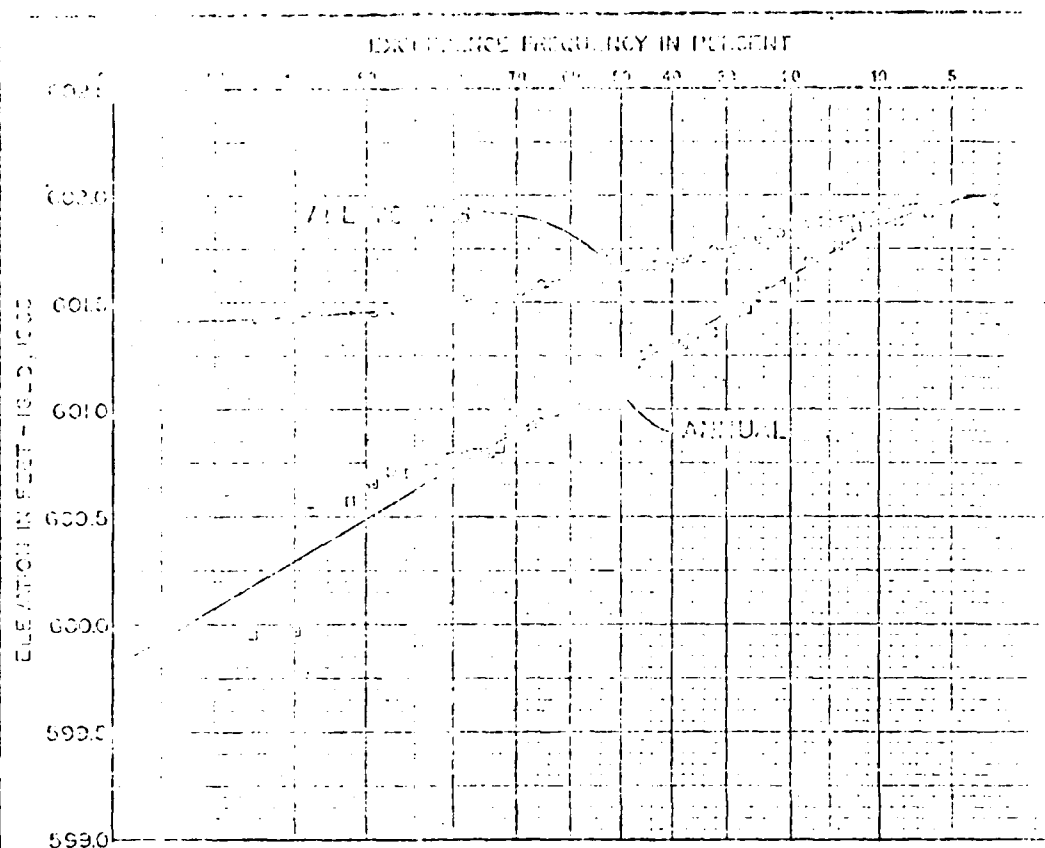
In addition to the annual fluctuations, oscillations of irregular amount and duration occur. These short-term changes are referred to as wind setup and seiche. They are caused by differential atmospheric pressures and by the tractive force of wind on the water surface. Changes of this type can be up to 2 feet but seldom exceed 1 foot above or below the normal level. The unusually severe storm of 28 November 1905 temporarily raised the water level by 2.3 feet in Duluth-Superior Harbor.

Because it was undesirable for navigation charts to show greater depths than were available, the U.S. Lake Survey in 1901 adopted new reference planes for use on its charts. The planes were called "Standard Low Water" and were selected such that their elevations would be lower than any stage that might be expected to occur during the navigation season. These planes are now called the Low Water Datums for the lakes; for Lake Superior the level is set at elevation 600 IGLD (International Great Lakes Datum) 1955. Federal navigation improvement depths are also referred to this datum plane.

The discharge of water from Lake Superior to the lower lakes has been completely regulated by control structures since 1921. These control structures are located on the St. Marys River at the head of St. Marys Falls. They have been operated under Orders of Approval of the International Joint Commission to maintain the mean monthly level of the lake as closely as possible between 600.5 and 602.0 feet. The highest recorded mean monthly water surface elevation at Duluth was 602.03 in August 1973; the lowest was 598.02 in April 1926. For the period 1900 to 1970, the average low in March was 599.83 feet and the average high in September was 600.93 feet.

For the Port Wing Highway 13 site, the design water surface level was computed as follows:

Duluth gage, 10-year mean monthly level	601.93
Duluth gage, 1-year short-term rise	<u>1.00</u>
Design level	602.93

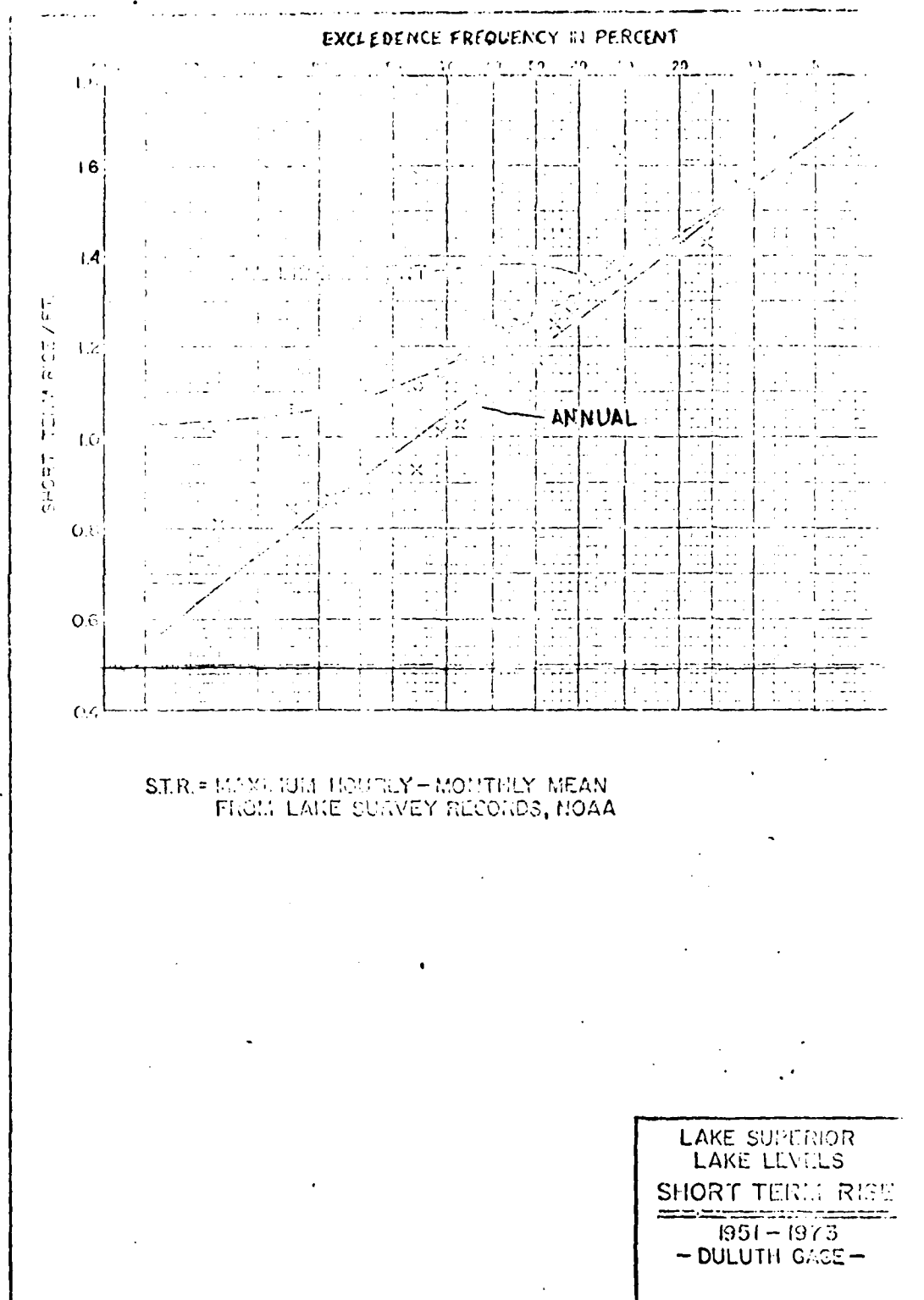


NOTE: LAKE SUPERIOR OUTFLOW BECAME FULLY REGULATED IN 1921. LAKE LEVELS RECORDED PRIOR TO 1921 WERE NOT USED FOR THIS FREQUENCY STUDY. ALL POINTS PLOTTED USING LEARDS PLOTTING POINTS.

ANNUAL CURVE - BASED ON HIGHEST MEAN MONTHLY LEVEL FOR EACH YEAR

ALL MONTHS CURVE - BASED ON ALL THE MEAN MONTHLY LEVELS FOR THE PERIOD OF RECORD.

LAKE LEVEL - FREQUENCY CURVES
LAKE SUPERIOR DULUTH GAGE
PERIOD OF RECORD: 1921 - 1974
13 DECEMBER 1974



Appendix 2
2-4

[Faint, illegible text]

CALCULATION OF DESIGN WAVE

The design wave was taken from the Waterways Experiment Station's "Design Waves for Lake Superior."

Site #15

Azimuth angle = 180° (wind from north)

Deepwater wave = 13.1 feet, $T = 7.6$ seconds, $L_o = 296$ feet

	<u>Slope</u>
Foreshore	0.013
Nearshore	0.036
Toe	0.090
Bluff	0.350
Offshore	0.010

Distance to breakers = 324 feet from shoreline

$d_s = 6.1$ feet

Consider a wave of $H_o = 13.1$ feet, $T = 7.6$, $L_o = 296$ feet

Toe depth = 6.1 feet

Bottom slope = 0.01 (offshore)

Find breaking depth

Average refraction coefficient for a 7.6-second wave is 0.84 (from Minnesota Point report)

$$d_s/L_o = 6.1/296 = 0.0206$$

$$H/H_o' = 1.213$$

$$H_s = 13.1 \times 0.84 \times 1.213 = 13.3$$

$$H_o' = 11.0, H_o'/gT^2 = 11.0/1,860 = 0.0059$$

$$H_b/H_o' = 0.96, H_b = 10.6 \text{ feet}, H_b/gT^2 = 0.0057$$

Breaking depth range: $B = 1.22$ 12.9 feet

$A = 1.53$ 16.8 feet

Try a smaller wave.

Try $H_o = 7.0$, $T = 6.3$, $L_o = 203$

$$d_s/L_o = 0.030, H/H_o' = 1.125, K_R = 0.75$$

$$H_s = 7 \times 0.75 \times 1.125 = 5.9 \text{ feet}$$

$$H_o' = 5.9/1.125 = 5.25 \quad H_o'/gT^2 = 5.25/1,278 = 0.0041$$

$$H_b/H_o' = 1.05$$

$$H_b = 5.5$$

$$H_b/gT^2 = 0.0043$$

$$d_b/H_b = 1.21, d_1 = 6.7 \text{ feet}$$

$$1.53, d_2 = 8.4 \text{ feet}$$

Try $H_o = 6.5$, $T = 6.2$, $L_o = 197$, $K_R = 0.71$

$$d/L_o = 0.031$$

$$H/H_o' = 1.118$$

$$H_s = 1.118 \times 0.71 \times 6.5$$

$$= 5.2 \text{ feet}$$

$$H_o' = 4.6 \text{ feet}$$

$$H_o'/gT^2 = 4.6/1,238 = 0.0037$$

$$H_b/H_o' = 1.05$$

$$H_b = 4.8 \quad H_b/gT^2 = 0.0039$$

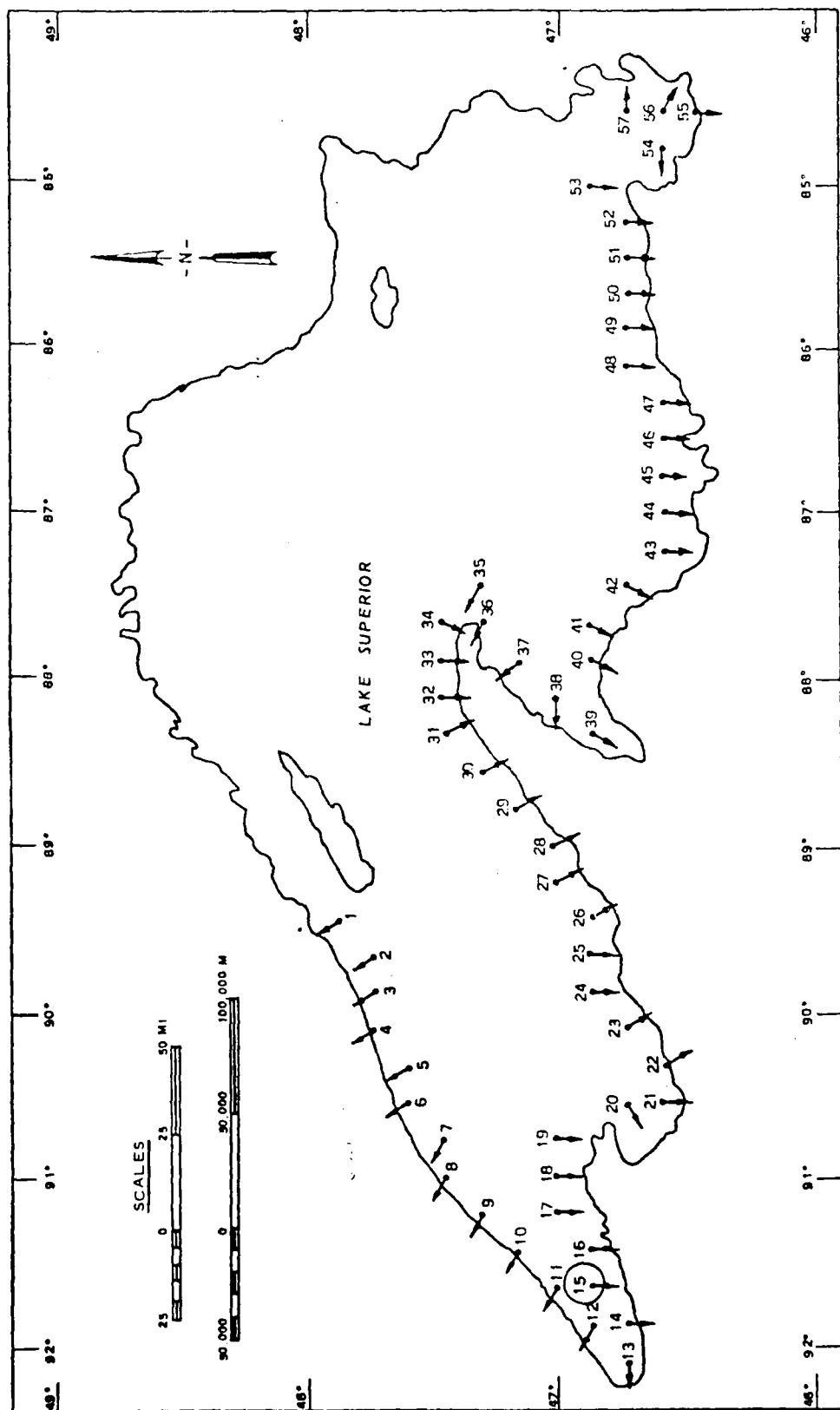
$$B = 1.20$$

$$d_1 = 5.8 \text{ feet}$$

$$A = 1.52$$

$$d_2 = 7.3 \text{ feet}$$

Use $H_o = 6.5$ -foot wave



Azimuths of Normal Shoreline Vectors

<u>Shoreline Point</u>	<u>Azimuth</u>	<u>Shoreline Point</u>	<u>Azimuth</u>
1	330	30	150
2	330	31	150
3	330	32	180
4	330	33	180
5	330	34	210
6	300	35	300
7	300	36	300
8	300	37	330
9	300	38	270
10	300	39	210
11	300	40	210
12	300	41	210
13	270	42	210
14	180	43	180
Port 15	180	44	180
Wing 16	180	45	180
17	180	46	180
18	180	47	180
19	180	48	180
20	210	49	180
21	180	50	180
22	150	51	180
23	150	52	180
24	180	53	180
25	180	54	270
26	150	55	180
27	150	56	120
28	150	57	90

TABLE OF EXTREMES ESTIMATES
GRID LOCATION 14,7 LAT=46.90 LON=91.51

IRON PIER
WI

SHORELINE GRID POINT 15

WINTER
ANGLE CLASSES

	1	2	3	ALL
5	12.1(1.3)	10.5(1.3)	8.2(1.3)	12.2(0.5)
10	13.1(1.3)	12.1(1.8)	8.9(1.8)	13.1(1.7)
20	13.3(2.2)	13.4(2.2)	9.5(2.2)	14.1(0.8)
50	14.4(2.6)	14.4(2.8)	10.2(2.8)	15.1(1.0)
100	15.1(3.2)	15.3(3.2)	10.8(3.2)	15.7(1.2)

SPRING
ANGLE CLASSES

	1	2	3	ALL
5	7.5(1.4)	6.7(1.4)	6.3(1.4)	7.5(0.8)
10	9.2(1.9)	9.1(1.9)	7.5(1.9)	9.9(1.1)
20	11.3(2.4)	11.0(2.4)	7.9(2.4)	11.5(1.4)
50	13.4(3.0)	13.0(3.0)	8.7(3.0)	13.5(1.7)
100	14.2(3.4)	14.2(3.4)	9.1(3.4)	14.3(2.0)

SUMMER
ANGLE CLASSES

	1	2	3	ALL
5	4.3(1.6)	4.6(1.6)	5.2(1.6)	6.2(0.3)
10	5.6(2.1)	6.6(2.1)	5.6(2.1)	6.9(0.5)
20	6.6(2.6)	7.9(2.6)	6.2(2.6)	8.0(1.6)
50	7.4(3.2)	9.5(3.2)	6.6(3.2)	9.6(0.7)
100	8.2(3.7)	10.2(3.7)	6.6(3.7)	10.3(0.8)

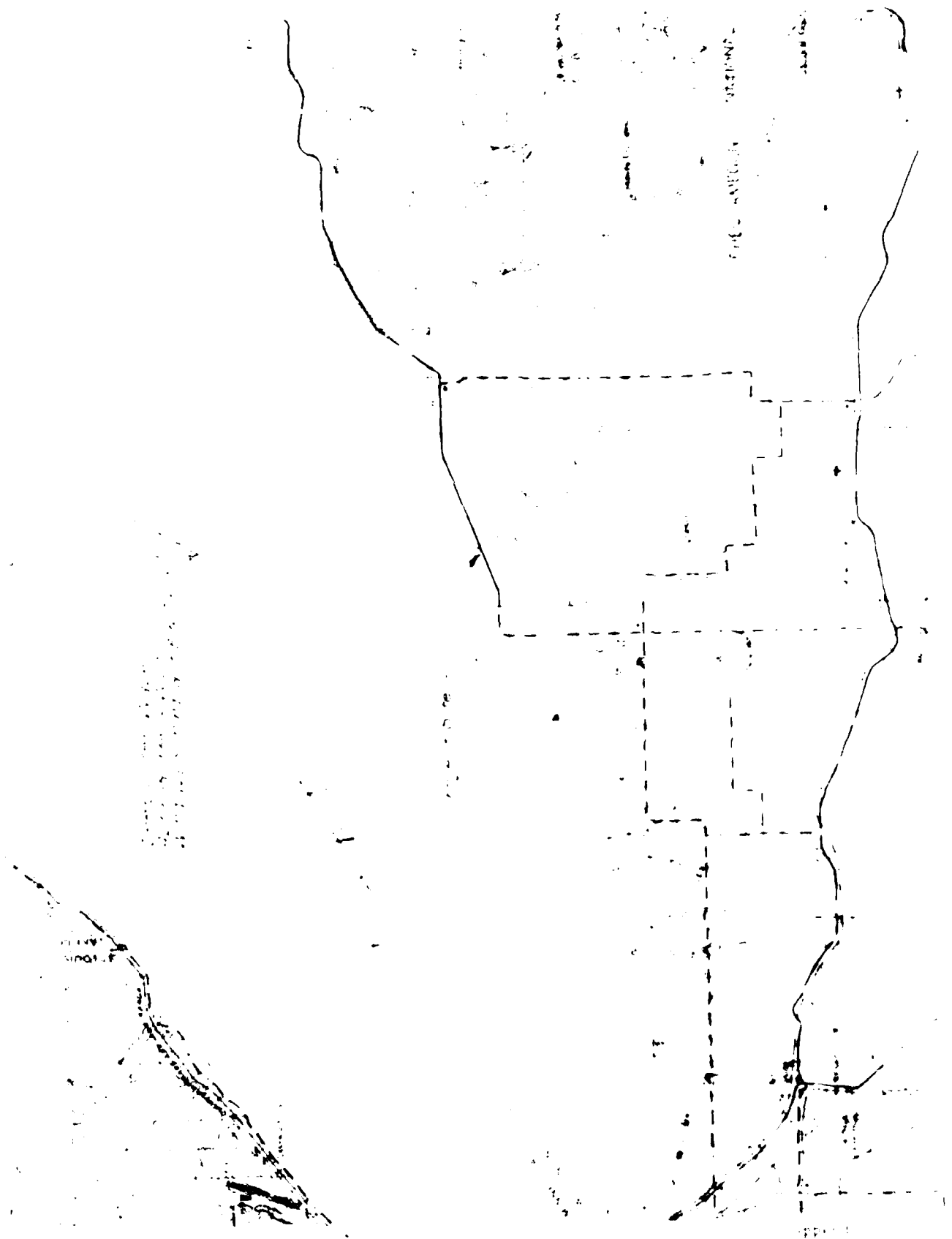
FALL
ANGLE CLASSES

	1	2	3	ALL
5	9.2(1.4)	9.8(1.4)	8.2(1.4)	10.8(0.3)
10	10.8(1.8)	10.8(1.8)	8.5(1.8)	11.8(0.5)
20	12.1(2.3)	11.5(2.3)	8.9(2.3)	12.5(0.6)
50	13.4(2.8)	12.1(2.8)	9.2(2.8)	13.5(0.7)
100	14.1(3.3)	12.8(3.3)	9.2(3.3)	14.2(0.8)

GRID LOCATION 14.4 LAT 46.00 LONG 91.91 IRON RIVER
VI
GRID POINT NUMBER 10

SIGNIFICANT PERIOD BY ANGLE CLASS AND WAVE HEIGHT

WAVE HEIGHT (FT)	ANGLE CLASS		
	1	2	3
1	3.8	3.4	3.4
2	4.8	4.6	4.4
3	5.3	5.0	5.1
4	5.7	5.4	5.4
5	6.3	5.6	5.6
6	6.6	5.9	6.0
7	7.0	6.1	6.2
8	7.3	6.4	6.4
9	7.6	6.6	6.6
10	8.0	6.9	6.9
11	8.3	7.2	7.1
12	8.6	7.4	7.3
13	8.9	7.7	7.5
14	9.3	7.9	7.7
15	9.6	8.2	7.9
16	9.9	8.5	8.1
17	10.3	8.7	8.3
18	10.6	9.0	8.5
19	10.9	9.2	8.7
20	11.3	9.5	8.9
21	11.6	9.8	9.2
22	11.9	10.0	9.4
23	12.2	10.3	9.6
24	12.6	10.5	9.8
25	12.9	10.8	10.0



[illegible]

① This is the deepwater wave which will break at the depth dictated by the slope of the bluff and offshore. Max deepwater wave possible for a 10 yr recurrence is 16.15 ft. (from 19.25 minus crest), which will break before reaching a depth of 6 ft. Design wave height determined by successive trials.

Regression coefficient assumed from 11 cases to hint study which had similar findings

TYPE	DESCRIPTION	SLOPE	H ₀ g ¹²	Δs H ₀	R H ₀	R	Maximum Runup Elevation	suggested top of structure
Section 1	structure vegetation	1 on 4	0097	133	117	54 ft	608.3	606.0
Section 2	concrete vegetation	1 on 3			132	61	609.0	607.0
Section 3	concrete vegetation	1 on 3			132	61	609.0	607.0
Section 4	concrete block	1 on 4			099	4.6	607.5	606.0
Section 6	4 Section 4 Runup	vert			241	11.1	614.0	610.0
Section 7	Runup	1 on 2 1/2			137	6.2	609.1	607.0
All Sections	Smooth	1 on 3	0097		205	9.4	612.3	609.0

46-540

Design water surface level is 602.9 (IGLD 1955).
Suggested top elevation is set at the economic limit consistent with potential wave damage to vegetated slope.

APPENDIX 3

COOPERATIVE AGREEMENT

DRAFT CONTRACT

THIS AGREEMENT entered into this day of by and between the UNITED STATES OF AMERICA (hereinafter called the GOVERNMENT) represented by the contracting officer executing this agreement, and the State of Wisconsin, Department of Transportation (hereinafter called the STATE)

WITNESSETH THAT:

WHEREAS, establishment of a shoreline erosion control demonstration project at State Highway 13 near Port Wing, Wisconsin, was authorized by Section 54 of the Water Resources Development Act of 1974 (PUBLIC LAW 93-251); and

WHEREAS, the STATE represents that it has the authority and capability to furnish the non-Federal cooperation required by the Federal legislation authorizing the Project and other applicable law;

NOW, THEREFORE, the parties agree as follows:

1. The STATE agrees that, if the Government shall commence construction of the Port Wing Project substantially in accordance with the Port Wing, Wisconsin, Shoreline Demonstration Project Preconstruction Report and with Federal legislation authorizing such Project, the STATE shall, in consideration of the Government commencing construction of such Project, fulfill the requirements of non-Federal cooperation specified in such legislation, to wit:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction, operation, maintenance, repair, monitoring, and demonstration of the Project, as defined by the Chief of Engineers or his designee.

Appendix B

3-1

b. Pay or contribute in services and cash twenty-five percent (25%) of the total first cost of construction of the Project presently estimated to be \$_____. Such construction costs shall be computed in accordance with the schedule set out in Exhibit A and made a part hereof.

c. Assume all costs of operation, maintenance, and repairs of the Project upon its completion. "Completion of the Project" is defined as that date on which the Government has terminated its responsibilities for construction, operation, evaluation, and demonstration of the Project and transferred all of its jurisdiction and control over the Project to the STATE. Based upon current authorized and continued Federal funding, the completion date is expected to be 30 September 1980, unless extended by subsequent congressional authority.

d. Hold and Save the United States free from all damages arising out of the State's obligations as set forth in this Agreement. However, the State shall not be responsible for damages due to the fault or negligence of the United States or its contractors in the construction, operation, maintenance, repair, monitoring, and demonstration of the Project.

e. Permit public access to, and continued public use of, the shoreline to be protected by the Project. Such public access shall be made available at no fee, either on an open basis or by schedule, during the life of the Port King Demonstration Project.

f. Comply with Sections 219 and 305 of the Uniform Relocation Assistance and Land Acquisition Policies Act of 1970 approved 2 January 1974 (Public Law 91-646).

Appendix A

A.1

g. Furnish, as part of this Agreement, an assurance (Exhibit B) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000 d. et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

2. The STATE hereby gives the Government a right to enter upon, at reasonable times and in a reasonable manner, lands which the STATE owns or controls for the purpose of construction, operation, maintenance, repair, monitoring, demonstration, and modifications of the Project structures as deemed necessary by the Chief of Engineers.

This Agreement is subject to the approval of the Secretary of the Army.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA THE WISCONSIN DEPARTMENT OF TRANSPORTATION

BY: _____ BY: _____

Secretary of the Army

EXHIBIT "A"

Schedule of Work Items

Excavation
Granular fill
Filter cloth
Seeding
Riprap
Cobblestone structure
Concrete block structure
Fire structure
Steel-pile structure
Supervision and Administration
Permit Contract

The total first cost of construction shall be determined upon completion of the contract and will include the cost of the supervision and administration of the contract. The local sponsor share shall be computed as a percentage of the total first cost as described above.

EXHIBIT B

ASSURANCE OF COMPLIANCE WITH THE DEPARTMENT OF
DEFENSE DIRECTIVE UNDER TITLE VI OF THE CIVIL
RIGHTS ACT OF 1964

_____ (hereinafter called "Applicant-Recipient")

HEREBY AGREES THAT it will comply with title VI of the Civil Rights Act of 1964 (P.L. 88-352) and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 300, issued as Department of Defense Directive 5500.11, December 28, 1964) issued pursuant to that title, to the end that, in accordance with title VI of that Act and the Directive, no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant-Recipient receives Federal financial assistance from The Department of the Army and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant-Recipient by the Department of the Army, this assurance shall obligate the Applicant-Recipient, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided this assurance shall obligate the Applicant-Recipient for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant-Recipient for the period during which the Federal financial assistance is extended to it by the Department of the Army.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Applicant-Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

Dated _____

BY: _____

(Applicant-Recipient's Mailing Address)

Appendix 3
A-5

DATE
FILMED
8