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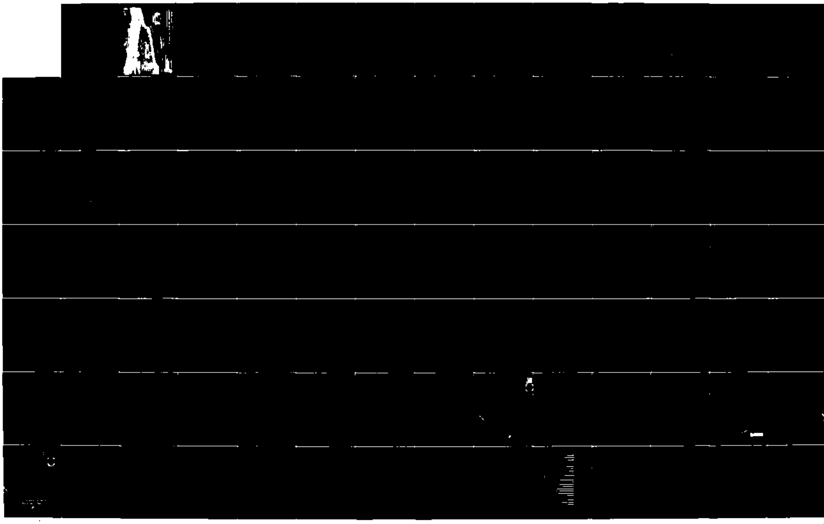

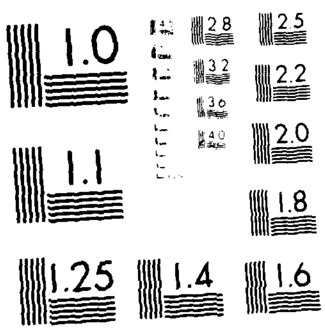

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Section 107 Detailed Project Report

WARROAD CHANNEL PROJECT

Warroad, Minnesota

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The city of Warroad, Minnesota developed a recreational complex adjacent to Lake of the Woods in 1970, which included an inland marina. However, the marina basin does not have a navigable access to Lake of the Woods, and has been idle. A reconnaissance report concluded that construction of a marina access channel was feasible and recommended a detailed project report be prepared. This project report consists of a main report with appendixes. The main report describes the planning process and contains basic information used to arrive at the study's conclusions and recommendations. The appendixes su~~lement the main report with more detailed data and analysis.

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WARROAD CHANNEL PROJECT

SECTION 107

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INTRODUCTION

In 1970 the city of Warroad began development of a recreational complex adjacent to Lake of the Woods at Warroad. The complex includes an inland marina basin which was excavated in 1972. However, the marina basin does not have navigable access to Lake of the Woods and has been idle since its excavation.

On 12 May 1972, the Warroad City Council adopted a resolution requesting that the Corps study the feasibility of constructing an access channel from the marina basin to Lake of the Woods. A reconnaissance report dated 27 November 1974 concluded that construction of a marina access channel was feasible and recommended that a detailed project report be prepared.

STUDY AUTHORITY

Authority for this detailed project report is provided by Section 107 of the River and Harbor Act of 1960, as amended. The text of this act is in appendix A.

SCOPE OF THE STUDY

Channel alignment, foundation materials, hydraulic, economic, environmental, and archeological investigations were conducted for this study. An alternative channel alignment study; a cultural resources survey; and a report on the chemical, physical, and biological properties of the project area were done by private consultants. The other studies were done by Corps personnel.

STUDY PARTICIPANTS AND COORDINATION

The report has been developed by the Corps of Engineers with the participation of the city of Warroad and a citizens advisory committee. The study has been closely coordinated with local, State, and Federal agencies. Appendix C contains copies of pertinent letters and minutes of citizens advisory committee meetings.

STUDIES OF OTHERS

In November 1974, the Warroad Planning Commission completed a comprehensive guide plan entitled City of Warroad, Minnesota, Comprehensive Guide Plan. The city has also prepared a recreation plan entitled Lake of the Woods Beach Front Development at Warroad.

See appendix A for additional studies relating to the Warroad channel project.

THE REPORT AND STUDY PROCESS

This detailed project report consists of a main report with appendixes. The main report describes the planning process and contains the basic information used to arrive at the study's conclusions and recommendations. Pages 3 through 19 describe the study area and the problems the study addresses. Pages 20 through 41 describe the alternative plans considered for providing small boat access between Lake of the Woods and the marina basin. Pages 42 through 61 contain a detailed description of the overland channel plan recommended for construction. The appendixes supplement the main report with more detailed data and analysis.

PROBLEM IDENTIFICATION

This section defines the project area and the problems the study addresses. The section also produces a set of planning objectives. These objectives are used in succeeding sections to formulate and evaluate alternative plans.

NATIONAL OBJECTIVES

The planning objectives must encompass both national and local considerations. Corps regulations specify that project objectives shall include National Economic Development (NED), Environmental Quality (EQ), Regional Development (RD), and Social Well-Being (SWB).

Additional objectives for each project are based on local considerations. These local planning objectives are developed after an investigation of existing conditions; future conditions if no Federal action is taken; and problems, needs, and opportunities in the study area.

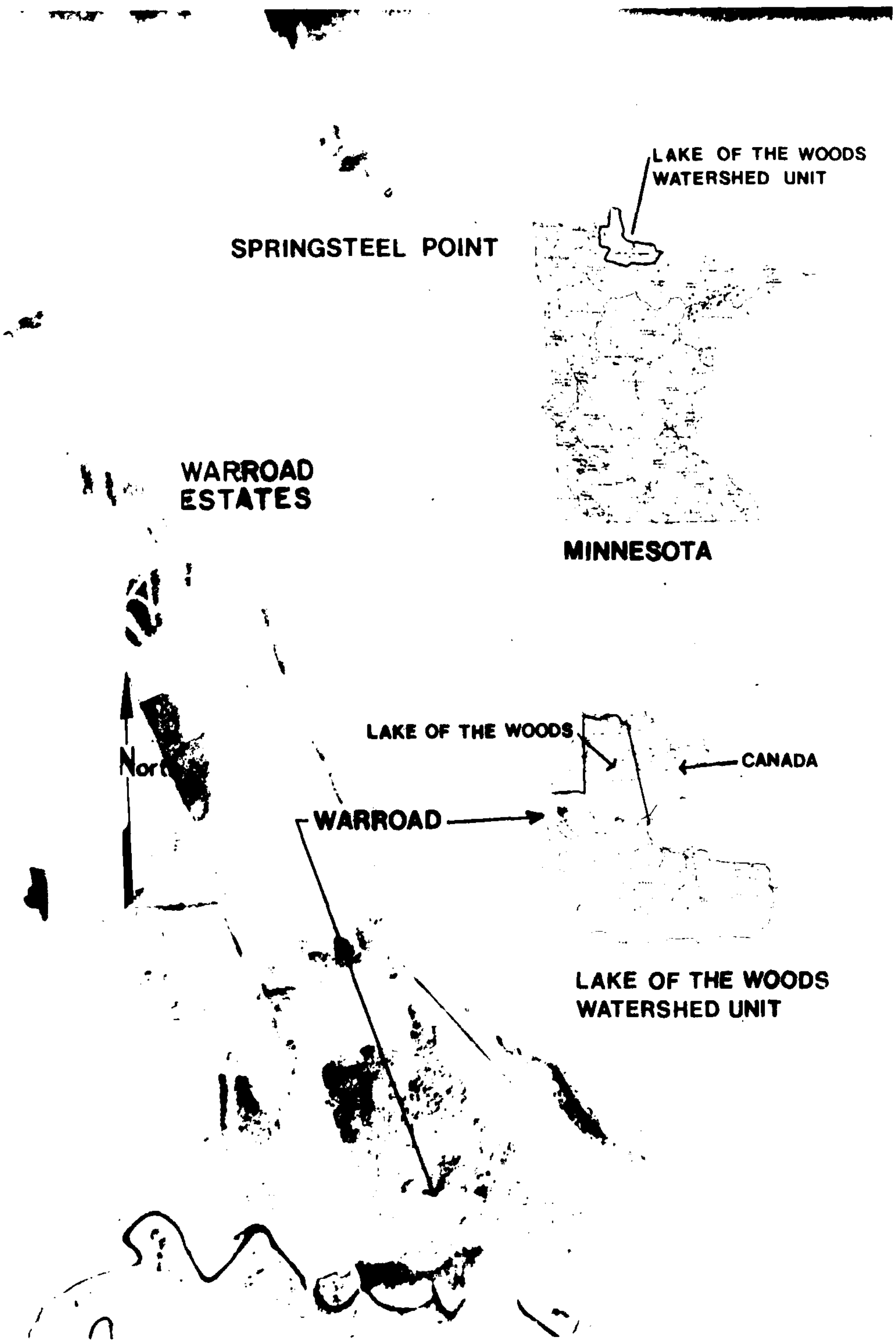
EXISTING CONDITIONS

Study Area

The study area was defined as the city of Warroad and that portion of Lake of the Woods within a 2-mile radius of the mouth of the Warroad River. Because of the straightforward nature of the problem to be addressed by this report, the study area appears to easily encompass study concerns and solutions.

Location

Warroad is in Roseau County in northwestern Minnesota. The city occupies both banks of the Warroad River, which flows into Muskeg Bay of Lake of the Woods. Warroad Harbor is on the southwest shore of the bay (see figure 1).



LOCATION MAP

FIGURE 1

Topography and Geology

Roseau County is generally flat. Low ridges of sand and gravel oriented east-west are thought to be abandoned beach ridges marking the retreat of Lake Agassiz. Lake of the Woods is a remnant of Lake Agassiz, which covered the area following the Wisconsin glaciation.

The crystalline bedrock of the area is overlain by 75 to 115 feet of water-deposited clay, silt, and sand. The land surface slopes to the north about 10 feet per mile.

Soils

Approximately one-third of the soils in Roseau County are organic (peat) soils consisting almost entirely of plant remains. A combination of mineral and organic soils exists in the immediate area of Warroad. The shore of Muskeg Bay is a peat bog which extends inland up to one-half mile. Remaining soils are a composite of lacustrine clays, silts, and sands.

Climate

The climate is characterized by a wide range in temperatures, short growing seasons, and long cold winters. The average growing season is 118 days. This short growing season is offset to some degree by the extended hours of sunlight caused by the high latitude of the area.

The average annual temperature is 37.3° F. Average monthly temperatures vary from 1.1° F in January to 67.3° F in July. Extreme temperatures of record are -50° F and 103° F.

Average annual precipitation is 20.7 inches, which is considered subhumid. However, the level terrain, moisture-retaining soils, and low evaporation rates result in a more humid climate than the precipitation indicates. Normal monthly precipitation varies from 0.55 inch in February to 3.46 inches in June. About two-thirds of the annual precipitation falls from April through August. Average annual snowfall is 47 inches, and snow covers the ground an average of 139 days per year.

According to weather data collected at the airport in International Falls, Minnesota, the predominant storm direction (winds greater than 15 miles per hour) is N 80 E. The critical direction for storm winds at Warroad is the sector bounded by N 23°E and N 79°E. Warroad harbor is sheltered from the predominant storm direction. The southern portion of Lake of the Woods is shallow, rarely exceeding 35 feet in depth. The maximum wave calculated for the Warroad area, representing a 20-year occurence, would have a height of 5.3 feet. As these waves approach the Warroad shore, they would be modified by bottom conditions varying from sandy soil to heavy stands of vegetation. Winds can raise the water surface a maximum of 1.92 feet at Warroad, representing a 50-year occurence. Appendix D contains a detailed description of the wind and wave climate in the study area.

Drainage

Drainage is generally very poor, and hundreds of miles of drainage ditches have been constructed throughout Roseau County. The poor drainage results from lack of slope; fine-grained soils, many of which have tightly compacted subsoils; and a high water table. At Warroad, the water table is at or near the surface and, on occasion, wells have overflowed.

The Warroad River provides natural drainage in eastern Roseau County. The headwaters of the river are in a swampy area about 13 miles south of Warroad. The river is geomorphically "young" and has a well-defined, deep channel and relatively narrow floodplain. Before dredged material was placed on the right bank and the channel was narrowed, the river was about one-fourth mile wide at Warroad.

Vegetation

Roseau County is in a transitional vegetation zone. The original postglacial flora in the east was hardwood with a mixture of conifers. The original vegetation at Warroad was mixed stands of aspen, balsam, cedar, jack pine, spruce, and tamarack. In the west, grassland was predominant and the central portion was grassland with hardwood (aspen) encroachment from the east.

Because of the forest industry, very little virgin growth remains. The forest vegetation in unmanaged areas consists of conifers, balsam fir, white pine, spruce, balm of Gilead, poplar, elm, ash, birch, and tamarack. Much of this vegetation is second growth and scraggly. Reforestation attempts have been successful and commercial growths of aspen, black spruce, spruce, pine, balsam fir, tamarack, white cedar, and mixed hardwoods are harvested yearly.

Myrtle-leaf willow, tag alder, lone birch, and small poplar grow in the poorly drained areas. Ground cover in the bogs is variable and includes sphagnum moss, leatherleaf, Labrador tea, cranberry, cassandra, snowberry, dwarf Kalmia, pitcher plants, crowberry, cotton grass, and other sedges and grasses. A few marshy areas support wild rice.

Fish and Wildlife

The Warroad area provides habitat for over 38 species of fish including walleye, perch, bass, pike, sunfish, muskellunge, trout, and commercially imported species such as burbot, tulibee, and white suckers. At one time, lake sturgeon were abundant but overfishing has greatly reduced their numbers.

The variety of fish and wildlife in the region contributes to the high rate of tourism and recreation activities. Cold water and warmwater fishing is enjoyed year-round. Commercial fishing also plays an important role in the Rainy River basin, with 60 percent of the basin's potential habitat being commercially fished. Lake of the Woods has been the most important commercial fishing spot in the basin, producing 80 percent of the annual landings during the last 35 years.

The aquatic environment and adjacent lands provide food and shelter for many species of waterfowl, shorebirds, songbirds, upland game birds, and birds of prey.

Approximately 50 species of mammals inhabit the forest areas including white-tailed deer, black bear, fox, skunk, porcupine, squirrel, mouse, weasel, beaver, and snowshoe hare. Moose and timber wolves, an endangered species, can be found in the shore area. Rare or uncommon mustelids, such as the pine marten, fisher, and otter, inhabit the more remote forest areas.

Cultural Resources

The study has been coordinated with the Minnesota State Historic Preservation Officer and the State Archeologist. The National Register of Historic Places was consulted to determine if significant properties would be affected by the project. A cultural resources survey was conducted by Bemidji State University, Bemidji, Minnesota, entitled Cultural Resources Survey of Small Boat Harbor Project at Lake of the Woods, Warroad, Minnesota, 15 November 1977. No significant historical or archeological resources were identified in the project area. Appendix H contains a summary of the cultural resources survey.

Population Characteristics[1]

In 1970, the population of Roseau County was 11,569, representing an average density of 6.9 persons per square mile. Between 1950 and 1960, Warroad's population rose from 1,276 to 1,309. By 1970, its population had declined to 1,086. The estimated 1977 population had risen to 1,350 (estimate approved by State Demographer). Because of increased recreation and industrial development opportunities, the population is expected to continue its recent increases.

Employment[1]

Window manufacturing, hockey stick manufacturing, tourist-related businesses, and the public school system are Warroad's major employers. Other sources of employment include the Canadian National Railway; Burlington Northern, Inc.; commercial fishing operations; and retail stores. About 50 persons, including seasonal employees, fishing guides, seaplane pilots, and marina personnel, hold harbor-related jobs.

The number of farms in Roseau County declined from 1,700 in 1959 to 1,334 in 1974. In the same period, the total acres in farmland increased from 544,544 to 586,600. Thus, average farm size increased from 320 to 440 acres.

Personal and Per Capita Income[1]

In 1970, total personal income for Roseau County was estimated at $27,740,000 (1967 dollars) which represents a 65-percent increase over the 1960 estimate. Minnesota experienced a 60-percent increase over the same period.

Per capita income for Roseau County increased 70 percent from $1,404 in 1960 to $2,388 in 1970. The 1970 figure is considerably less than the State figure of $3,398, partly because of the larger proportion of agricultural and rural income in the county.

(1) Appendix A and the environmental assessment (appendix J) contain additional demographic data.

Transportation(1)

Warroad is at the junction of Minnesota Highways 313 and 11, which provide access to Canada, North Dakota, and the rest of Minnesota. The city is served by several truck firms, including local cartage and common carriers. Rail service is provided by the Canadian National Railway and Burlington Northern Railroad. A paved and lighted municipal airstrip with a 3,700-foot runway is 3 miles north of Warroad.

Commercial Fishing and Shipping (1)

Lake of the Woods has been commercially fished since the 1880's. Most of the catch is rough fish and 85 percent is used as mink feed at local ranches. Commercial fishing has declined in recent years.

Before 1968, supplies for Angle Inlet were shipped by water from Warroad. In 1968, a road to Angle Inlet was constructed, and waterborne freight traffic has declined.

Recreation and Navigation

Lake of the Woods is supplied primarily by the Rainy River and drained by the Winnipeg River, both of which are regulated by hydroelectric requirements. The International Joint Commission agreement of 1925 specifies that lake levels are to be maintained between 1056 and 1061.25 (1929 adjustment). Lake levels have varied between 1054.63 (27 February 1925) and 1063.50 (1 July 1916) Appendix D contains a detailed description of lake levels.

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(1) Appendix A and the environmental assessment (appendix J) contain additional transportation and commercial use data.

Warroad Harbor lies at the mouth of the Warroad River. The harbor was authorized by the River and Harbor Act of 3 March 1899, as amended by the emergency River and Harbor Act of 6 June 1900. Existing facilities include a channel 9,200 feet long, 100 feet wide, and 6 feet deep; a turning basin 200 by 900 feet and 6 feet deep; and a 457-foot long rubble-mound jetty parallel to the channel extending about 350 feet lakeward. A public walkway and handrailing were built on the jetty in 1972.

Warroad is developing a recreational complex north of the Warroad River adjacent to Lake of the Woods. Warroad and the Heritage Conservation and Recreation Service (formerly Bureau of Outdoor Recreation) have funded construction of the complex to date. The complex includes a marina, campground, swimming pool, boat launching ramp, and day-use park area. As of July 1979, the marina basin had been excavated, the pool was completed, and 36 of 71 campground sites were completed.

Wastewater Treatment

In July 1971 the Minnesota Pollution Control Agency evaluated wastewater treatment needs at Warroad and indicated a need for sewer separation and upgrading of existing treatment levels. Warroad is implementing a program to accomplish these tasks.

Water Supply and Quality

No major water supply problems are apparent. Municipal water is obtained from local wells. Open water in the area is classified for industrial consumption and fisheries and recreation according to the Water Quality Management Plan for the Rainy River Basin, prepared by the Minnesota Pollution Control Agency.

CONDITIONS IF NO FEDERAL ACTION TAKEN (WITHOUT CONDITION)

Warroad is a slowly growing community. The population lost to outmigration in the 1960's is returning as recreation and industrial job opportunities develop. From 1970 to 1977, the population increased from 1,086 (U.S. census) to 1,350 (estimate approved by State Demographer), an increase of about 3.5 percent per year. From 1972 through 1974, Warroad had 24 new housing starts and an 18-unit apartment building under construction - a significant increase for a city its size. Warroad is anticipated to continue to grow slowly as retail and industrial development continues. Tourism and recreational fishing will continue to be an important part of Warroad's economy.

Future cultural and environmental conditions in the study area are not expected to be significantly affected by the decision to build or not build the channel project. These conditions are anticipated to remain similar to existing conditions for the near and intermediate future. Lake of the Woods is a major recreational outlet for Warroad and regional citizens and is expected to remain so in the future.

PROBLEMS, NEEDS, AND OPPORTUNITIES

Problems and Needs

The need for additional small-boat facilities in Warroad has existed for several years. Warroad officials have expressed concern about congested and inadequate small-boat facilities since 1970.

During the boating season, Warroad Harbor is crowded with seaplane landings and takeoffs, commercial and recreational boat traffic, water skiing, and boat launching activities. All of these uses are confined within a long, narrow harbor. Boat conflicts cause significant safety hazards and boat operating problems.

This report examines those water-related activities that bear on the need for the proposed marina access channel. Existing boating needs fall into three categories:

a. Seasonal boat slips. These slips are used by people who berth their boats for the entire boating season.

b. Transient boat slips. The slips are used for shorter periods of time (an average of 4 days) by fishermen and boaters staying at area campgrounds, motels, or homes. Transient slips may also be used by visiting boats which are based at other marinas (this demand has not been analyzed for this report).

c. Launching ramps and facilities (day-use boaters or fishermen). These facilities are for people who launch and retrieve their boats for each day's use.

Existing Seasonal. - All seasonal slips at Warroad Harbor and nearby Springsteel Island Resort are now used to capacity. A new residential subdivision, Warroad Estates, is being developed about 2.5 miles north of the Warroad River. As of June 1979, about 95 of the 188 available slips were rented. Within the next several years, as the subdivision is filled, rental of more slips to subdivision residents will leave fewer slips available to the general public. The following table summarizes the supply and use of Warroad area boat slips.

Warroad area boat slip supply and use

Location	Supply (1979)	Use (1979)	Surplus (1979)	Projected future additional supply
Warroad Harbor	235 (1)	235	0	0
Warroad Estates	188	95	93	0
Springsteel Island	300	300	0	0
Warroad Marina (after completion of proposed channel project)	-	-	-	100 in 1981, 90 in 1982
Total	723	630	93	190 in 1982

(1) Of the total, 75 slips are on private property along the river. The remainder are in the harbor itself.

Existing Transient Slips. - A large demand for transient boating slips is unmet. Excellent walleye fishing attracts large numbers of anglers to Lake of the Woods at Warroad. Many of these fishermen camp at the municipal campground or stay at area motels. Because their visits often last several days, these boaters would use transient slips if they were available, rather than launch and retrieve their boats daily.

The large boats often used on Lake of the Woods are difficult to launch and retrieve every day, especially in bad weather. Transient slips would serve these fishermen and reduce the pressure on overtaxed boat launching facilities. Transient slips would also serve boats based in other harbors visiting or seeking refuge.

As discussed in the previous section, some of the slips at Warroad Estates are not yet occupied on a seasonal basis. Although these slips could be used by transient boaters, they are not easily accessible to existing camping and motel accommodations, restaurants, and supplies.

Existing Launching Ramps and Facilities. - The Warroad Harbor municipal ramp handles most of the boat launchings in the area. Use of the ramp and adjacent parking area is free, and boat fueling and sanitation facilities are available in the harbor. Supplies, restaurants, and recreation facilities are readily available in nearby downtown Warroad. Boat service and some supplies and amenities are also available at Springsteel Island Resort and Warroad Estates.

During peak use times (weekends and holidays during the fishing season) the municipal ramp often operates at capacity. Facilities for auto/trailer maneuvering and parking are inadequate, creating congestion on land during peak periods. Boats are launched into the confined channel, contributing to crowding and boat traffic conflicts on the river. Improved boat launching facilities are needed to increase accessibility to the lake and relieve the congested, unsafe conditions.

The location of the ramp near the mouth of the Warroad River also exposes the area to lake waves and wind. Launching or retrieving boats during inclement weather is difficult, especially when large numbers of boats are seeking refuge from a storm.

Projected Demand for Small-Boat Facilities

Area recreation studies, information on local boat sales and registration, and information from residents have been used to project demand for boat facilities. This information, which is summarized here, is presented in detail in appendix I.

Excellent fishing in Lake of the Woods and the attraction of northern Minnesota's many recreational opportunities bring many visitors to the Warroad area each year. Data developed for the State Comprehensive Outdoor Recreation Plan (SCORP) showed an estimated 706,000 tourist visits in the Lake of the Woods-Rainy Lake area in 1970. The University of Minnesota's Agricultural Extension Service estimates that 4,080 boats per season are brought into the Lake of the Woods area on Highways 11, 313, and 72. In addition, development of Voyageurs National Park is expected to increase substantially the number of tourists traveling through Roseau County. Many local people also use area boating resources. In 1975, over 2,000 boats were registered in Lake of the Woods and Roseau Counties, with each boat used an estimated 40 times per season. Local marina operators report sales of about 40 boats per year in the 18- to 20-foot class.

The following table summarizes various estimates of boating demand for the region.

Summary of boating demand

Study	Past or projected growth in demand (percent per year)	Comment
Upper Great Lakes Regional Recreational Planning Study	6	Annual increase in boating for the region which includes Lake of the Woods County, 1972-1980.
Souris-Red-Rainy River Basins Comprehensive Study	3	Annual increase in boating recreation days for Rainy River basin, 1968-1980.
Souris-Red-Rainy River Basins Comprehensive Study	6	Increase in boating-related land development needed to satisfy demand for outdoor recreation, 1968-1980.
State Comprehensive Outdoor Recreation Plan (SCORP)	1	Annual increase in activity occasions for Lake of the Woods and four adjacent counties, 1978-1990. Study recommends more public lake access in region.
Boat registrations, Lake of the Woods County	17	Average annual increase over the last 8 years.
Boat registrations, Roseau County	22	Average annual increase over last 8 years.

Demand for Seasonal Slips. - Demand for seasonal slips in the Warroad area is anticipated to increase from 5 to 8 percent annually. Although this growth rate is consistent with the findings of area recreation studies, it may be conservative in light of the high annual increases in local boat registrations.

Demand for Transient Slips. - Warroad already has a large unmet demand for transient slips. Municipal records show that about 70 percent of local campers bring boats with them. These campers stay an average of 4 days and would use slips to avoid the inconvenience of launching and retrieving their boats each day. Fishermen staying at area motels and private residences might also use transient slips if they were available.

Development of Voyageurs National Park as well as local improvements in Warroad's camping and recreation facilities are expected to supply increased demand for transient slips. In 1981, the projected completion date of the proposed channel, the existing demand for transient slip days will be an estimated 2,920. This demand is equivalent to 21 seasonal slips. After 1981, the demand for transient slips is expected to increase from 5 to 8 percent annually.

The following figure shows projected supply and demand curves for Warroad area boat slips. Curves are shown for projected 5-, 6.5-, and 8-percent annual growth rates. Transient and seasonal slips have been combined. Existing unmet transient slip demand is not shown on the demand curves.

WARROAD AREA SLIP SUPPLY AND DEMAND

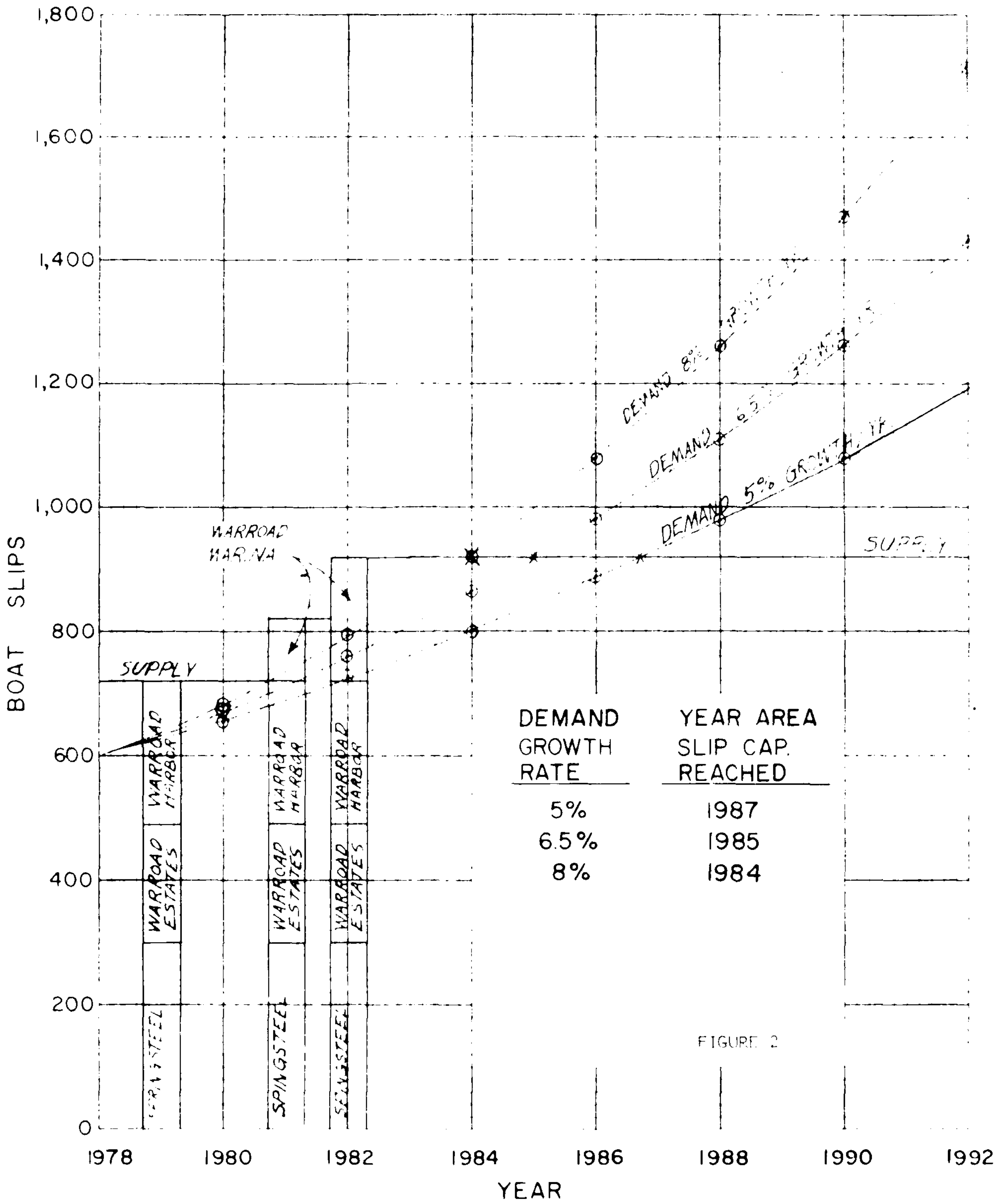


FIGURE 2

Demand for Launching Facilities. - Increases in local and visitor use described in previous sections will also increase the pressure on existing boat launching facilities. With the proposed access channel project, the municipal ramp would be relocated to the new marina in 1981. The following table summarizes projected demand for boat launchings.

Projected boat launchings

Item	Warroad Harbor 1973	Warroad Harbor 1980	Marina 1981	Marina Equivalent seasonal slips (1981)
Day use (1-day only)	1,875	2,640	2,495 (1)	18 (3)
Transient (4-day average)	1,875	2,640	695 (2)	20 (4)
Total	3,750	5,280	3,190	38

(1) Based on 5-percent annual increase and 90 percent of day-use launchings at marina (2,640 x 1.05 x 0.90).

(2) Based on a 5-percent annual increase in launchings, transient boaters launching only once during their 4-day stay, and 100 percent of transient launchings occurring at the marina (2,640 x 1.05 ÷ 4 x 1.00).

(3) Boat launchings converted to seasonal slip equivalent on the basis of a 140-day boating season (2,495 ÷ 140).

(4) Transient boat launchings converted to seasonal slip equivalent on the basis of a 4-day use of marina slips and a 140-day season (695 x 4 ÷ 140).

Marina boat launchings are expected to increase from 5 to 8 percent annually for 10 years after the marina opens, and remain constant. Uncertainties regarding development of competing facilities make it difficult to predict launching increases beyond 10 years.

Opportunities

Lake of the Woods at Warroad has a large potential for further development as a recreational resource. Such development would provide additional recreational opportunities for regional citizens and improve the local economy. Warroad has a comprehensive plan for guiding this development to improve the living environment of its citizens. However, further recreational development is constrained by lack of boat berths. Construction of a boat access between Lake of the Woods and the inland marina basin would make these additional boat berths available. It would also help relieve the congested conditions in Warroad Harbor.

LOCAL PLANNING OBJECTIVES

Based on existing and probable future conditions in Warroad and the problems, needs, and opportunities discussed earlier in this section, a set of local planning objectives has been developed.

a. Provide boat access to the inland marina basin. The access channel should provide safe access to the marina basin with a minimum of boat conflicts. Lake access to the marina and between the marina and boat servicing facilities in the Warroad River should be convenient.

b. Provide a channel compatible with the recreational park complex. The access channel will be part of a boating, swimming, and camping recreational complex. The channel should be compatible with this complex.

c. Minimize local cooperation requirements. Warroad, because of its small population, has limited economic resources. The local cooperation requirements must be consistent with these resources.

FORMULATION OF PRELIMINARY PLANS

The purpose of this section is to identify and evaluate alternative plans for accomplishing the national and local planning objectives.

MANAGEMENT MEASURES

No nonstructural measures were identified for providing boat access to the inland marina. Construction of a channel between the marina basin and lake or the Warroad River channel was the only measure identified.

PLAN FORMULATION RATIONALE

Plans should fulfill as many of the planning objectives as possible. Sufficient information on each plan must be developed and discussed so the plans can be compared and evaluated.

PLANS OF OTHERS

The original recreational complex master plan had a marina access channel passing under the Taylor Road Bridge north of the marina. This plan has been designated alternative plan A. The reconnaissance report was based on this alternative.

The citizens advisory committee identified an alternative channel alignment that would pass under the Taylor Road Bridge and continue on land adjacent to Lake of the Woods to the Warroad River mouth. This alternative was designated alternative E. Alternative E encroached upon the lakeshore wetlands and was, therefore, environmentally costly. Alignment E also required hazardous sharp turns with inadequate sight distances. The alternative was determined to be unacceptable for environmental and safety reasons and was not considered further.

ANALYSIS OF PLANS CONSIDERED IN PRELIMINARY PLANNING

In addition to the two plans developed by others, alternatives B, C, and D were developed during the study. A summary description of all the plans follows:

Alternative A

A straight channel from the existing Taylor Road Bridge running northeasterly approximately 4,800 feet out into deep water in Lake of the Woods. A jetty would be required to reduce maintenance dredging costs.

Alternative B

A 4,800-foot channel similar to alternative A except for a "dogleg" between the bridge and the sandbar. A jetty would be required to reduce maintenance dredging costs.

Alternative C

A 3,800-foot channel dredged in the lake from the Taylor Road Bridge running parallel with the shoreline to a point east of the existing jetty where it would join the Warroad River channel. A jetty would be required to reduce maintenance dredging costs.

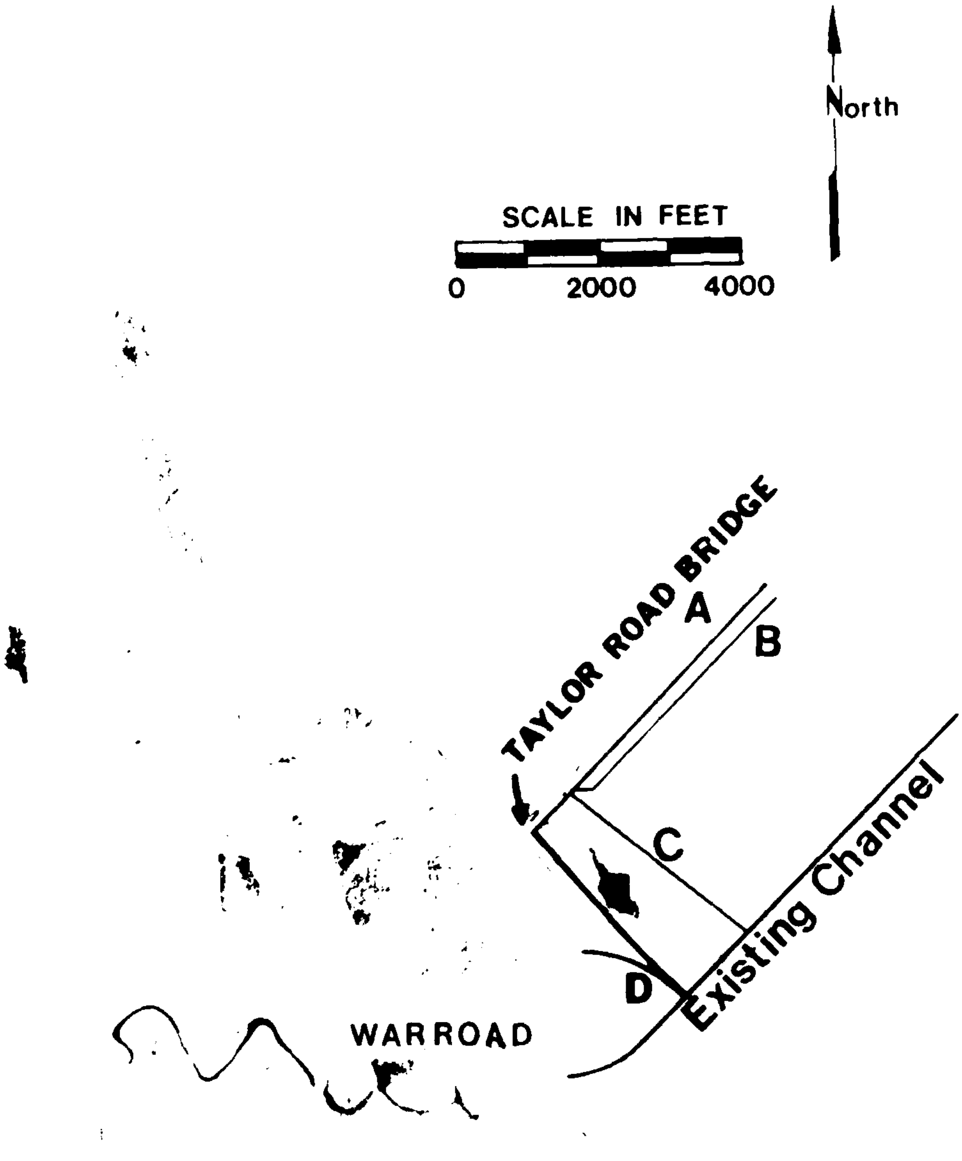
Alternative D

Excavation of a 1,700-foot overland channel through the city park from the inland marina to a point near the base of the existing jetty.

Alternative E

Excavation of an overland channel in the area between CSAH (County State Aid Highway) 74 and the shoreline between the existing Taylor Road Bridge and the Warroad River channel.

See figure 3 for a map of the alternative channel alignments.



ALTERNATE CHANNEL ALIGNMENTS

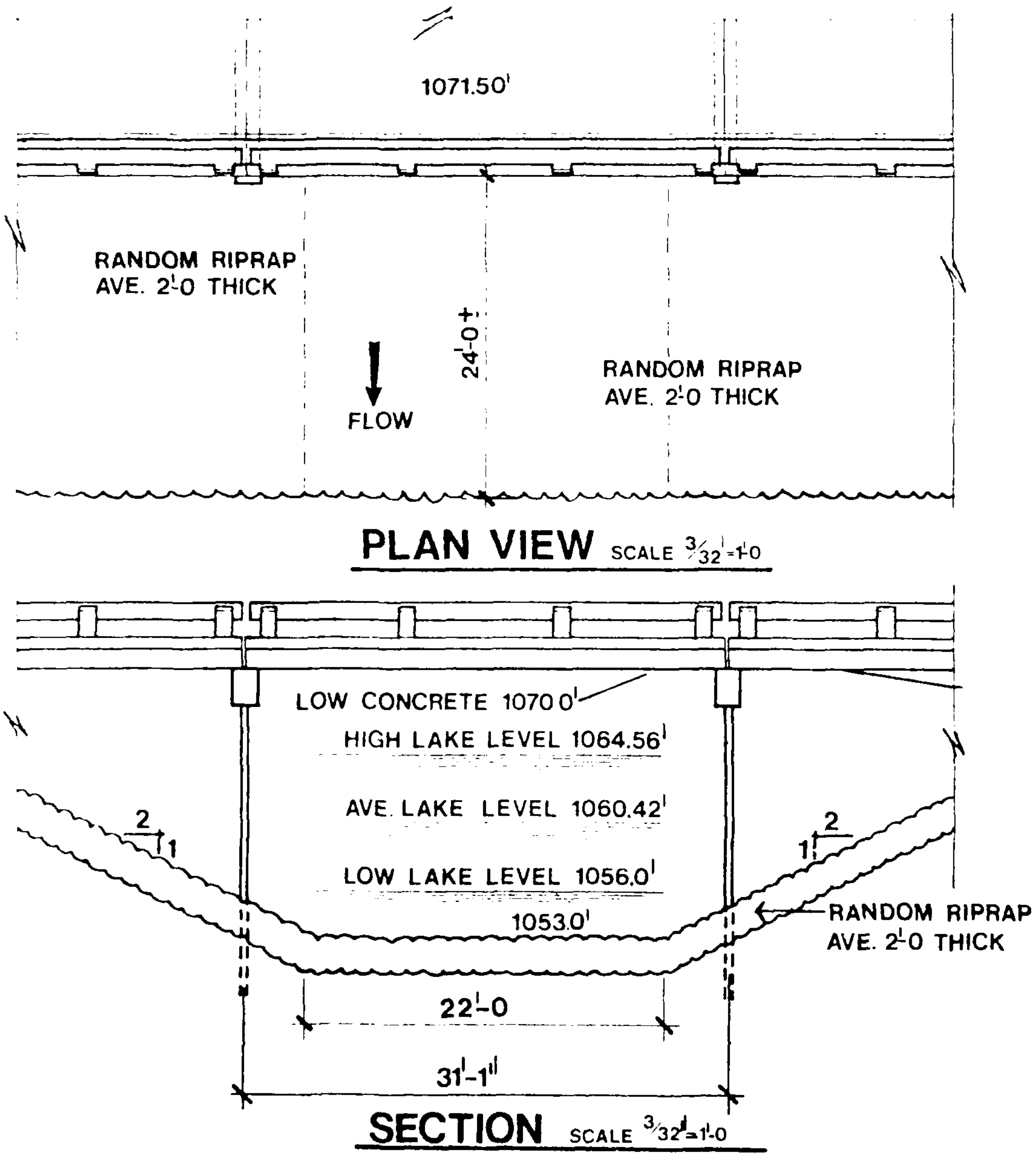
FIGURE 3

Description of Plans

Alternative A. - Alternative A uses an existing access channel from the marina to Taylor Road Bridge, goes under the bridge, and then runs perpendicular to the shoreline for about 4,800 feet to deep water.

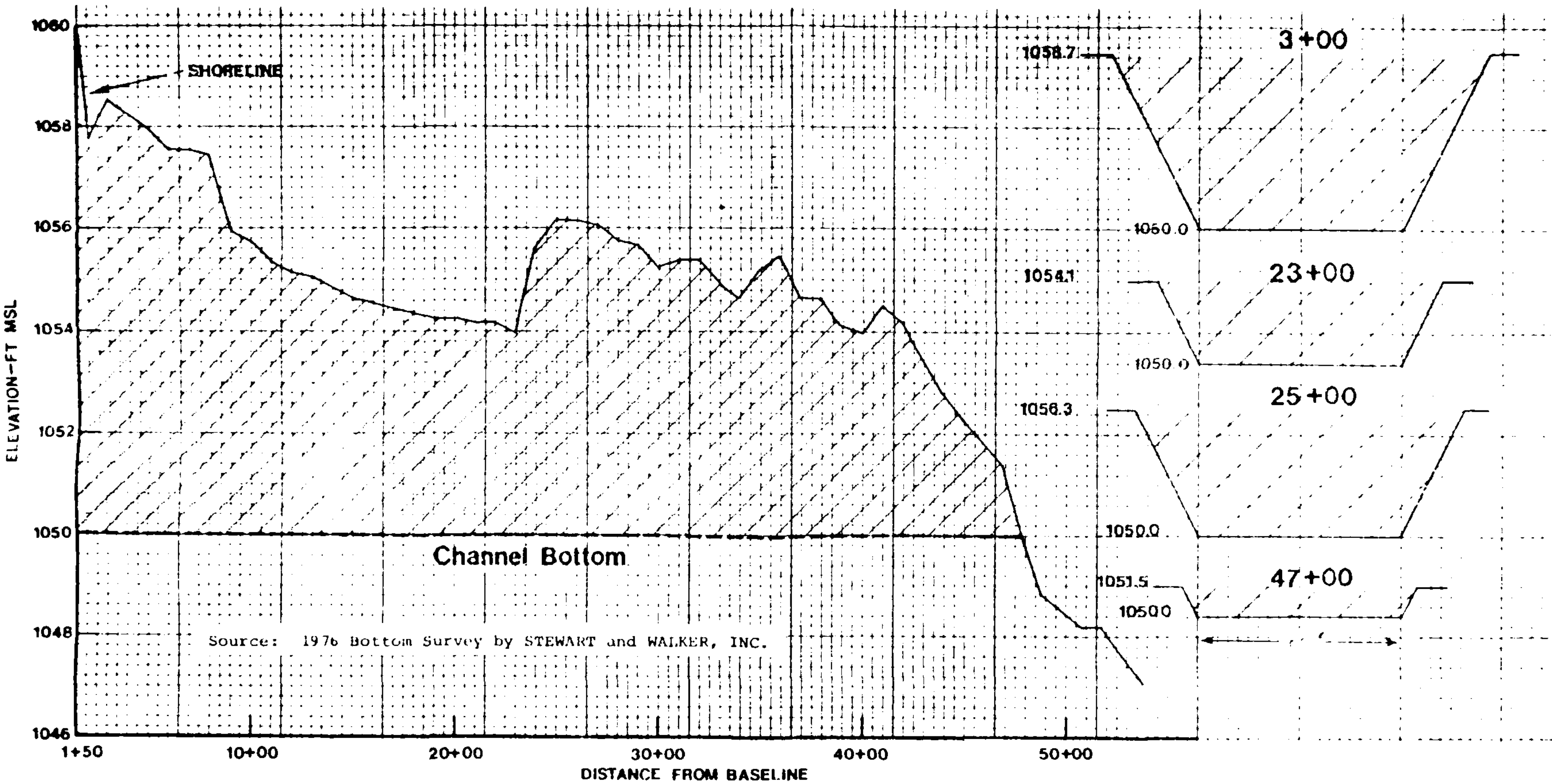
Figure 4 shows a cross section of the existing Taylor Road Bridge. Figure 5 shows channel cross sections and profile. The bridge does not have adequate vertical or horizontal clearances for safe and convenient passage of sailboats or larger motorboats. The channel takes a sharp turn on the landward side of the bridge. A turning basin would have to be excavated to provide an adequate turning radius for the larger sailboats and motorboats.

Studies indicate that littoral drift would tend to fill in the channel. A regular program of dredging or a protective jetty would be required to maintain channel navigation. For cost estimating purposes, construction of a protective jetty parallel to and north of the channel has been assumed.



BRIDGE NO. 68521 BOAT CHANNEL AT TAYLOR ROAD

FIGURE 4



CHANNEL ALTERNATIVE—A
PROFILE AND SECTIONS

FIGURE 5

Up to 125,000 cubic yards of dredged material would have to be disposed of. Minnesota Pollution Control Agency regulations would require on-land disposal of this material.

Navigational marking devices would be required to mark the channel alignment.

Alternative A has environmental costs associated with dredging lake bottom and shoreland materials. Dredging would disturb the benthic organisms, flora, and fauna present in the dredged area. It would also suspend fine materials in the water for a period of time. The channel would pass through a sandbar, removing a portion of a natural wave barrier. Construction of a protective jetty and maintenance dredging would disturb the littoral drift pattern.

Dredged soils would consist of sands, silty sands, sandy clays, silty clays with intermittent peat lenses, and gravel. Bottom sediments along the alignment exceed U.S. Environmental Protection Agency standards for the Great Lakes for chemical oxygen demand, violatile solids, copper, and nickel. The benthic fauna are primarily mollusks and lesser numbers of insects (midges). Appendix B contains an analysis of soil samples from the channel alignment area.

Evironmental impacts could be partially mitigated by placing a silt curtain around the dredge site to reduce turbidity. On-land dredged material disposal sites are available in the project area.

The estimated construction cost of alternative A is $2,250,000. Based on a 50-year project life and 6 7/8-percent interest rate, the ratio of benefits to costs is approximately 0.5. See appendix B for benefit calculations and construction cost estimate.

Alternative A would best accommodate future expansion of the marina if additional basins were developed north of the two existing basins. The jetty could provide a fishing platform.

Alternative B. - Alternative B is similar to A, but has a short section parallel to the shoreline between the shore and sandbar. The "dog-leg" would provide wave suppression to compensate for the loss of natural protection when the sandbar is pierced by the channel. The "dog-leg" would be difficult to mark and would produce boat operating and safety problems. The wave suppression benefits do not appear to justify the additional construction cost and navigation and safety problems.

Alternative C. - Alternative C follows an existing channel from the marina to the Taylor Road Bridge, passes under the bridge, runs parallel to the shoreline between the shoreline and the sandbar, and then connects to the existing Warroad River channel. The objective of alternative C is to use the existing bridge and the existing Warroad River channel to reduce construction and maintenance costs.

As with alternative A, use of Taylor Road Bridge results in inadequate vertical and horizontal clearances for the design boat. Alternative C requires a channel curve on the lake side of the bridge and at the channel's intersection with the Warroad River channel. Both curves present navigational marking, boat operating, and safety problems.

The sandbar would provide some wave protection for the channel. However, it is anticipated that a protective jetty or regular maintenance dredging would be required to prevent littoral drift from filling the channel. For cost estimating purposes, construction of a protective jetty parallel to and on the lake side of the channel has been assumed. Because of the shallow water, the volume of dredged excavation would be approximately the same as alternative A even though the alignment is shorter.

Alternatives A and C would have similar environmental impacts. Dredging would disturb the benthic flora and fauna in the dredged area. This impact may be greater than for alternative A because of the more shallow, productive water. Dredging would also suspend fine materials in the water for a period of time. Construction of a protective jetty and maintenance dredging would interrupt the littoral drift pattern. On-land disposal of dredged material would be required. Appendix B contains a summary of the analysis of soil and pollution samples from the channel alignment area.

The estimated construction cost of alternative C is $2,271,000. The ratio of benefits to costs is approximately 0.5. See appendix B for benefit calculations and cost estimate.

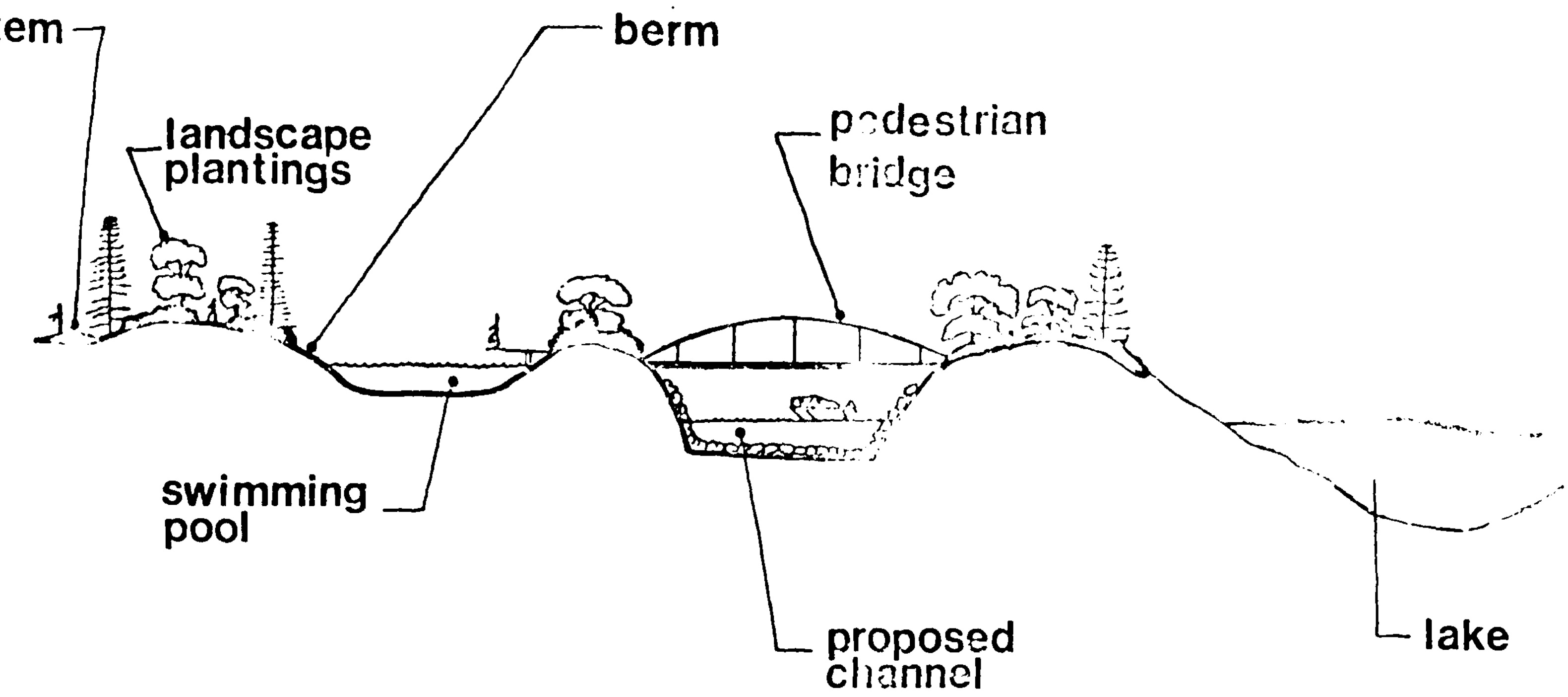
Alternative C could accommodate development of a deep draft motorboat and sailboat basin between the shoreline and the channel. This would be consistent with Warroad's long-range plans for development of its recreation complex. However, future development of such a basin would have a serious impact on shoreline wetlands. The protective jetty might create good shore fishing opportunities.

<u>Alternative D</u>. - Alternative D leaves the marina from the access channel between the two marina basins, curves between the sewage plant and the shoreline, and intersects the existing Warroad River channel approximately [illegible] feet south of the jetty base. The channel curve between the sewage plant and shoreline would be of sufficient radius to provide safe and convenient boating. It is anticipated that boat volumes and operating speeds would not be sufficient to create congestion and safety problems where the Warroad River and channel meet. All land needed for the channel is owned by the city. It is anticipated that the city would grant the Corps an easement for all channel and channel maintenance rights-of-way. The easement would also include rights-of-way to provide maintenance access to the existing government jetty.

Warroad's revised recreation complex master plan is based on selection of alternative D. The master plan also shows a two-lane boat launching ramp on the south side of the channel approximately 300 feet west of the channel's intersection with the river. The master plan calls for a vertical wall and widened channel section from the ramp to the river. The wall and widened section are to accommodate boat launching maneuvers and boat docking space. Analysis of alternative D for plan formulation purposes includes the ramp, wall, and widened channel section. However, concerns have been raised regarding conflict between boat launching activities and through-channel traffic and the additional costs of incorporating the ramp, wall, and widened channel section into the plan. If alternative D is selected, alternative boat launching ramp locations will be studied. The master plan also shows a pedestrian bridge over the channel.

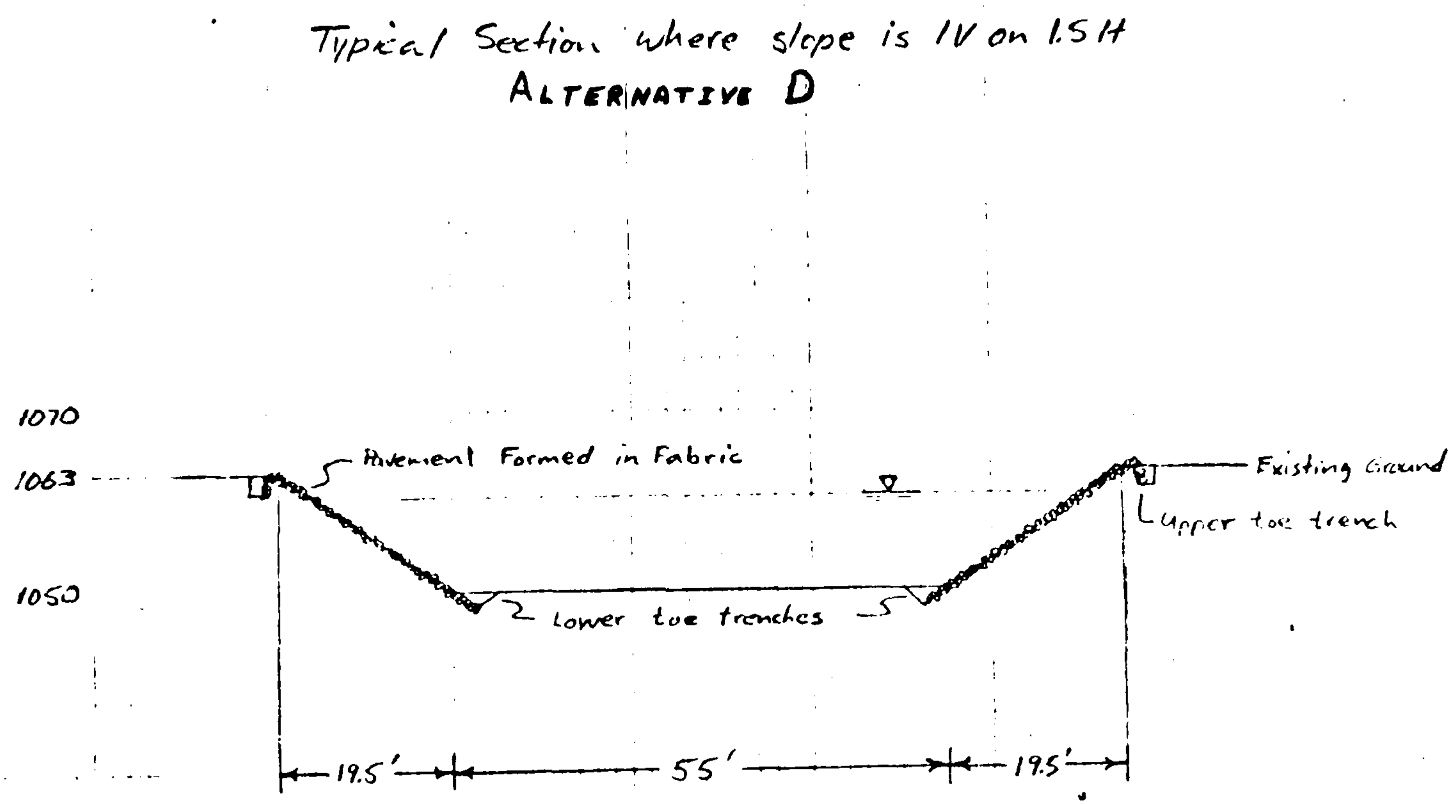
Neither the launching ramp facilities nor the pedestrian bridge are required for general navigation purposes. The cost of these items has therefore not been assigned to general navigation costs and would be funded by non-Corps sources.

Preliminary alignment layout, cross sections, and slope protection design materials have been prepared for alternative D. The park/channel concept plan, a typical cross section, and the alignment are shown in figures 6, 7, and 8. Poor soil conditions and propeller wash from passing boats would require slope protection for the channel. Plan formulation cost estimates are based on fabric-formed concrete pavement protection. This technique would protect the banks from erosion and sloughing and be aesthetically compatible with the park. The fabric-formed pavement would allow steeper banks to be used than possible with riprap and would require less right-of-way. The filter point type of pavement would reduce water pressure behind the pavement.



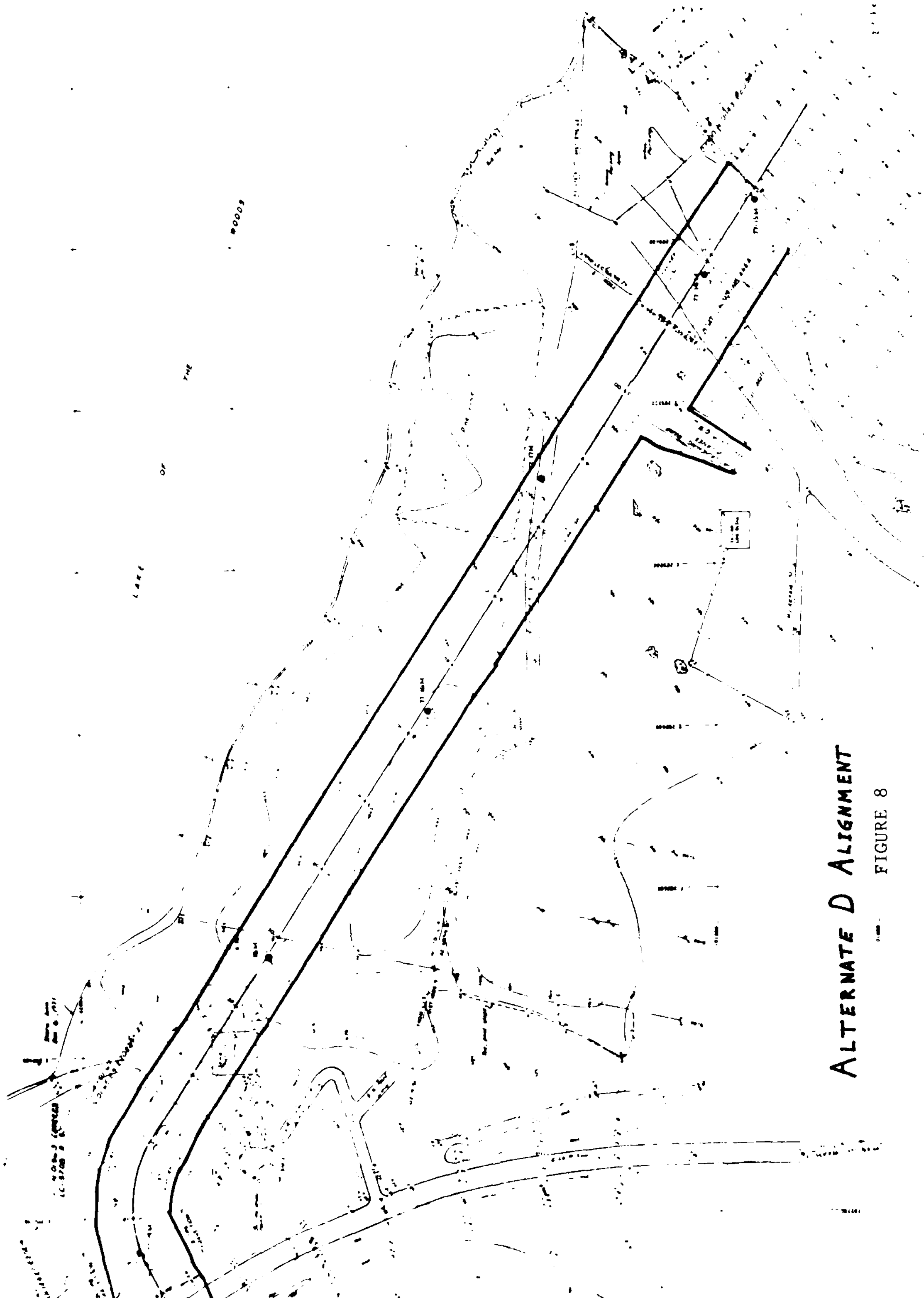
CITY PARK AND CHANNEL ALTERNATE D CONCEPT

FIGURE 6



Scale - 1 inch = 20 feet

FIGURE 7



ALTERNATE D ALIGNMENT

FIGURE 8

The excavated volume would be approximately 75,000 cubic yards. The city's consultant for the design of the recreation complex has stated that all the excavated material can be used to form landscaped berms and for road, parking lot, and campground fill. A landscaped berm would be used to protect the channel from overtopping when lake levels are high. The excavated portion of the channel would probably be isolated from the Warroad River until its junction with the river is excavated. Impacts on water quality during construction would therefore be minimal.

Construction of alternative D would require relocation of a sewage outflow pipe, removal of sewage sludge basins, and either abandonment of a segment of CSAH 74 (Taylor Road) or construction of a bridge. Warroad has programmed a new sewage plant for construction in the summer of 1980 or 1981. A temporary sewage outflow pipe would have to be constructed. Removal of the sewage settling basins would require that sludge be disposed of temporarily at an alternate location approved by the Minnesota Pollution Control Agency. Channel alignment D crosses CSAH 74 adjacent to the access channel between the two marina basins. The affected segment of CSAH 74 could be abandoned, or a bridge could be constructed to accommodate the channel. The bridge would be designed to provide adequate clearances for 30-foot motorboats. For plan formulation purposes, it has been assumed a bridge would be constructed on a slightly realigned CSAH 74. The bridge construction, temporary sludge disposal, and the sewage outflow pipe relocation are not general navigation costs; they would, therefore, be funded by non-Corps sources.

Alternative D would have the least environmental costs of the four alternatives analyzed. The alignment lies above elevation 1062 feet msl (mean sea level), 1929 adjustment, except for a short segment adjacent to the sewage plant which dips to 1061. Lake of the Woods water levels have been above 1062 only twice since the 1925 Lake of the Woods Convention established the treaty high water level at 1061. The channel would require the relocation or replacement of several coniferous trees and excavation of sod.

Samples from four boring sites along the channel alignment were analyzed for nutrients, heavy metals, and pesticides. Communication with the Minnesota Pollution Control Agency has determined that, with the exception of the area around the sewage treatment plant and near the Warroad River, material excavated from the channel could be disposed of at any location above the high-water mark. The sewage sludge material and material excavated near the Warroad River would need to be disposed of in accordance with Minnesota Pollution Control Agency regulations. See apendix B for an analysis of the samples.

An interchange of water between the marina, channel, and lake will be necessary to prevent water stagnation in the marina. Alternative D appears to offer the best flushing action because of two water connections to the lake via the existing Taylor Road Bridge and the proposed channel. The other alternatives would have only one connection via Taylor Road Bridge.

Members of the citizens advisory committee and local officials believe the overland channel would be compatible with the park. The channel would provide opportunities to fish and watch passing boats. The excavated material would be used to create berms and landscaping features, which would complement the otherwise flat terrain, providing observation areas and other points of interest.

A cultural resources survey of the area was conducted by Bemidji State University, Bemidji, Minnesota. Historical documents indicate a Chippewa village and fur trading post existed at one time in the area of the Warroad River mouth. A field survey determined that the area was composed primarily of recent fill and dredged lake sediments to a depth of about 4.5 feet. According to the original survey map of 1896, the project area was marshy. Because the cultural resources survey did not yield significant cultural remains, no impact on cultural resources is anticipated. However, because there is a possibility of deeply buried remains, the report recommended that an archeologist be present during construction in the event that previously undetected cultural remains are encountered.

The estimated construction cost of alternative D is $465,000. The ratio of benefits to costs is approximately 2.03. Appendix B contains the benefit calculations and cost estimate.

All public and government agency comments received to date favor alternative D over the other alternatives. Warroad officials, the citizens advisory committee, and the consultant designing the recreation complex favor D for economic and environmental reasons. The Minnesota Department of Natural Resources (DNR); Minnesota Pollution Control Agency (MPCA); U.S. Fish and Wildlife Service; U.S. Environmental Protection Agency (EPA); and the Corps of Engineers, St. Paul District, Environmental Resources Branch favor D for environmental reasons.

Comparative Assessment and Evaluation of Plans

Three steps were taken to assess and evaluate the alternative plans.

1. Appraise fulfillment of local planning objectives:

   - Provide boat access to the inland marina basin.
   - Provide a channel compatible with the recreational park complex.
   - Minimize local cooperation requirements.

2. Appraise fulfillment of national objectives:

   - National Economic Development (NED)
   - Environmental Quality (EQ)
   - Regional Development (RD)
   - Social Well-Being (SWB)

3. Apply a set of evaluation criteria:

- The acceptability of a plan is determined by analyzing its acceptance by concerned publics. A plan is acceptable if it is, or is likely to be, supported by some significant segment of the public.
- The completeness of a plan is determined by analyzing whether all necessary investments or other actions necessary to insure full attainment of the plan have been included.
- The effectiveness of a plan is determined by analyzing the plan's technical performance.
- The efficiency of a plan is determined by analyzing the plan's ability to achieve the planning objectives and NED and EQ outputs in the least costly way.
- The certainty of a plan is determined by analyzing in general terms the likelihood that implementation of the plan would achieve the planning objectives and contribute to the NED and EQ accounts.
- The geographic scope is determined by analyzing the relevancy of the geographic area encompassed by the plan; it must be large enough to encompass a full understanding of the problems and focused enough to make the proposed solutions effective.
- The NED benefit-cost ratio of a plan is determined by analyzing the economic benefits in relationship to the economic costs.
- The reversibility of a plan is determined by analyzing the capability, as public needs and values change or should unusual future circumstances so warrant, of restoring the partially or fully implemented plan to approximate the "without condition".
- The stability of a plan is determined by analyzing the range of alternative futures, data, and/or assumptions which can be meaningfully accommodated within the recommended plan or minor modifications. Greater stability generally indicates a more desirable plan.

The following three tables summarize the contributions of the plans to local and national planning objectives.

Assessment of local planning objectives

Local planning objective	Plan A	Plan B	Plan C	Plan D
1. Provide boat access to marina basin				
a. Boat safety	Requires 90° turn with poor sight distances. 1, 5, 8, 9	Requires 90° blind turn, two 90° turns in lake. 1, 5, 8, 9	Requires 90° blind turn, two 90° turns in lake. 1, 5, 8, 9	Requires merging with Warroad Channel, good sight distances. 1, 5, 8, 9
b. Convenient access to marina and fueling facilities	No convenient access from marina to boat services (approximately 3 miles). 1, 6, 8, 9	No convenient access from marina to boat services (approximately 3 miles). 1, 6, 8, 9	Access from marina to boat services approximately 1½ miles. 1, 6, 8, 9	Access from marina to boat services approximately one-half mile) 1, 6, 8, 9
c. Adequate vertical and horizontal clearances	Inadequate, 22 feet horizontal and 9.5 feet average vertical. 1, 5, 8, 9	Inadequate, 22 feet horizontal and 9.[illegible] feet average vertical. 1, 5, 8, 9	Inadequate, 22 feet horizontal and 9.5 feet average vertical. 1, 5, 8, 9	Adequate, 55 feet horizontal, 13.[illegible] feet average vertical. 1, 5, 8, 9
2. Compatible with recreational park complex				
a. Park user safety	Does not affect park safety. 1, 6, 8, 9	Does not affect park safety. 1, 6, 8, 9	Does not affect park safety. 1, 6, 8, 9	Water safety, requires climbable channel banks. 1, 6, 8, 9
b. Interference with park activities	Does not interfere with park activities. 1, 6, 8, 9	Does not interfere with park activities. 1, 6, 8, 9	Does not interfere with park activities. 1, 6, 8, 9	Requires pedestrian bridge or circuitous route to fishing jetty. 1, 6, 8, 9
c. Aesthetics	Does not affect park aesthetics. 1, 6, 8, 9	Does not affect park aesthetics. 1, 6, 8, 9	Does not affect park aesthetics. 1, 6, 8, 9	Design compatible with park aesthetics; boat watching is park amenity. 1, 6, 8, 9
3. Minimize local cooperation requirements	$1,125,000 non-Corps first cost. 1, 5, 7, 9	$1,125,000 non-Corps first cost. 1, 5, 7, 9	$1,135,000 non-Corps first cost. 1, 5, 7, 9	$233,000 non-Corps first cost. 1, 5, 7, 9.

Index of footnotes:

<u>Timing</u>
1. Impact is expected to occur prior to or during implementation of the plan.
2. Impact is expected within 15 years following plan implementation.
3. Impact is expected in a longer time frame (15 or more years following implementation).

<u>Uncertainty</u>*
4. The uncertainty associated with the impact is 50 percent or more.
5. The uncertainty is between 10 percent and 50 percent.
6. The uncertainty is less than 10 percent.

<u>Exclusivity</u>
7. Overlapping entry; fully monetized in NED account.
8. Overlapping entry; not fully monetized in NED account.

<u>Actuality</u>
9. Impact will occur with implementation.
10. Impact will occur only when specific additional actions are carried out during implementation.
11. Impact will not occur because necessary additional actions are lacking.

* Easily reversible measures are desirable in cases where uncertainty of impact is high.

Assessment [illegible]

NATIONAL [illegible]

[illegible]

Summary comparison of alternative plans

	No action plan	Plan A	Plan B	Plan [illegible]	Plan [illegible]
A. Plan description	-	Straight [illegible] ft. channel from Taylor Rd. bridge to deep water; [illegible],800 ft. breakwater	Same as "A" with "Dogleg" between bridge & [illegible]; [illegible],800 ft. breakwater	[illegible] Rd. bridge parallel [illegible] shore [illegible] River [illegible] breakwater	[illegible]
B. [illegible] evaluation					
[illegible] Contributions to local planning objectives					
[illegible]	[illegible]	Inadequate [illegible]	Inadequate [illegible]	Inadequate [illegible]	[illegible]
[illegible] Compatible with [illegible] park [illegible]	Marina would remain idle	Fully compatible	Fully compatible	Fully compatible	[illegible]
[illegible] Minimize [illegible] requirements	No requirements	Approx. $1,125,000	Approx. $1,1[illegible]	Approx. $1,1[illegible]	[illegible]
[illegible] Contributions to national planning objectives					
a. National economic development					
[illegible] Net annual benefit	0	-$84,000	[illegible]	[illegible]	[illegible]
[illegible] Benefit/cost ratio	0	0.[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Environmental quality					
[illegible] Wetlands destroyed	-	[illegible] acres	[illegible] acres	[illegible] acres	[illegible]
[illegible] Volume material excavated		[illegible],[illegible] cu. yd. [illegible] water dredging requires maintenance dredging every 25 yrs.	[illegible] cu. yd. [illegible] water dredging	[illegible] cu. yd. [illegible] water dredging	[illegible] Plan least damaging to the environment
[illegible] Social well being	No stimulus [illegible] in recreational opportunities		All plans provide increased recreational opportunities and are compatible with park & community plans. No persons, farms or businesses are displaced.		
[illegible] Regional development	Contributes to [illegible] development		All plans [illegible] construction [illegible] addition [illegible] would stimulate [illegible] and thereby generate tax revenues, [illegible] sales, and contribute to positive economic growth. [illegible] "D" provides the safest [illegible] boat access, its positive effects may be slightly greater.		
[illegible] specific evaluation criteria					
[illegible] Acceptability	Not acceptable to community	Not acceptable to local people, State [illegible]			Preferred [illegible] State, [illegible]
[illegible] Completeness	Marina [illegible] remain idle	All plans are complete [illegible] achieve their [illegible]			
[illegible] Effectiveness	Not effective	High maintenance dredging costs and need for protective jetty reduce effectiveness.			Most effective
[illegible] Efficiency	Not efficient [illegible]	High economic & environmental costs, [illegible] effectiveness [illegible] objectives.			Most efficient
[illegible]	High certainty	All plans have similar [illegible] of attaining objectives [illegible]			
[illegible]	-	All plans have similar geographic scope			
[illegible] Benefit/cost ratio	[illegible]	0.49	[illegible]	[illegible]	[illegible]
[illegible] Reversibility	Remains existing [illegible]	Littoral drift would restore lake bed to pre-[illegible] conditions in a few decades			High [illegible]
[illegible] Stability	Highly stable	Moderate range in predicted benefits [illegible] feasibility			Stable [illegible] affects [illegible] ratio
[illegible] Ranking of plans [illegible] (1-best; [illegible]-worst)					
[illegible] National economic development	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] NED plan
[illegible] Environmental quality	[illegible]	2	[illegible]	[illegible]	[illegible]
[illegible] Social well being	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Regional development	[illegible]	2	[illegible]	[illegible]	[illegible]
[illegible] plans [illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]
[illegible] Implementation responsibility					
[illegible] Federal	No implementation	[illegible] design of channel, contribute [illegible] of general navigation construction cost and construction administration, maintain channel general navigation facilities.			
[illegible] Coast Guard	No implementation	Provide navigation aids			
[illegible] Local cooperation	No implementation	Contribute 1/2 of channel general navigation construction cost, provide all channel nongeneral navigation construction costs (boat launching ramp, and additional costs of ramp associated items if included in plan), maintain all nongeneral navigation items.			

The previous table was reviewed for evaluation items related to each other. For example, NED, RD, benefit-cost ratio, efficiency, and minimizing local cooperation requirements all relate strongly to the economic features of the plans. When the plans responded similarly to related items, these items were combined. The items in this example were combined into a single item - cost effectiveness. When all plans rated the same on a particular item, that item could be eliminated. Combining related items and eliminating those where all plans rated the same produced a set of independent evaluation items best suited to distinguish between plans. The following table shows which items were combined and which were eliminated to produce the summary evaluation items.

Summary evaluation items

Summary evaluation items	Local planning objectives	National planning objectives	Evaluation criteria
Cost effectiveness	Minimize local cooperation requirements	National economic development, regional development, stability	Effectiveness, efficiency, benefit-cost ratio
Acceptability to public	-	-	Acceptability
Environmental impact	Compatible with recreation complex	Environmental quality, social well being, reversibility	-
Safe, convenient boat access	Provide access to marina	-	-
Items eliminated (do not distinguish between plans)	-	-	Completeness, certainty, geographic scope

The following table, "Evaluation summary," is based on the information contained in the previous four tables.

Evaluation summary

Evaluation item	Plan A	Plan B	Plan C	Plan D
Cost effectiveness	Low	Low	Low	High
Acceptability to public	Low	Low	Low	High
Negative environmental impacts	Medium	Medium	Medium	Low
Provide safe, convenient boat access	Medium	Low	Low	High

NED PLAN AND PLAN LEAST DAMAGING TO THE ENVIRONMENT

Plan D has the greatest net NED benefits and has been designated the NED plan.

The plan which makes the greatest net environmental contributions to the project area is called the EQ plan. An EQ plan could not be developed because no opportunities for improving environmental quality were related to or created by development of the project. No significant loss of environmental quality near the project area could be predicted. Plan D is located within a city park. Land needed for the channel would have more value for social well-being when used for the channel than it would as a natural resource. The loss of land for the channel is not significant in light of the vast acreage of natural resource lands in the area. Plan D is the most environmentally satisfactory alternative and it has been designated the least environmentally damaging plan.

RATIONALE FOR SELECTION OF PLAN D

Alternative D is the selected plan. The selection was based primarily on these factors:

a. Alternative D is clearly the most economical plan. Both construction and maintenance costs are substantially lower for plan D than for the other plans. It is the NED plan.

b. The local community and State and Federal agencies strongly favor plan D.

c. Alternative D has the least environmental impact since it does not require lake dredging for construction and maintenance and has a minimum impact on wetlands. It is the least environmentally damaging plan.

d. Alternative D provides safe, [illegible] access to the marina.

[illegible] PLAN.

After selection of the overland channel, coordination meetings were held with Warroad, the Minnesota Department of Natural Resources, U.S. Fish and Wildlife Service, U.S. Economic Development Administration, and the Minnesota State Planning Agency. Two channel design issues were identified at these meetings: (1) Should the boat launching ramp be located in the channel, in the Warroad River, or in the marina basin? (2) Should a new CSAH 74 bridge be constructed over the proposed channel, or should a segment of CSAH 74 be abandoned at the proposed channel?

Tables showing the relative merits of the alternative ramp locations and CSAH 74 solutions were presented at a joint meeting of the citizens advisory committee and city council on 22 March 1979. The city's design consultant for the recreational park complex discussed the relationship of the alternatives to the park plan. The city's engineering consultant for its current street reconstruction program discussed the relationship of the alternatives to the street system. A representative from the Roseau County Highway Department commented on the feasibility of abandoning a segment of CSAH 74 at the proposed channel. Information presented at the meeting and meeting minutes are in appendix C.

The citizens advisory committee unanimously recommended that the launching ramp be constructed in the marina basin and that a segment of CSAH 74 at the proposed channel be abandoned. The committee thought the marina ramp location would be more compatible with the Warroad street system, would simplify channel construction, reduce construction costs, and be more compatible with boat traffic patterns. The committee also thought that abandoning a segment of CSAH 74 would reduce the impact of CSAH 74 traffic on the park, allow sailboats access to the marina, and reduce construction costs. The Warroad City Council passed a motion requesting the Corps to follow the committee's recommendation.

With the exception of the boat launching ramp and CSAH 74 plan modifications, the channel plan assessed and evaluated in detail is the same as alternative D analyzed during formulation of preliminary plans.

PLAN DESCRIPTION

Alignment

The overland channel would intersect with the marina basin at the access channel between the north and south bays. From the marina basin, it would curve between the sewage plant and lake shoreline, run approximately parallel to the shoreline in a southeasterly direction, and intersect the Warroad River channel approximately 300 feet south of the Government jetty base. The channel would be approximately 1,700 feet long. The channel curve near the sewage plant would have a 150-foot radius of curvature, which would satisfy the minimum radius of curvature suggested for 75-foot long motorboats Channel banks at the confluence with the marina basins would be flared to permit smoother boat turning movements.

A raised berm would be constructed on the lake side of the channel. The berm would be a multiple-purpose structure that would reduce the chances of water from the lake overtopping the channel bank, thereby reducing siltation in the channel and protecting the fabric formed pavement from undermining. The berm would have an aggregate top surface for pedestrian, bicycle, and light maintenance vehicle traffic. The path would provide access to the park area between the channel and lake and would provide fishing access to the Government jetty. The berm would also provide a convenient and inexpensive way to use some of the excavated material. The berm would have a surface elevation of 1065 approximately 2 1/2 feet above the existing ground surface. Plate 1 shows the channel and berm alignment. Plate 2 shows how the channel would relate to the Lake of the Woods Beachfront Development at Warroad plan.

Cross Section

The channel would be 55 feet wide across the bottom, consistent with design standards for 11-foot wide motorboats. The channel banks would have a slope of 1 foot vertical for every 1.5 feet horizontal except for transition areas at the marina and Warroad River where the slope is 1 foot vertical for every 2 feet horizontal. Channel width between the bank tops would range from approximately 95 to 115 feet. Channel bottom elevation would be 1050 msl. Since lake elevations are regulated between elevations 1056 and 1061, the channel water depth would vary between 6 and 11 feet. Average water depth would be 10 feet. Plate 3 shows a typical channel cross section.

Poor soil conditions and propeller wash from passing boats would necessitate slope protection for the channel banks. Several methods of slope protection were considered. Steel and aluminum sheet pile were rejected for cost and water safety reasons. Conventional riprap was rejected because of the lack of availability in the area and high cost. Gabions and conventionally formed concrete pavement were rejected because of high cost. The channel design is based on the use of fabric-formed pavement. The technique should protect the banks from erosion and sloughing and be aesthetically compatible with the park. Because the fabric-formed pavement would allow steeper banks than riprap, it would conserve parkland. Weep holes or permeable joints would be provided to reduce water pressure behind the pavement.

Right-of-Way

The channel's right-of-way width would be 220 feet, with 100 feet on the land side of the channel center line and 120 feet on the lake side of the center line. The additional right-of-way on the channel's lake side would be needed for the protective berm. Additional land would be needed on the channel's lake side at the confluence of the channel and river to provide for the berm and Government jetty. Plate 1 shows the project right-of-way.

All right-of-way is owned by the city of Warroad. A perpetual easement for the right-of-way would be granted to the United States. The easement would insure perpetual use of the channel for public general navigation purposes and Corps maintenance access to the channel and Government jetty.

The Corps would also be granted a temporary easement for construction purposes and for transportation and placement of materials excavated from the channel.

Excavation and Grading

Approximately 58,000 cubic yards of material would be excavated from the channel. This amount is less than the 75,000 cubic yards estimated when the overland channel was compared to the other plans. The reduction has resulted from moving the boat launching ramp to the marina and from more detailed quantity calculations. The channel's confluences with the marina basin and river would be excavated last, simplifying the excavation of most of the material. This method would also reduce the amount of turbidity entering the marina and the Warroad River. The marina basins were excavated in the dry using dozers and scrapers. Because of the channel's proximity to the lake, more expensive dragline excavation methods could be necessary for all or part of the channel excavation. Pages J-37 and 38 of the environmental assessment (appendix J of this report) show chemical analysis sampling stations and the results of the channel analysis.

Approximately 58,000 cubic yards of excavated material would be placed according to the following plan:

a. About 2,500 cubic yards would be placed in the protective berm adjacent to the lake side of the channel. About 800 cubic yards of the 2,500 would be placed in the wetlands area adjacent to the sewage plant. Soil boring and chemical analysis information would be used to select the cleanest, most suitable material for construction of the berm.

b. The Warroad sewage treatment plant's sludge settling (dewatering) tanks are located on the channel alignment. Warroad has been developing plans for a new sewage treatment plant independently of the channel project. However, the new treatment plant will not be in operation until September 1982 or later. The sludge dewatering tanks would, therefore, have to be removed before the new plant is in operation. The digested liquid sludge would be handled according to the interim wastewater treatment plan prepared by an engineering consultant for the city of Warroad. Plate 4 shows the interim wastewater treatment plan. Appendix C contains letters dated 18 February, 13 March, and 31 March, 1980 from Stewart and Walker, the city's engineering consultant, to the Minnesota Pollution Control Agency and the Corps of Engineers. These letters describe the interim wastewater treatment plan and its operation. Appendix C also contains a letter dated 21 March 1980 from the Minnesota Pollution Control Agency to the Corps which states that the agency has no objections to the interim wastewater treatment plan. Warroad would be responsible for excavating the sludge from the existing tanks and disposing of it in a manner approved by the Minnesota Pollution Control Agency. Warroad would also be responsible for constructing and operating the interim wastewater treatment plan. Except for the sludge dewatering tanks and outfall pipe (see the relocation of utilities section on page 48), the existing treatment plant would not be affected by construction of the channel.

Soil next to the sludge beds has been contaminated with sludge. This soil would be excavated to a depth of 4 feet beneath the drying beds and a distance of 4 feet outside the perimeter of the beds. Further excavation may be required if visual observation indicates that the material underneath and adjacent to the beds has been contaminated to greater distances. A total of about 750 cubic yards of soil outside the tanks is contaminated with sludge. This material would be disposed of in the same manner as the sludge in the existing tanks. Excavation and disposal of the contaminated soils adjacent to the sludge beds would be part of the channel construction project.

c. About 4,500 cubic yards of material in the first 100 feet of channel inland from the Warroad River has elevated levels of pollutants. This material would be placed above the existing ground level but not adjacent to the top of the fill. Road fill or a landscaped berm would be two possible uses for the material. The soil would be covered by an impermeable layer of material such as clay or roadway surfacing.

d. Concrete rubble from the sludge tanks (about 30 cubic yards) and part of an existing pile of concrete rubble lie along the channel alignment. This material would be used as road or parking lot fill or incorporated into a landscaped berm. The rubble would be placed above the existing ground level but not adjacent to the surface where it would be exposed to surface runoff.

e. All the remaining excavated material would be placed as upland fill on the land side of the channel. The fill would be used to construct roads, parking lots, and landscaped berms. Plate 5, Excavation Material Placement Plan, shows the location and approximate quantity of each fill location.

The placement plan was developed through coordination with Warroad, the Minnesota Pollution Control Agency's Divisions of Water Quality and Solid Wastes, Minnesota Department of Natural Resources, and the U.S. Fish and Wildlife Service.

A cultural resources survey of the project area did not identify any significant archeological, historical, or architectural resources. However, an archeologist would review excavated material placement sites and be present during excavation, as necessary, to insure protection of any cultural resources not identified by the survey.

Hydraulic Design

Wind and boat wake wave erosion effects would be concentrated where the channel intersects with the river and marina basins. Riprap would be used for bank protection at these transition areas because of its wave dampening effects, flexibility, and ease of maintenance.

No potential significant boat operating problems or water safety problems have been identified. Channel design has been coordinated with the U.S. Coast Guard. The Coast Guard would establish one minor light structure and two plastic buoys as navigation aids.

The proposed channel and the existing shallow water connection under Taylor Road Bridge would provide water circulation between the marina basin and Lake of the Woods. Water would circulate because of changing lake water levels, precipitation, and groundwater flows. If water stagnation were to beome a problem, mechanical circulation could be provided. The installation of a water circulation pump, if required, would be a local responsibility.

Relocation of Utilities

A segment of CSAH 74, the sewage plant sludge dewatering tanks, and the sewage plant outfall pipe would need to be removed to allow construction of the channel.

On 22 March 1979, the Warroad City Council passed a motion adopting the citizens advisory committee's recommendation that a short segment of CSAH 74 between Lake Street and Taylor Road bridge be abandoned. This would eliminate the road/channel conflict. Warroad, in conjunction with Roseau County and the State of Minnesota, is considering the reconstruction and extension (from Lake Street to CSAH 74) of an existing city street which lies west of the marina. This street would provide improved access to Lakeview Park, the marina basins, and some undeveloped land. As such, the street would be part of the self-liquidating facilities. Because the street work, if undertaken, would not be necessary for the channel project and would be part of the self-liquidating facilities, its cost has not been included in the project costs.

As discussed in the excavation and grading section, Warroad would be responsible for implementing the interim wastewater treatment plan. This plan includes relocation of the sewage plant outflow pipe as well as construction of new sludge beds. The pipe presently runs from the sewage plant, crosses the channel alignment, and enters the mouth of the Warroad River. Implementation of the interim wastewater plan is necessary for construction of the project, and its cost has been included in the project costs.

Warroad would be responsible for any other utility relocations which have not been identified, but may prove necessary.

IMPACT ASSESSMENT

This section discusses the overland channel's economic, environmental, and social impacts. Federal law requires that a number of specific impacts be assessed for a project of this nature. Those items specified by Section 122 of Public Law 91-611 are marked with an asterisk (*).

Economic Impacts

The costs and benefits of the overland channel are based on July 1979 prices, a 7 1/8-percent interest rate, and an estimated 50-year project life.

Benefits. - Benefits have been calculated for four groups of boats that would use the channel:

1. Warroad-based boats using marina slips rented for the season (seasonal slip demand).

2. Existing boats which would use transient slips if they were available (latent transient slip demand).

3. Future transient boats added because of natural growth (future transient slip demand).

4. Boats launched at the marina boat launching ramp but not berthed at the marina (day-use launching demand).

Benefits were calculated in accordance with the Corps small-boat benefit procedures given in EM 1120-2-113. Boat demand projections and benefits were developed by the Corps Environmental Resources Branch. Boat values are based on May 1980 boat prices. Rates of return on depreciated investment were selected from ranges specified in EM 1120-2-113. Benefits assume a 5-percent average compounded annual increase in demand for seasonal and transient slips. A latent transient slip demand for 21 seasonal equivalent slips is assumed. It is also assumed that the 1981 day-use boat launching demand will be 2,495 launches per year (18 equivalent seasonal slips) and that boat launching will increase 5 percent per year for 10 years and then remain constant. See appendix I for the detailed benefit analysis and calculations.

The benefits reflect updated boat values and the addition of two boat launching lanes in the marina; therefore, they vary from the benefits used for plan formulation. Updated benefits are presented in the following table.

Annual benefits - general navigation facility

Recreational navigation	
Seasonal craft use	$69,500
Transfer of existing transient (camper) craft	7,290
Future growth of transient (camper) craft	14,330
Day-use launching	3,430
Total	94,550

Costs. - The estimated first costs for general navigation facilities are $539,300. The channel project would not contain any nongeneral navigation (self-liquidating) facilities as defined by EM 1120-2-113, Benefit Evaluation and Cost Sharing for Small Boat Harbor Projects. The annual maintenance cost of the general navigation facility is estimated to be $8,400. The maintenance estimate assumes that 20 percent of the slope protection pavement would have to be replaced every 5 years, primarily as a result of ice damage. The maintenance cost may be significantly less; a conservative estimate was made because of the lack of long-term, severe weather experience with fabric-formed pavement.

The cost estimate in the following table reflects May 1980 construction costs. Appendix F contains the detailed cost estimate. The costs shown here reflect some plan refinements made since plan formulation; therefore, the cost and benefit-cost ratio vary from those used for plan formulation.

General navigation facility costs	
Item	First cost
Construction	$463,000
Aids to navigation	11,300
lands, easements, and rights-of-way (nonself-liquidating)	50,000
Relocate sewage plant outflow pipe	10,000
Temporary sludge bed	5,000
Total	539,300

Environmental Impacts

The Environmental Resources Branch has completed an environmental assessment for the overland channel. The environmental assessment is attached as Appendix J and is the primary basis for the environmental and social impact information presented here.

Endangered or Threatened Species. - No known endangered species inhabit the project area or its vicinity. The project area is within the range of two threatened species, the bald eagle and the eastern timber wolf, and an endangered species, the arctic peregrine falcon. The project is unlikely to affect these species since the project area does not provide suitable habitat. The State of Minnesota has classified the lake sturgeon as a species of uncertain or changing status. The lake sturgeon requires swift water or rapids for spawning and the project will not contribute or eliminate habitat.

Water Quality*. - Any increase in boating in the Warroad area would be likely to increase the possibility of spills at fueling facilities in the river channel. Public education, operator training, equipment inspection, and proper design of fueling facilities would minimize fuel spills. Similar techniques could be used to minimize the emptying of sewage holding tanks into the marina basin and the lake. Convenient access to the holding tank dump station along with minimum fees and qualified attendants should allay concerns about the potential problem. Natural water circulation between the lake and marina basin via Taylor Road Bridge and the overland channel should be adequate to prevent water stagnation in the marina basin. If natural water circulation proved inadequate, mechanical circulation would be necessary.

Turbidity levels could be elevated when the excavated channel is filled with water. Excavation of the channel ends last and slow filling of the channel should minimize the impact on the marina and river channel. Banks would be protected with fabric-formed pavement and would not contribute to elevated turbidity levels.

The public notice and evaluation guidelines as defined by Section 404 of the Clean Water Act have been complied with. The 404(b) evaluation is on pages J-44 through J-55 of the environmental assessment (appendix J). A *Water Quality Certificate* has been received from the State of Minnesota (see appendix C).

Air Quality*. - During construction, air pollutants would be emitted by heavy construction equipment. After construction, air emissions would be produced by the additional boat and auto traffic attracted by the marina. The project is not anticipated to have a significant, adverse effect on air quality.

Natural Resources*. - Alternative D would use dry, overland excavation. About 3.9 acres of land which is currently open, grassed city park would change from terrestrial to aquatic habitat. Approximately 12 to 15 trees would be relocated or replaced to allow for construction of the protective berm. The berm would be located to minimize the number of trees disturbed. Approximately 100 feet of riverbank would be destroyed and 200 feet disturbed by the channel where it enters the Warroad River. The approximately 3,300 feet of channel bank created by the project may adequately replace this. Riprap installed at the mouth of the channel during construction should provide habitat for benthic invertebrates. Maintenance dredging requirements would be very minimal.

Wetlands. - About 0.5 acre of wetlands would be converted to water area (access channel) and land area (channel bank and protective berm). The wetland is in a confined area near the sewage plant and probably does not provide significant spawning or rearing habitat since it is above the normal water level. A small amount of waterfowl habitat could be eliminated.

No material would be placed into a wetland area or below the ordinary high-water mark of Lake of the Woods, with the exception of the approximately 0.5 acre of wetland area adjacent to the sewage plant. No excavation work would be done under or on the lake side of the existing CSAH74 (Taylor Road) Bridge.

In accordance with Executive Order 11990 (Protection of Wetlands), the availability of feasible alternative channel alignments which would result in no wetland destruction was fully investigated. The selected alignment has the minimum wetland impact. The impact on the approximately 0.5 acre of wetland adjacent to the sewage plant cannot be avoided. Moving the channel and protective berm farther inland would require relocation of a swimming pool and the sewage treatment plant and is not feasible. To minimize its total width, the channel has the minimum bottom width and steepest slopes consistent with sound engineering practices. The berm is also as low and narrow as practical and still serve its essential protection and pathway functions.

Aquatic Habitat. - About 200 feet of the Warroad River's north bank would be eliminated. The channel banks, especially the riprap at the channel's confluences with the marina and the river, would provide new aquatic habitat.

Man-Made Resources*. - The channel would provide access to the existing marina basin and allow the basin to be used for its intended purpose. Operation of the marina would also encourage greater use of Warroad's private and public facilities. The purpose of the channel is to serve a recreational boating need. The channel is consistent with the water oriented recreational purposes of Lakeview Park.

Cultural Resources. - No significant cultural resources would be affected by construction of the project. No sites in the project area are listed on the National Register of Historic Places. A cultural resources survey revealed no substantial evidence of premodern activity along channel alignment and disposal areas. However, the history of fur trading and Indian habitation of the Warroad area requires that an archeologist be present during excavation. If previously undetected materials were encountered during construction, the work would immediately be discontinued and the significance of the remains evaluated according to National Register criteria.

Social Impacts. - The project would involve no relocation of businesses, farms*, or people* since all the required land is owned by the city. The completion of the project is viewed by the city not only as necessary to operation of the marina, but as an important component to development of the city park.

The increase in recreational craft capacity would be expected to result in secondary economic benefits to the area beyond the primary benefits derived from slip fees and fuel, maintenance, bait, and equipment expenditures. These secondary benefits would accrue from purchases for food, lodging, and entertainment in the local area. This income could contribute to an increase in employment*, at least on a seasonal basis. A small, temporary increase in local employment would accompany construction of the project. The increased local business activity* would result in somewhat higher tax revenues* and property values*, although these effects will not be large. The project is not expected to affect local industrial activity*.

Increased use by recreationists from adjacent States and Canada would provide in-transit economic benefits to the surrounding area which would contribute to community regional growth*. A beneficial effect on community cohesion* could result since the local economy is heavily dependent on recreation. Recreational opportunities would increase for local residents as well. Local support for the project is strong, and no opposition to implementation of the project has been identified.

Development of marina projects often increases demand on public services*, such as police and fire protection and solid waste disposal. Additional demands on public facilities* and recreation personnel can also occur. Methods of operation and regulation of campgrounds and marinas appear to be the major determinant of the extent that vandalism and minor civil disturbances might result from implementation of a harbor project. Completion of the Warroad project, however, is not likely to cause a significant increase in serving demands. In some instances, such as transportation, the project would actually alleviate some of the existing problems caused by congestion of roads serving the boat launching ramp area. Because many of the ancillary facilities required by a marina are already in place, stress on community services would be much less significant than that accompanying new marina development.

The confluence of the channel and Warroad River is thought to have adequate boat operating capacity, and a significant boat congestion and safety hazard is not expected to occur there. The relocation of the boat launching ramp and swimming area from the Warroad River would reduce the congestion and safety problems which have occurred in the river in the past.

Routing the channel through the public park is currently being considered as an aesthetic improvement* by the city. The canal-like channel would provide a focal point for observation of boat passage to and from the marina. This position must be balanced against the alternative view that noise and air quality effects resulting from the boat traffic might be an intrusion on some forms of recreation and that the channel could reduce the aesthetic quality of the park for some users. At present, however, the city believes that the proposed channel would be a net positive addition to the park system, and so is supporting a design of the channel which maximizes its viewing potential.

Construction activities would produce a temporary increase in noise. Additional auto and boat traffic generated by the marina would increase noise levels after construction is completed. However, the additional noise would be small and would not be anticipated to have a significant adverse effect.

IMPLEMENTATION RESPONSIBILITIES

Established policy requires that local interests share in the costs of general navigation facilities for small-boat harbors in proportion to the local benefits. Benefits are allocated to general and local accounts in accordance with guidelines. General navigation project costs are then apportioned to Federal and non-Federal interests on the basis of the ratio of general to local benefits.

Benefit Allocation

The project will result in recreational navigation benefits. EM 1120-2-113, Benefit Evaluation and Cost-Sharing for Small-Boat Harbor Projects, specifies that these be allocated as one-half general and one-half local benefits. Allocation of benefits is presented in the following table.

Allocation of benefits

Type of benefit	Allocated benefits: Total	General	Local
Recreational navigation			
Seasonal craft use	$69,500	$34,750	$34,750
Transfer of existing transient (camper) craft	7,290	3,645	3,645
Future growth of transient (camper) craft	14,330	7,165	7,165
Day-use launching	3,430	1,715	1,715
Totals	94,550	47,275	47,275
Totals (percent)	100	50	50

Cost Apportionment

Project benefits are 50 percent general and 50 percent local. General navigation facility costs have therefore been apportioned 50 percent to Federal and 50 percent to non-Federal interests. Cost apportionment and computation and presentation of annual changes are presented in the following tables.

Apportionment of costs

Estimated project costs			
First costs: (general navigation facilities)			
Federal			
Corps of Engineers, general navigation facilities		$463,000	
Coast Guard, aids to navigation		11,300	
Total Federal			$474,300
Non-Federal			
Nonself-liquidating lands, easements, and rights-of-way		50,000	
Relocate sewage plant outflow pipe		10,000	
Temporary sludge bed		5,000	
Total non-Federal			65,000
Total project costs			539,300 (1)
Annual maintenance			
Corps of Engineers		8,000	
Coast Guard, navigation aids		400	
Total annual maintenance			8,400
Apportionment of first costs:			
Federal			
Corps of Engineers (0.50 x $463,000)	231,500		
Coast Guard (1.00 x $11,300)	11,300	242,800	
Non-Federal			
Cash contribution (0.50 x $463,000)	231,500		
Lands, easements, and rights-of-way	50,000		
Relocate sewage plant outflow pipe	10,000		
Temporary sludge bed	5,000	296,500	
Total project costs			539,300

(1) Does not include about $198,100 in project preauthorization costs.

Computation and presentation of annual charges		
Federal annual charges		
Interest and amortization (0.07360 x $242,800)	$17,900	
Maintenance	8,400	
Total Federal annual charges		$26,300
Non-Federal annual charges		
Interest and amortization (0.07360 x $296,500)	21,800	
Total non-Federal annual charges		21,800
Total project annual charges		48,100
Net annual benefits		
Total annual benefits	94,550	
Total annual costs	48,100	46,450
Benefit-cost ratio		
$94,550 ÷ $48,100	=	1.97

Corps Responsibilities

Corps responsibilities include the following activities:

a. Prepare construction plans and specifications.

b. Administer and supervise construction operations.

c. Contribute 50 percent of the total first cost for construction of general navigation facilities.

d. Maintain general navigation facilities.

Local Responsibilities

The city, as local sponsor of the project, must agree to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project and subsequent maintenance of the project and of the Government jetty, including suitable upland areas for placement of excavated materials, in accordance with project right-of-way and excavation material placement plans.

b. Accomplish all alterations and relocations of buildings, streets, sewers, utilities and other structures and improvements made necessary by project construction.

c. Contribute 50 percent of the total first cost for construction of general navigation facilities.

d. Contribute all costs in excess of the Federal cost limitation of $2,000,000.

e. Hold and save the United States free from damages due to the construction, operation and maintenance of the project, not including damages due to the fault or negligence of the United States or its contractors.

f. Insure that expenditure of Corps funds will result in a project that is integrally complete and fully effective by providing and maintaining:

(1) An adequate public landing with provisions for dispersing potable water and disposing of boat sanitary wastes, available to all on equal terms.

(2) Piers, slips, floats, and similar marina and mooring facilities as needed for transient and local boats, including necessary dockage, police, and fire protection services, open to all on equal terms.

(3) Access roads, parking areas, boat launching ramps, and other necessary public use shore facilities.

The improvements described above are to be provided without material deviation from the Lake of the Woods Beachfront Development at Warroad plan.

g. Establish a competent and properly constituted body empowered to regulate the use, growth, and development of the marina facilities and insure that the facilities shall be open to all on equal terms.

h. Establish regulations prohibiting the discharge of untreated sewage, garbage, and other pollutants in the waters of the harbor by users thereof, which regulations shall be in accordance with applicable laws or regulations of Federal, State, and local authorities responsible for pollution prevention and control.

i. Comply with the provisions of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970," Public Law 91-646, approved 2 January 1971, in the acquisition of lands, easements, and rights-of-way necessary for the construction and subsequent maintenance of the project.

PUBLIC VIEWS

Views of Federal Agencies

The study has been coordinated with the following Federal agencies.

Coast Guard
Environmental Protection Agency
Fish and Wildlife Service
Federal Housing Administration
Federal Highway Administration
Soil Conservation Service
Heritage Conservation and Recreation Service
National Weather Service
Public Health Service

Views of Non-Federal Agencies and Others

The study has been coordinated with the following non-Federal agencies.

Local

City of Warroad
Citizens Advisory Committee
Roseau County
Northwest Regional Development Commission

State

Minnesota Historical Society

Minnesota Department of Transportation

Minnesota Department of Health

Minnesota Department of Administration

Minnesota Department of Natural Resources

Minnesota Pollution Control Agency

Minnesota State Planning Agency

University of Minnesota Anthropology Department

SUMMARY ANALYSIS OF FINAL PLAN

The following table is a summary analysis of the overland channel. The impacts of the channel with respect to NED, EQ, SWB, and RD are compared to existing conditions and the most probable future conditions if the channel is not constructed. The contributions of the plan to the local planning objectives, national objectives, and evaluation criteria were also analyzed and compared to existing and most probable future conditions if the channel is not constructed.

$94,550

539,300

39,700

8,400

48,100

56,450

1.97

aggregates,

stated.

Summary analysis of final plan (cont)

Item	Base condition - 1979	Without condition (most probable future with no action)	Overland channel detailed plan
5. Social well-being (SWB)(cont)			
b. Adverse impacts			
Noise*	Low noise levels.	Base condition continues.	Small increase in noise due to construction and additional boats and autos.
Displacement of people	No residences on right-of-way.	None.	None.
Man-made resources, cultural artifacts	None identified.	None identified.	No effect anticipated; site will be monitored during construction.
Health and safety	Boat conflicts, boat congestion in river.	Boat conflicts, congestion in river becomes more severe.	Possible water safety hazard.
6. [illegible]			
a. Beneficial impacts			
[illegible]*	Moderate rate of employment increases in commercial and industrial jobs continues.		Additional jobs for construction; small increase in marina-related employment.
[illegible]*	Moderate rate of tax revenue growth continues.		Additional revenues associated with marina-induced development.
[illegible]*	[illegible] rate of property value [illegible] continues.		Slight additional increase due to marina induced development.
[illegible]*	[illegible] continues and [illegible] has capital [illegible] streets, sewer [illegible].		Marina will provide additional recreation facility; will not overtax existing facilities.
[illegible]*	[illegible] public services [illegible].		Marina will require some additional police, fire, sanitation services.
[illegible]*	[illegible] rate [illegible] business and industrial [illegible] expansion continues.		Additional marina induced sales; industry not affected.
[illegible]*	Moderate rate of [illegible] development continues.		Small amount of additional regional growth induced by marina.
b. Adverse impacts			
[illegible] farms*	[illegible] continues; [illegible] farms affected.		No farms affected.
Displacement [illegible]*	[illegible]		No businesses affected.
7. [illegible] evaluation			
a. [illegible]			
b. [illegible]	[illegible] access.	[illegible] access.	Good access.
c. [illegible]*	[illegible] not used.	Marina basin not used.	Channel is integral part of park, necessary for marina; campground to function as planned.

Summary analysis of final plan (cont)

Item	Plan description: Base condition - 1979	Without condition (most probable future with no action)	Overland channel detailed plan
. Contributions to local planning objectives (cont)			
c. Minimum local coop. requirements	No return on local marina investment.	No return on local marina investment.	Most economical plan to provide marina boat access.
2. Contributions to national objectives			
a. National economic development	No benefits realized from existing marina basin; recreational economic development constrained by lack of boat slips.		Favorable benefit-cost ratio, substantial positive net benefits.
b. Environmental quality	Parkland.	Parkland remains.	No significant environmental effects associated with channel construction.
c. Social well-being	Present and future development of recreational boat-related opportunities constrained by lack of marina facilities.		Additional recreational opportunities; small increase in marina and tourist-related jobs.
d. Regional development	Moderate rate of growth continues; recreational economic development constrained by lack of boat facilities.		Small increase in jobs and tax revenues due to marina-induced economic development.
3. Plan response to associated evaluation criteria	The overland channel responds favorably to acceptability, completeness, effectiveness, efficiency, certainty, geographic scope, B/C ratio, and stability. The cost to restore the channel to its former state would be high; the reversibility is therefore low.		
4. Rankings of plan contributions	The overland channel ranks higher than the base condition and most probable future condition in relation to NED, SWB, and RD. The overland channel has no significant EQ effects and ranks evenly with the base and most probable future condition in relation to EQ effects.		

. Implementation responsibilities

Corps responsibilities

1. Prepare construction plans, specifications.
2. Administer and supervise construction.
3. Contribute 50 percent of general navigation facilities first cost.
4. Maintain general navigation facilities.

Non-Corps responsibilities

1. Provide lands, easements, and rights-of-way.
2. Relocation and alterations of utilities.
3. Contribute 50 percent of general navigation facilities first cost.
4. Contribute all costs in excess of the Federal first cost limitation of $2,000,000.
5. Hold and save United States free from damages except those due to fault or negligence of United States and contractors.
6. Provide marina-related improvements without material deviation from park plan.
7. Establish a body to operate the marina facilities.
8. Establish regulations to prohibit pollution in harbor waters.

* Items specifically required by Public Law 91-611, Section 122.

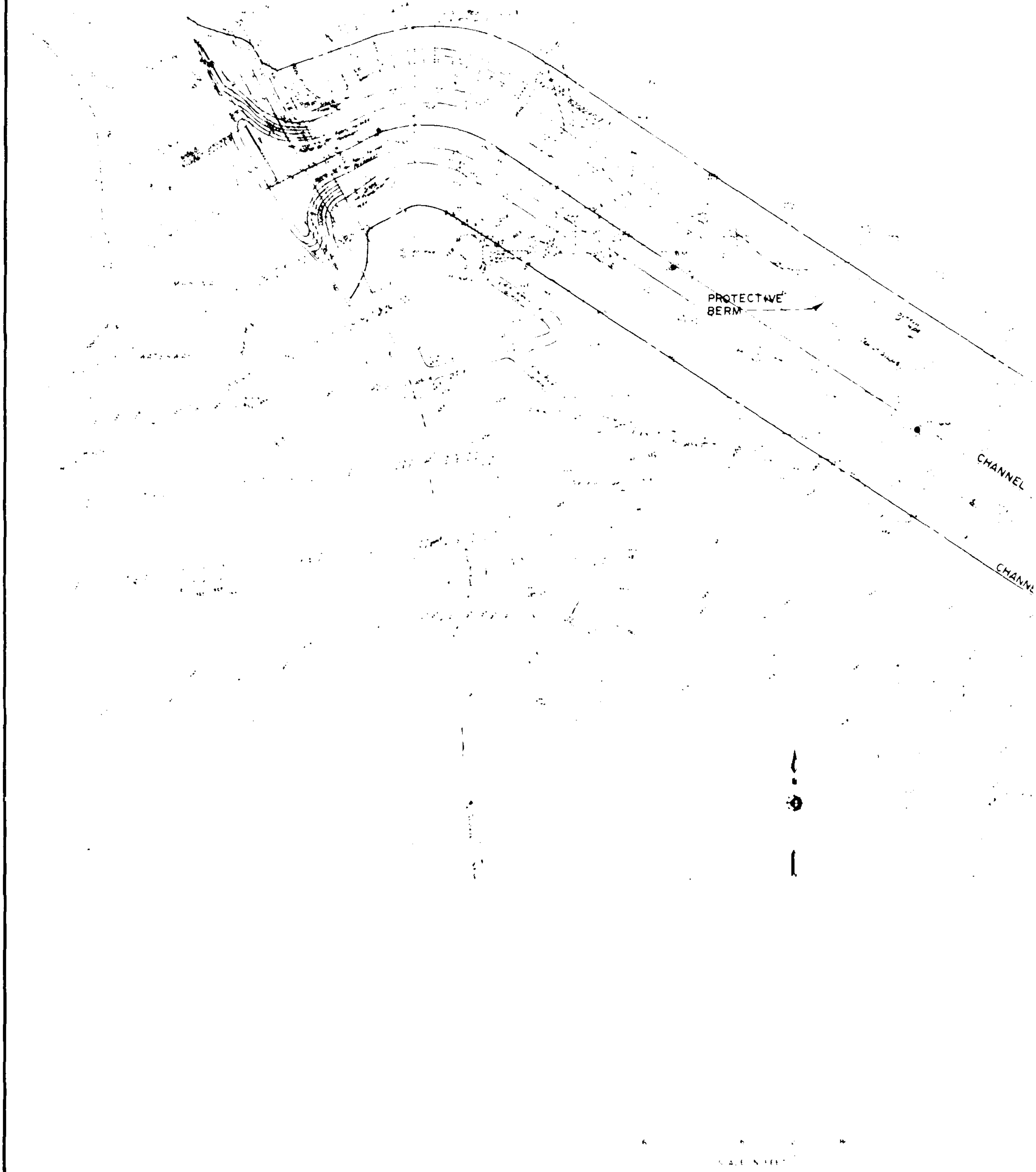
The overland channel clearly ranks higher than the base condition and the most probable future condition if a channel is not constructed with respect to NED, SWB, and RD. The channel has no significant EQ effects and has been designated the plan least damaging to the environment. There were no opportunities related to development of the channel project for development of an EQ plan.

The overland channel was designated the NED plan and the plan least damaging to the environment following the assessment and evaluation of the alternative channel plans. Detailed study and plan refinements since selection of the overland channel alternative have resulted in a more economical plan without additional environmental costs.

RECOMMENDATIONS

I recommend that the United States construct a small-boat marina access channel at Warroad, Minnesota, generally in accordance with the overland channel plan described herein, at an estimated Federal first cost of $242,800, and a Federal annual maintenance cost of $8,400.

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer


PROTECTIVE
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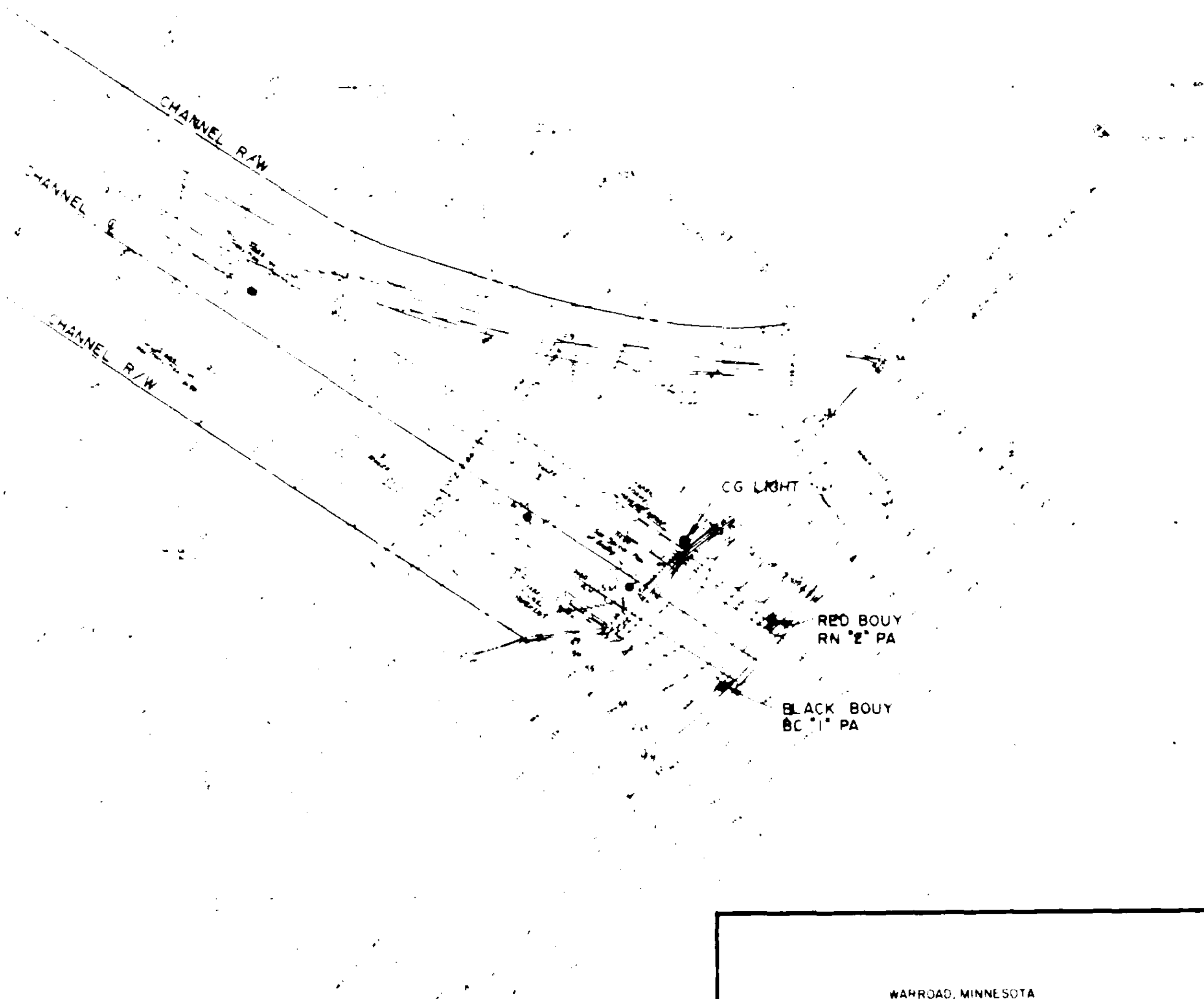


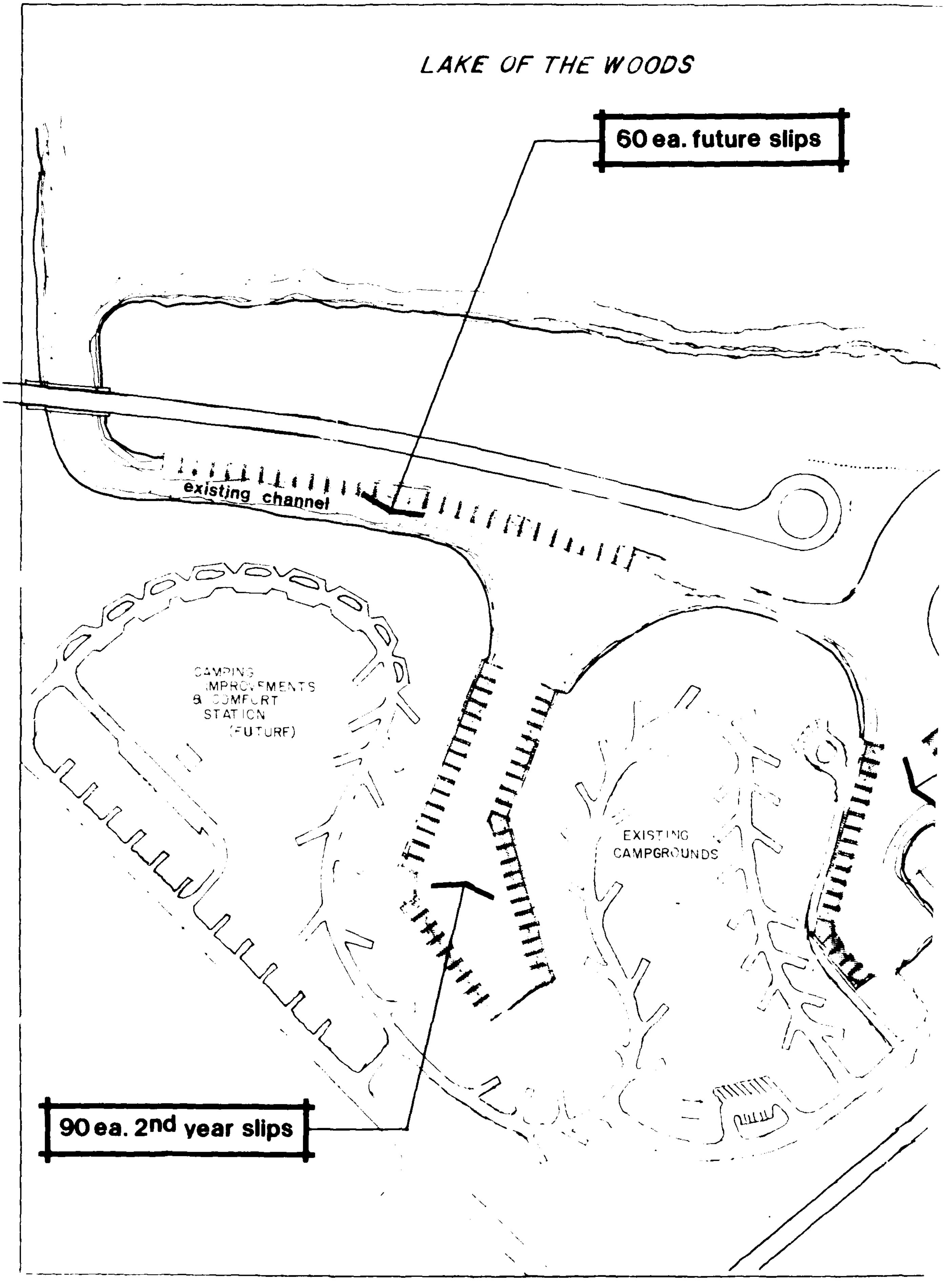
WARROAD, MINNESOTA

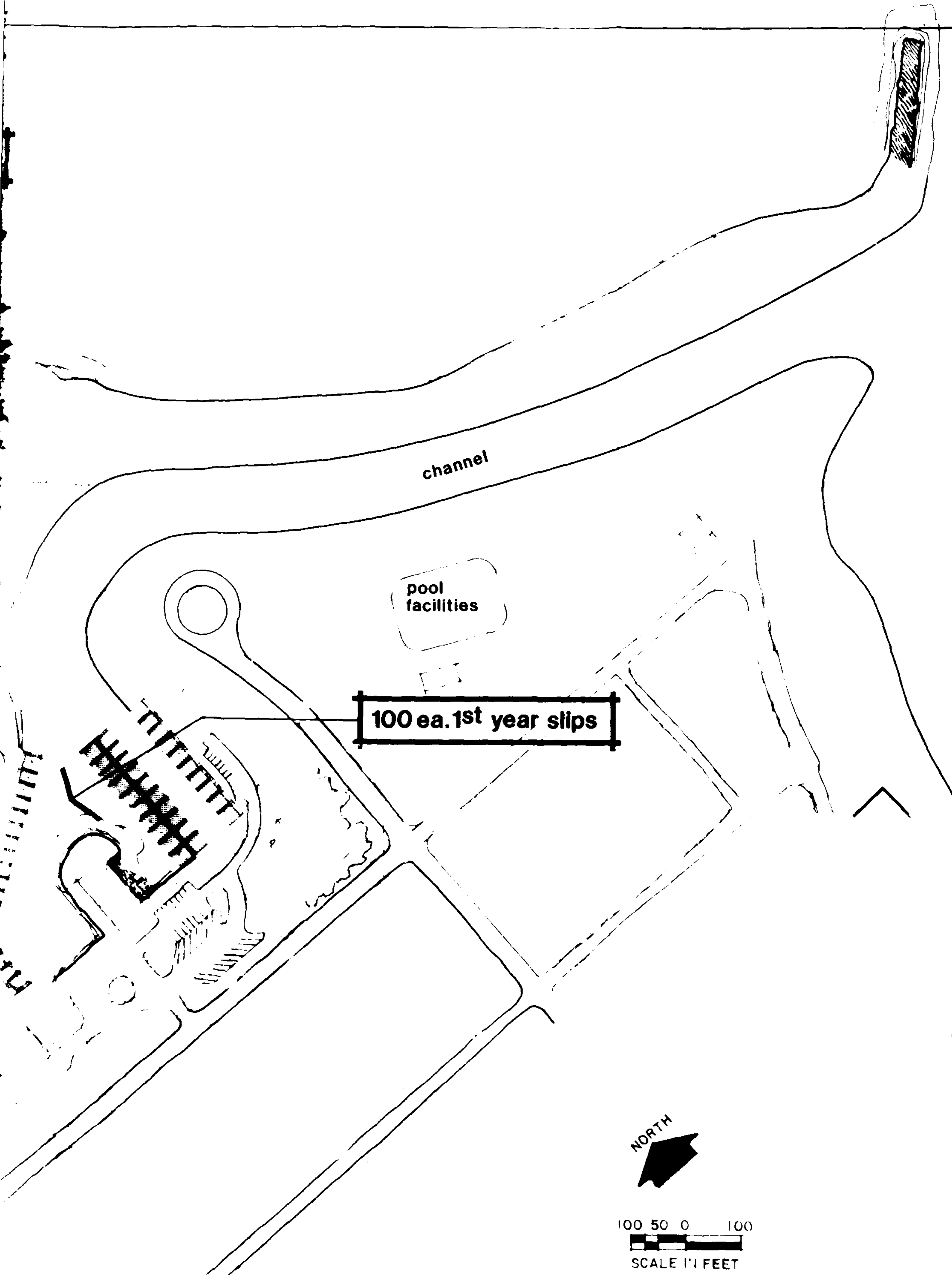
MARINA ACCESS CHANNEL

CHANNEL ALIGNMENT

ST. PAUL DISTRICT

PLATE 1


LAKE OF THE WOODS
60 ea. future slips
existing channel
CAMPING IMPROVEMENTS & COMFORT STATION (FUTURE)
EXISTING CAMPGROUNDS
90 ea. 2nd year slips



architec
ARCHITECTU
RESOURCES
JYRING
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consulta

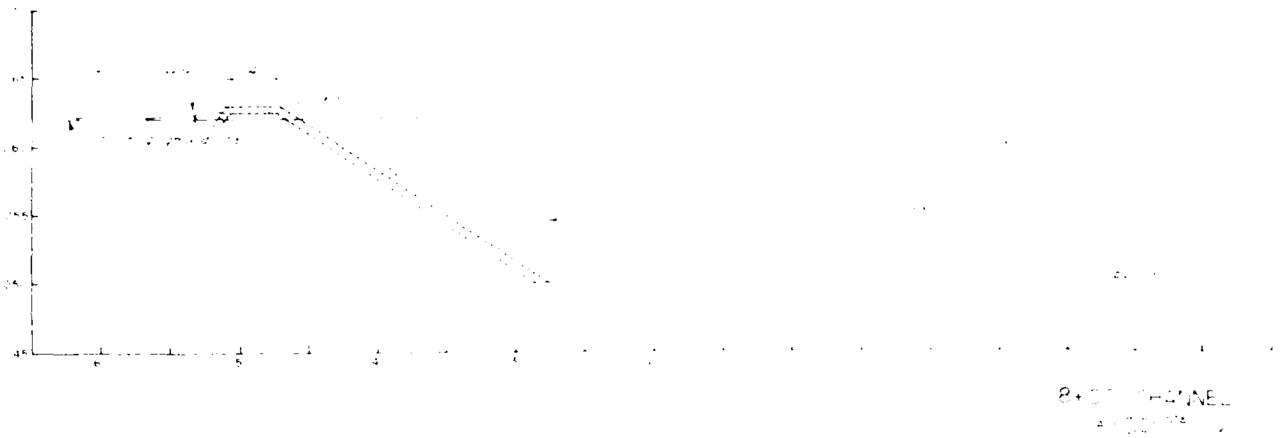
REVISIO

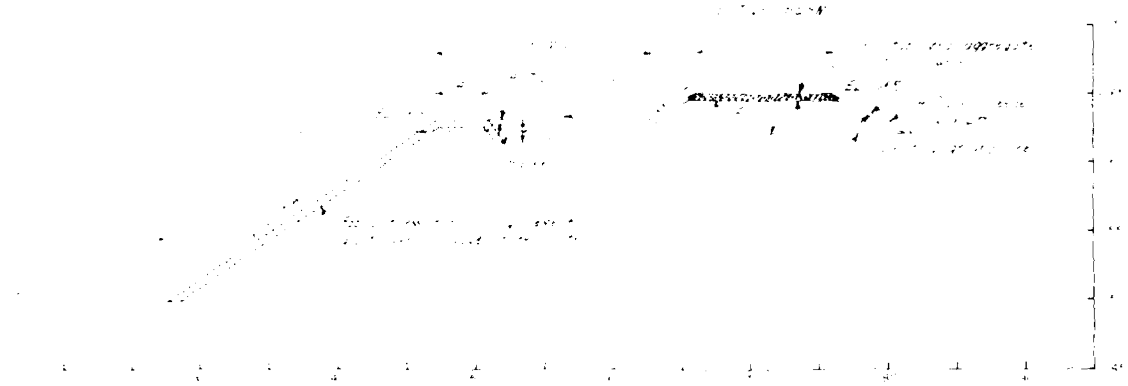
lake of the woods
beachfront development
at warroad

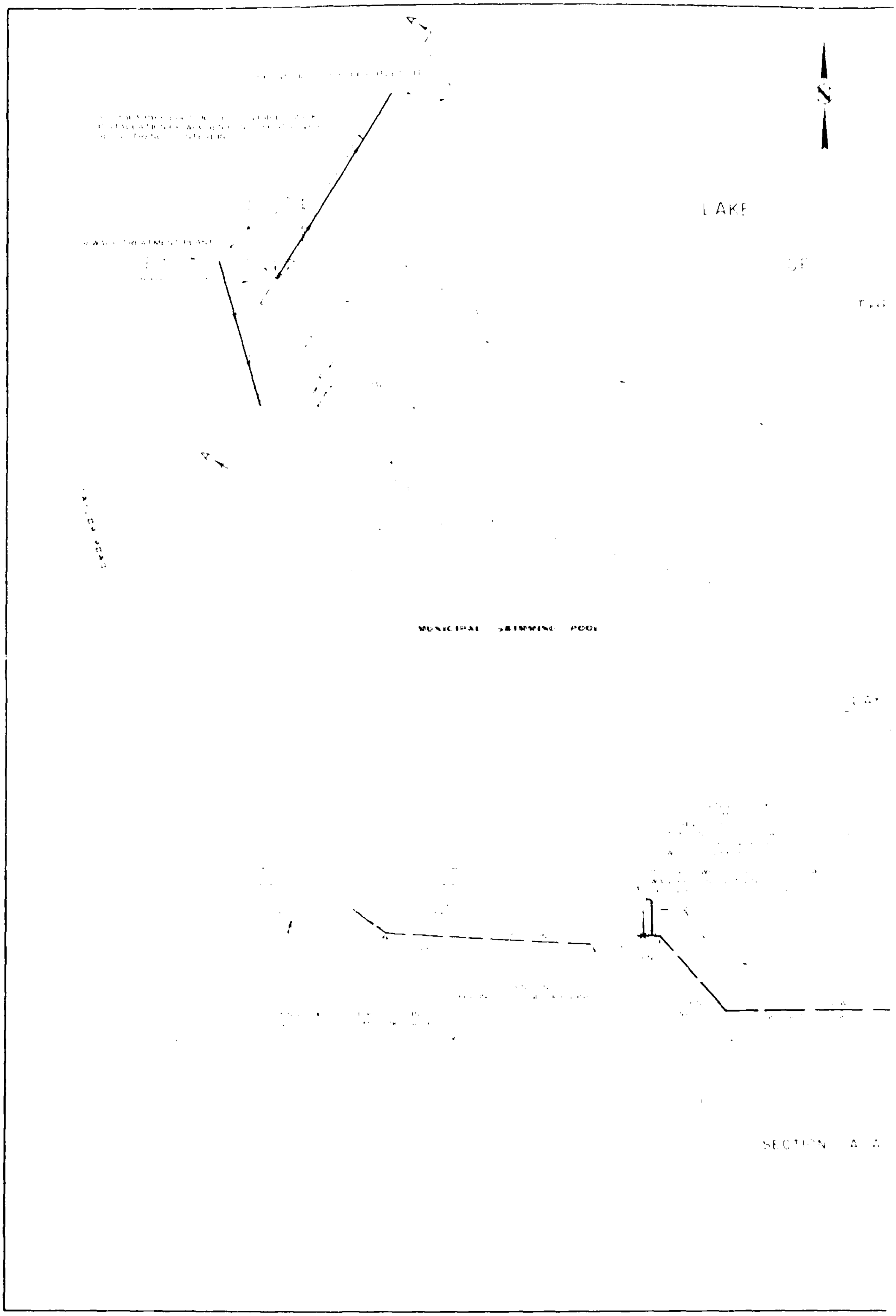
project
date
drawn
checked

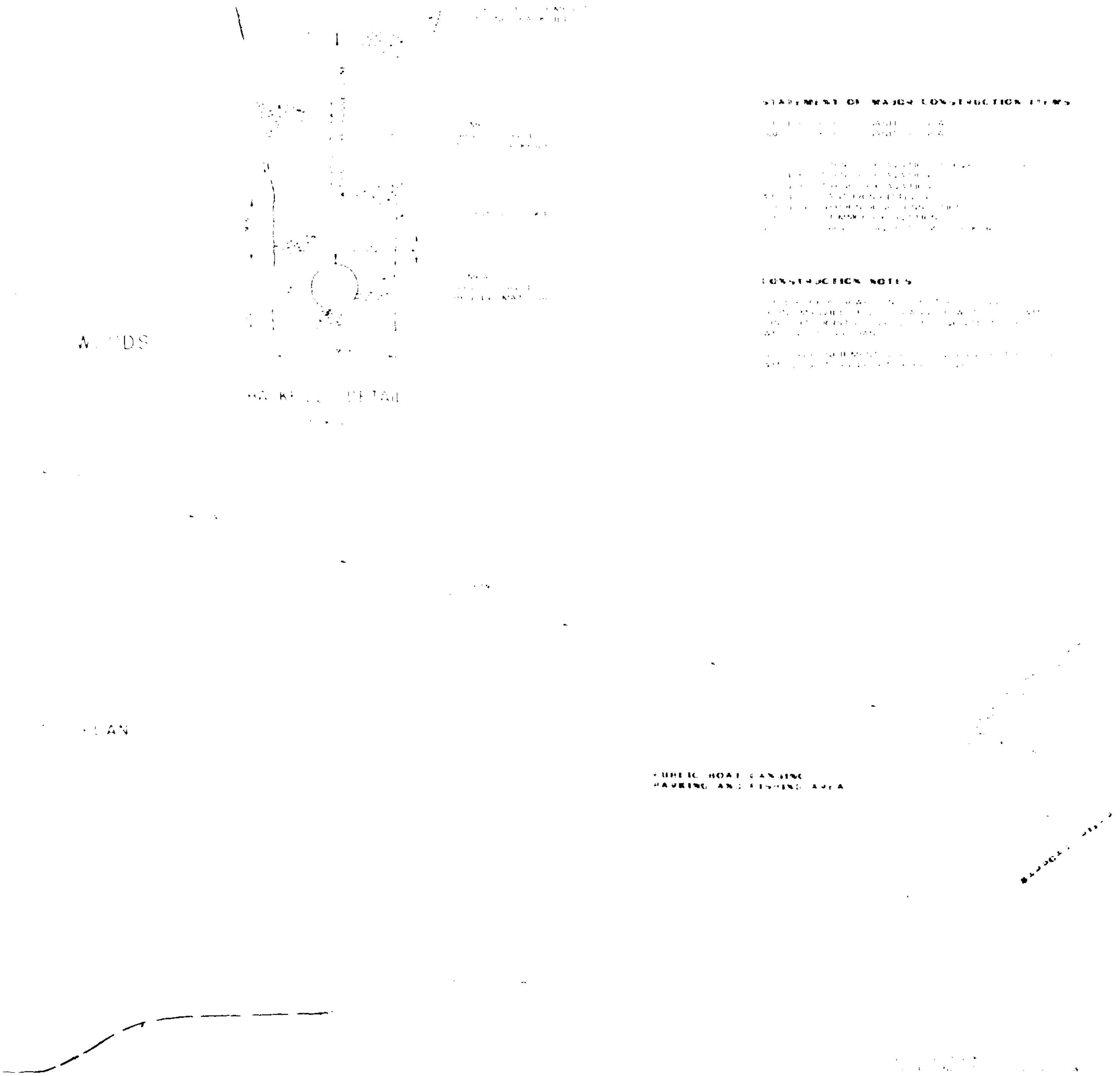
REVISED - 5/25

P






LAKE
MUNICIPAL SWIMMING POOL
SECTION A-A



STATEMENT OF MAJOR CONSTRUCTION ITEMS

CONSTRUCTION NOTES

PRELIMINARY

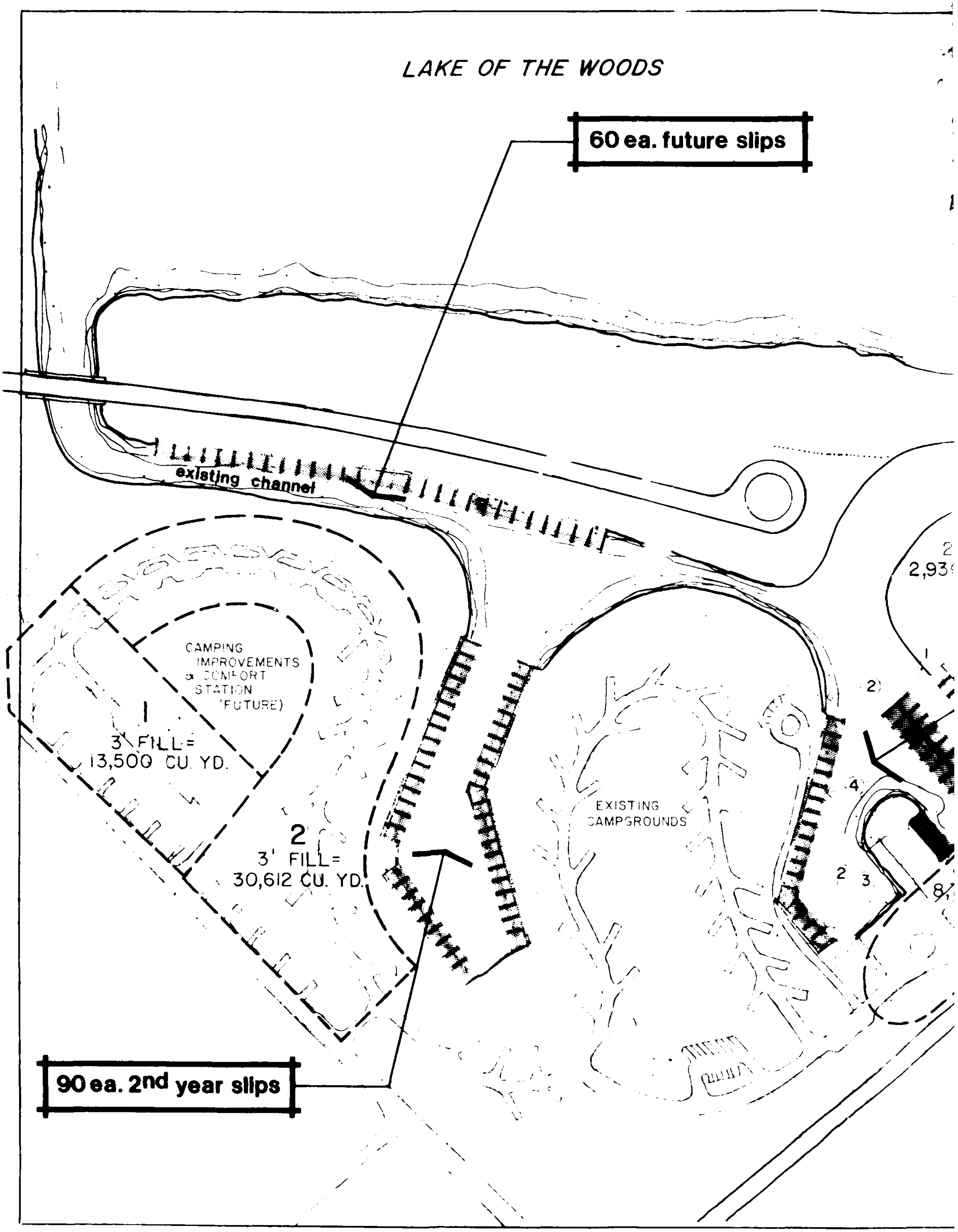
CERTIFICATION

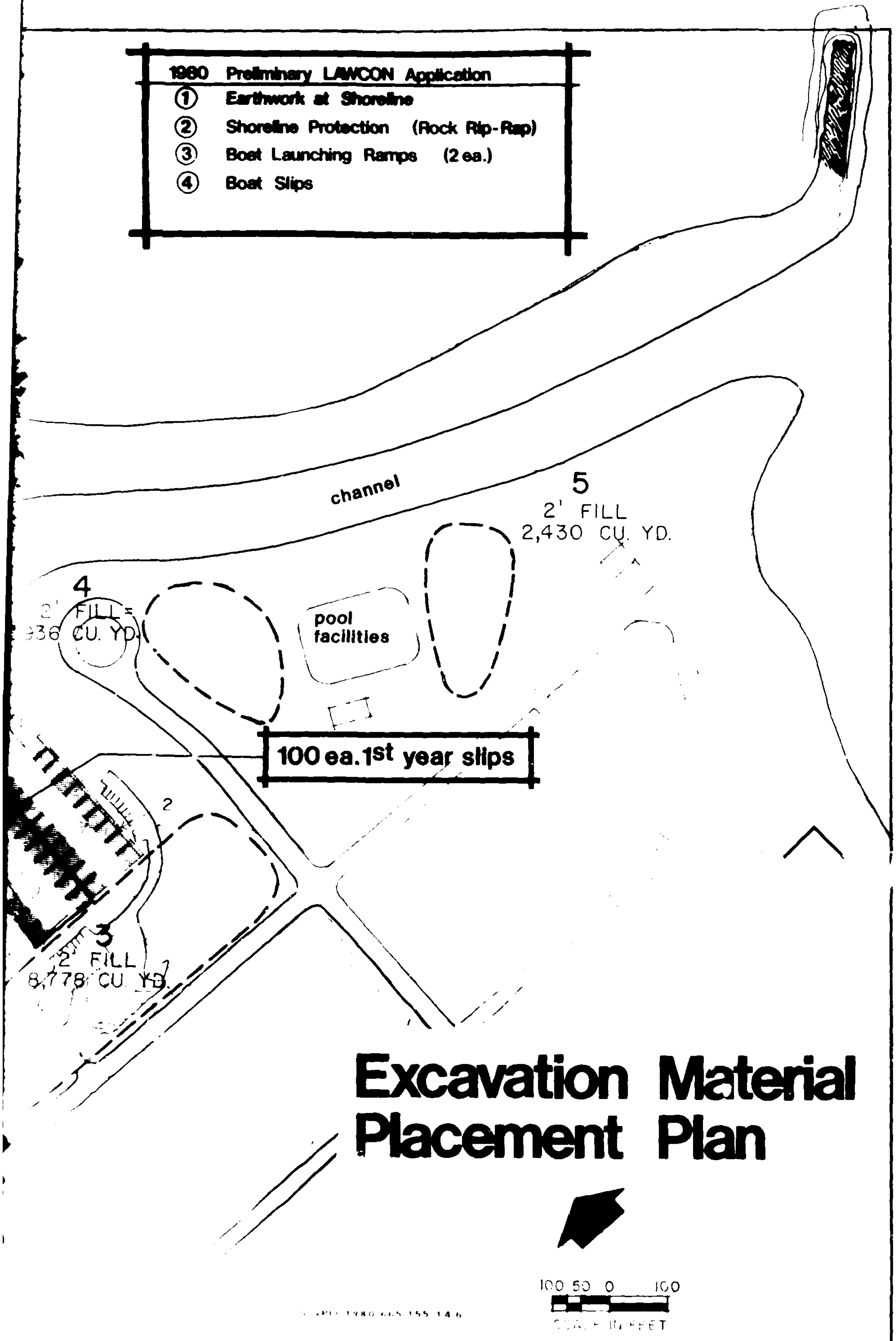
INTERIM WASTEWATER TREATMENT
CITY OF WARROAD, MINNESOTA

engineers
architects
land surveyors

Job No.	Date	Scale
Design	Drawn	Checked

PLATE 4


LAKE OF THE WOODS
60 ea. future slips
existing channel
CAMPING
IMPROVEMENTS
& COMFORT
STATION
(FUTURE)
1
3' FILL=
13,500 CU. YD.
2
3' FILL=
30,612 CU. YD.
EXISTING
CAMPGROUNDS
90 ea. 2nd year slips



WARROAD CHANNEL PROJECT

architectural resources inc

Architecture
Planning
Engineering
Landscape
Architecture

704 East Howard Street
Hibbing, Minnesota 55746
(218) 263-6868

?6 East Superior Street
?uth, Minnesota 55802
? 727 8481

Revisions

project no
date
drawn

I hereby certify that this plan specification or report was prepared by me or under my direct supervision and that I am a duly registered under the laws of the State of

Reg No

PLATE 5

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

PROBLEM IDENTIFICATION

A

P

P

E

N

D

I

X

A

Appendix A contains detailed description and technical information in support of the "Introduction" and "Problem Identification" sections of the main report. This additional information supplements the information provided in the main report and is not intended to be read alone.

TABLE OF CONTENTS

TABLES

FIGURES

PROJECT AUTHORITY

Authority for the study is provided by section 107 of the River and Harbor Act of 1960, as amended, which reads as follows:

"(a) The Secretary of the Army is authorized to allot from any appropriations hereafter made for rivers and harbors not to exceed $25,000,000 for any one fiscal year for the construction of small river and harbor improvement projects not specifically authorized by Congress which will result in substantial benefits to navigation and which can be operated consistently with appropriate and economic use of the waters of the Nation for other purposes, when in the opinion of the Chief of Engineers such work is advisable, if benefits are in excess of the costs.

"(b) Not more than $2,000,000 shall be allotted for the construction of a project under this section at any single locality and the amount allotted shall be sufficient to complete the Federal participation in the project under this section.

"(c) Local interests shall provide without cost to the United States all necessary lands, easements and rights-of-way for all projects to be constructed under the authority of this section. In addition, local interests may be required to hold and save the United States free from damages that may result from the construction and maintenance of the project, and may be required to provide such additional local cooperation as the Chief of Engineers deems appropriate. A State, county, municipality or other responsible local entity shall give assurance satisfactory to the Chief of Engineers that such conditions of cooperation as are required will be accomplished.

"(d) Non-Federal interests may be required to share in the cost of the project to the extent that the Chief of Engineers deems that such cost should not be borne by the Federal Government in view of the recreational or otherwise special or local nature of the project benefits.

"(e) Each project for which money is allotted under this section shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation other than routine maintenance, and except as may result from the normal procedure applying to projects authorized after submission of survey reports and projects constructed under the authority of this section shall be considered as authorized projects.

"(f) This section shall apply to, but not be limited to, the provision of low water access navigation channels from the existing channel of the Mississippi River to harbor areas heretofore or now established and located along the Mississippi River."

A reconnaissance report submitted on 27 November 1974 recommended further investigation and preparation of a detailed project report.

ANNUAL REPORTS, CHIEF OF ENGINEERS

The emergency River and Harbor Act approved 6 June 1900 authorized a preliminary survey of Warroad Harbor. The report on this survey was printed in House Document No. 92, 56th Congress, 2d session and recommended a plan of improvement.

The River and Harbor Act of 1902 established the Board of Engineers for Rivers and Harbors, a board of five engineer officers. Congress asked the Board to prepare a report on Warroad Harbor. The Board's report was published as House Document No. 396, 58th Congress, 2d session. The report stated that, based on the earlier survey, $45,000 was appropriated in 1902 to construct a dredge and construct and maintain a channel 7 feet deep and about 275 feet wide through the bar at the mouth of the Warroad River.

A preliminary examination of Warroad Harbor was authorized by an act of Congress in 1909. The report, published as House Document No. 703, 61st Congress, 2d session, recommended enlarging the basin to 900 by 500 feet, no channel deepening, and continued maintenance of the harbor. However, House Document No. 467, 69th Congress, 1st session, and the Chief of Engineers in April 1948 recommended the project be curtailed by reducing widths in the channels and turning basin.

RELATED STUDIES

The following studies provide related information.

Souris-Red-Rainy River Basins Comprehensive Study - Volume 5 - Appendix 1, Recreation and Preservation, 1972.

"Upper Great Lakes Regional Recreation Planning Study Part 2: Recreation Demand-Survey & Forecasts," Recreation Resources Center, University of Wisconsin, Extension, 1974.

Lake of the Woods and Rainy Lake Commission - Report to the Legislature, 1971.

Application of the Rate of Return Concept to Recreational Navigation Benefits, Chicago District, CofE, Philip Bernstein, September 1976.

"Impact of the Voyageurs National Park upon Roseau County," Uel Blank, University of Minnesota, February 1972.

Tourism in the Lake of the Woods-Rainy Lake Area, Uel Blank, University of Minnesota, November 1971.

The Fish Population Structure and Angling Harvest of Lake of the Woods, Minnesota, 1968-1970, Investigation Report #324, Minnesota Department of Natural Resources, 19 March 1974.

Warroad, Minnesota Comprehensive Guide Plan, City of Warroad Planning Commission, November 1974.

Warroad Small-Boat Harbor Channel Study, Warroad, Minnesota, March 1977, Eugene A. Hickok and Associates.

Cultural Resources Survey of Small-Boat Harbor Project at Lake of the Woods, Warroad, Minnesota, 15 November 1977, Alan P. Brew and William J. Yourd, Bemidji State University.

Section 107, Navigation Reconnaissance Report, Lake of the Woods at Warroad, Minnesota.

DESCRIPTIVE PUBLICATIONS

Published maps of the study area include:

a. Topographic quadrangle map, scale 1:24,000 with 10-foot contour intervals, prepared by the U.S. Geological Survey.

b. Topographic map, scale 1:250,000 with 50-foot contour intervals, prepared by the U.S. Army Topographic Command.

c. County highway maps, scales 1 inch = 2 miles and 1 inch = 1 mile, prepared by the Minnesota Department of Transportation.

Publications describing the study area include:

a. Minnesota Pollution Control Agency, Water Quality Management Plan, Rainy River Basin, July 1971.

b. Souris-Red-Rainy River Basin Comprehensive Study, 1972.

c. U.S. Department of the Interior, Warroad Recreation Area, Warroad, Minnesota.

WARROAD HARBOR, MINNESOTA

Commercial Fishing Volumes, 1955-1977

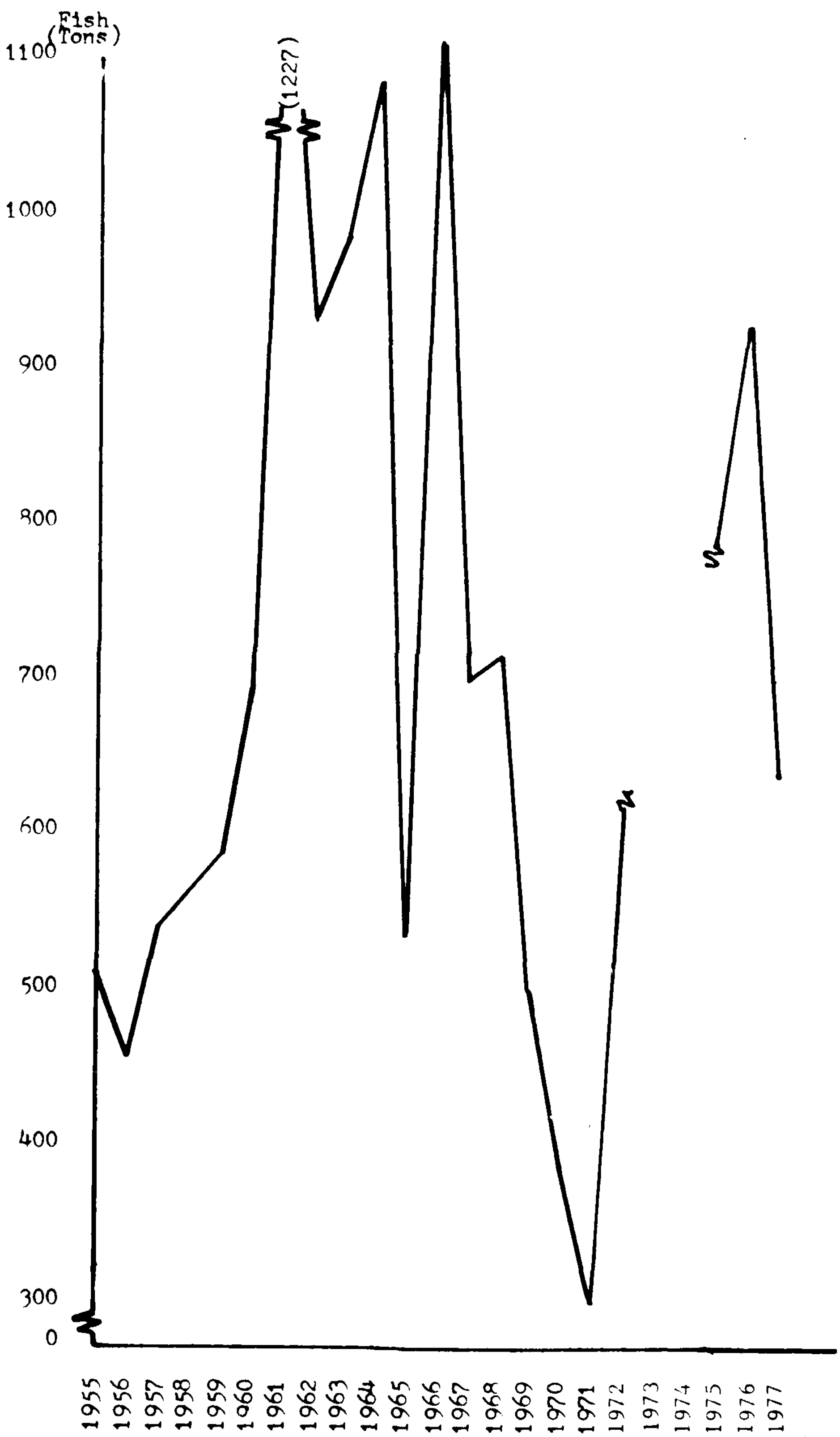
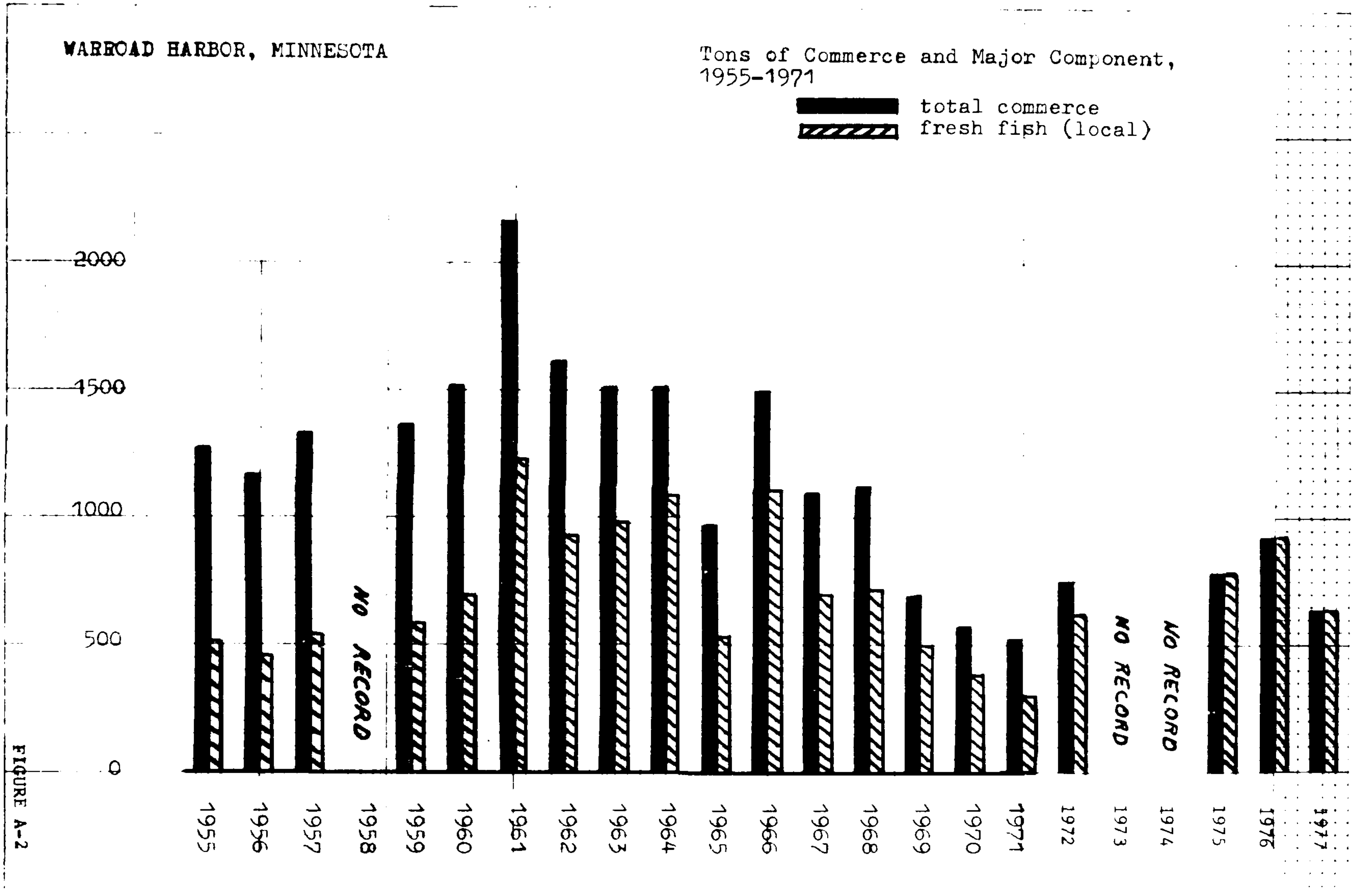


Figure A-1


WARROAD HARBOR, MINNESOTA
Tons of Commerce and Major Component, 1955-1971
total commerce
fresh fish (local)
2000
1500
1000
500
0
NO RECORD
NO RECORD
NO RECORD
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
FIGURE A-2

Personal and per capita income (1967 dollars)(1)

Item	Year								
	1950	1960	1970	1980	1990	2000	2010	2020	2030
Total personal income (in 1,000's)									
Roseau County	$15,936	$16,772	$27,740	$34,672	$45,599	$56,526	$72,925	$89,323	$105,721
Minnesota	5,828,000	8,100,000	12,987,000	19,731,000	28,279,000	40,236,000	56,500,000	72,766,000	89,030,000
Per capita income									
Roseau County	1,090	1,404	2,388	2,955	4,545	6,135	9,075	12,014	14,954
Minnesota	1,945	2,353	3,398	4,700	6,200	8,200	10,700	13,200	16,100
United States	2,064	2,498	3,476	4,700	6,100	8,100	10,650	13,200	16,100

SOURCE: 1972 OBERS Series E projections.

(1) **Additional profile data are presented** in the main report (problem identification section) and the **environmental assessment** (appendix J).

Employment statistics, Roseau County and Minnesota (1)

Item	Minnesota	Roseau County
Total employed	1,464,273	3,693
Agriculture, forestry, fisheries	111,030 (8%)	711 (19%)
Manufacturing	309,222 (21%)	903 (24%)
Median income	$9,931	$7,474
Median number of school years completed for persons over 25 years of age	12.2	9

(1) 1970 U.S. Census Bureau Statistics

Warroad employment statistics

Firm	Number of employees	Product
Marvin Lumber and Cedar Company	800	Millwork, grain elevator
Public school system	81	Educational
Cal's Motel	50	Resort complex
Christian Brothers, Inc.	27	Hockey sticks
Thermo-Lite, Inc.	10	Window manufacturing

Other sources of employment are the Canadian National Railway, Burlington Northern, Inc., commercial fishing operations, and retail stores. About 50 persons, including seasonal employees, fishing guides, seaplane pilots, and marina and attendant personnel, work at harbor-related jobs.

Social and economic characteristics of Warroad

Item	Number
Population	1,086
Percent foreign born	12.4
Percent born in Minnesota	70.8
Education	
Median school years completed (1)	8.2
Percent completing 4 years of high school or more (1)	29.1
Employment	
Percent of women in labor force (2)	66.0
Percent unemployed	7.2
Percent employed in manufacturing	25.0
Family income	
Median	$8,000
Percent below poverty level	20.4
Percent with income of $15,000 or more per year	14.2

SOURCE: U.S. Bureau of the Census, General Social and Economic Characteristics, Michigan, Minnesota, Wisconsin, 1970 Census of Population.

(1) Persons 25 years old or over.
(2) 16 years old and over.

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

FORMULATION, ASSESSMENT, AND EVALUATION OF PLANS

A P P E N D I X

B

AD-A184 683 WARROAD CHANNEL PROJECT SECTION 107 DETAILED PROJECT REPORT WARROAD MINNESOTA(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JUL 80 2/4

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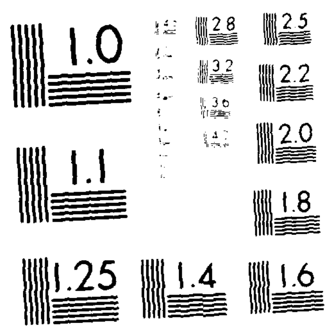

1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4
1.6

Appendix B contains more detailed information on the alternative plans described in the "Formulation of Preliminary Plans" section of the main report. The information was used to assess the impacts and evaluate the alternative plans.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCSED-ER	Warroad Small Boat Harbor

TO	FROM	DATE	CMT 1
Chief, Planning Branch	Chief, Environmental Resources Branch	July 1978 SHYNE/vb/7084	

1. The chemical analysis of samples taken by soil borings along the proposed channel alignment have been received and reviewed.

2. The Permits and Facilities Sections of the Division of Water Quality, Minnesota Pollution Control Agency have been consulted regarding the results of the chemical analysis.

3. Values for chemical parameters (see attached table and figure) were compared to EPA Standards for Great Lakes Sediments. The sample taken from the surface to the two foot depth adjacent to the sewage treatment plant (1063-1061 m.s.l.) exceeded EPA Standards for the following: Barium, Chemical Oxygen Demand, Copper, Cyanide, Lead, Mercury, Total Kjeldahl Nitrogen, Ammonium Nitrogen, Total Volatile Solids, and Zinc. Several pesticides were measured and PCB's approached but did not exceed the standards.

4. At all locations EPA Standards were exceeded for the following: Barium, Chemical Oxygen Demand, Cyanide, Total Kjeldahl Nitrogen, Ammonium Nitrogen and Total Volatile Solids.

5. With the exception of the area around the sewage treatment plant, material excavated from the channel may be disposed of in any location above the high water mark provided that proper site preparation is accomplished. The material shall be placed within berms and covered, if necessary to prevent erosion and runoff. Excavation should take place at a time of the year which will allow for successful vegetation of the material soon after placement has been completed.

6. The chemical analysis revealed that cyanide levels at sampling station 1 (located on the river bank) were nearly 5 times the mean level of cyanide at all stations. Because of this, it is suggested that the upper 6 feet of material excavated along the first 100 feet inland of the river bank be placed in an isolated, prepared, disposal site rather than in the city park. The amount of material to be excavated may be greater than necessary but a substantial number of chemical samples would be required to exactly define the area of high concentration.

7. The sludge settling (dewatering) tanks at the Warroad sewage treatment plant are located near the centerline of the proposed channel alighment. If channel construction would take place before completion of the new sewage treatment plant, (projected by MPCA to be 5 years away) then sludge disposal alternatives must be evaluated in the Environmental Assessment. These include: relocation of the existing tanks, realignment of the channel, construction of temporary storage facilities with dewatering or tank truck hauling with land application of wet sludge. If the selected alternative would require that liquid sludge be disposed of, then a sludge disposal plan must be prepared and submitted to the MPCA for approval.

DA FORM 2496 — REPLACES DD FORM 96, WHICH IS OBSOLETE.

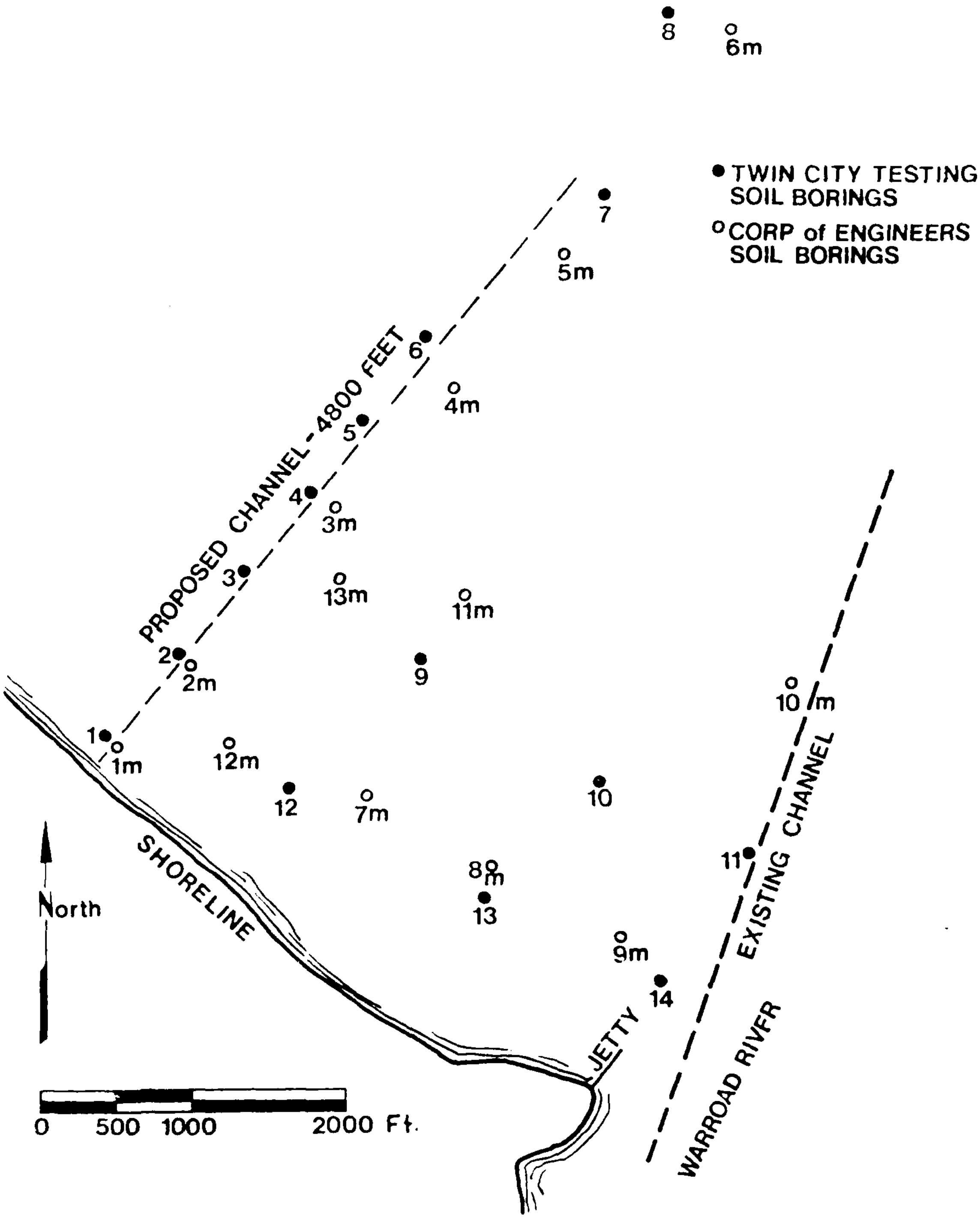
8. Guidelines for land application of sludge and information required by PCA will be available in the near future. A chemical analysis of sludge constitutents will be required as well as sludge volume, location of disposal area, acreage, soil type and water table elevation etc.

9. The full extent of contamination around the sewage treatment plant is unknown. Material that is visually identifiable as sludge and 4 feet of soil around and under it must be disposed of in the same manner and at the same location as the sludge in the tanks. The contamination does not appear to extend below 1055 m.s.l. (8 foot depth) so this may be considered as a lower limit of excavation for disposal.

Robert F. Post

ROBERT F. POST

The table and figure referred to in paragraph 3 are in appendix J.

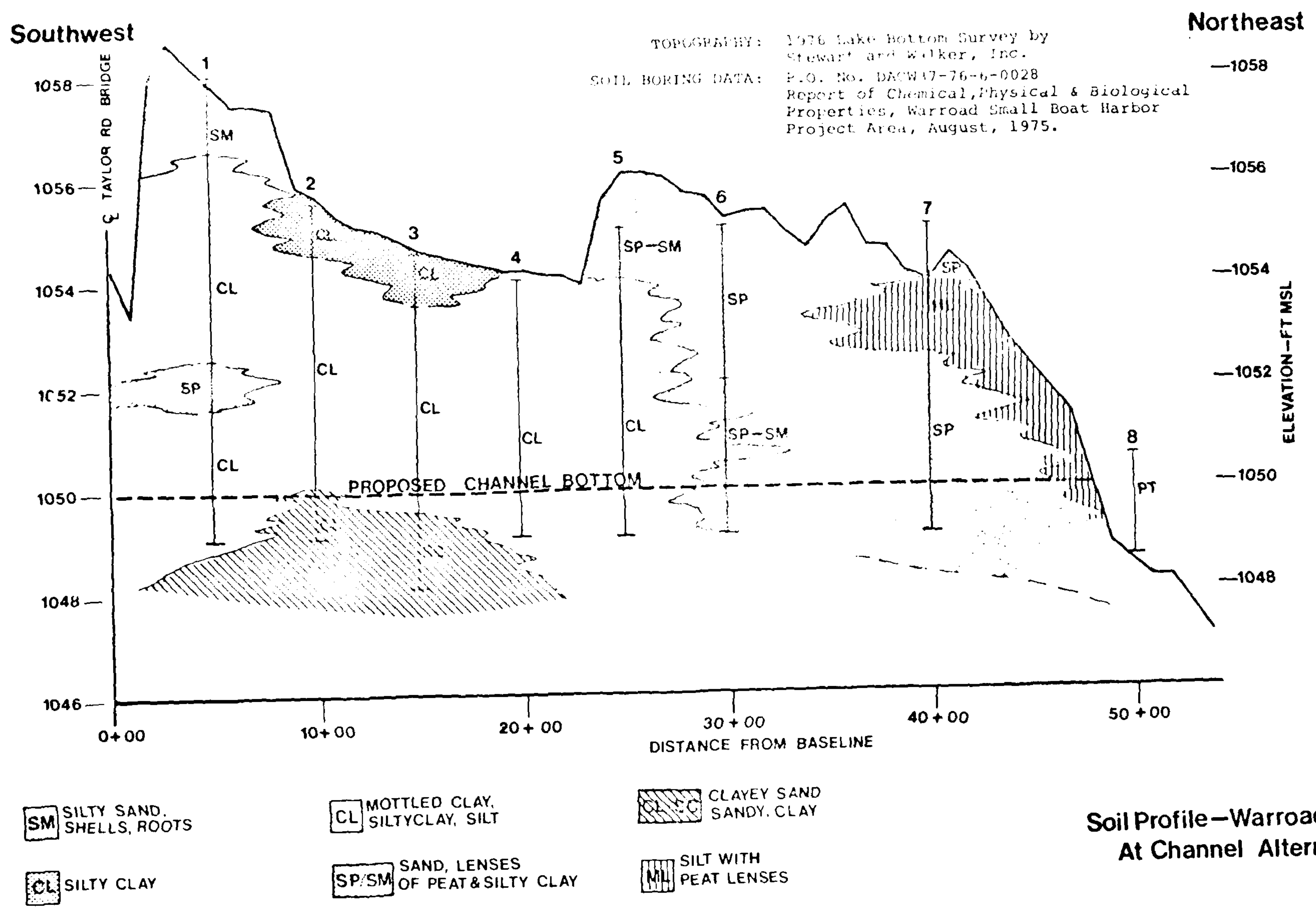


LAKE BOTTOM SOIL BORING LOCATION

Benthic organisms		Distance from shore: Sample site:	500 1	1,000 2	1,500 3	2,000 4	2,500 5	3,000 6	4,000 7	5,000 8	Total
Monusca	Sphaeriid clams		557	65	381	14				No living organisms found in this sampe	1,017
	Pisidium		150	31	83	22	6				292
	Valvata tricarinata		37	2	4	3					46
	Amnicola sp.		19	20	105	8	8				160
	Sphaerium sp.			101	79	27	3		3		213
	Musculium sp.				9						9
	Gyraulus sp.				11						11
	Snails										103
	Valvata sp.										1
	Physa sp.										2
Crustacea	Ostracoba		5								5
	Hyalella azteca		25		5		5	14			49
	Gamarus								4		4
Insecta	Cryptochironomus sp.		69	4			9		2		84
	Bezzia Sp.		10				2				
	Molanna (trichoptera)				23						23
	Xenochironomus sp.						1				1
	Tanytarsus sp.						25	208	41		274
	Trichoptera								1		1
	Hexagenia										6
Annelida	Helobdella sp.										3
	Lumbriculus sp.		177	5	5		65	4	8		258
	Limnodrilus sp.								2		8
	Tubifex sp.								2		2
	Leeches										5
Nemathalminthes	Nematodes							12			12
Moderate to harsh swampy odors were encountered in many of the sample sites			small stones and sand, considerable fibrous pl plant material	Fairly clean sand	Nothing noted in report	Clean sand	Clean sand	Clean sand	Sand and a little fibrous mtl.	Clean sand	Visual appearance

	Lower limit	Percent recovery
Polychlorinated biphenyls		
Arochlor 1242	2 mg/gm	65
Arochlor 1254	2 mg/gm	65

	EPA guide	Range in channel A sample site		
Volatile solids	<5.0%	1.73	to	2.27
COD	<40,000 mg/kg	4,034		7,724
Kjeldahl nitrogen	<1,000 mg/kg	4.3		1.0
Phosphorous	1,000 mg/gm	0.2		0.3
Oil and grease	< 1,000 mg/kg	160		360
Mercury	±1.0 mg/kg	0.02		0.20
Lead	< 40.0 mg/kg	3.3		5.3
Zinc	< 90.0 mg/kg	26		40
Arsenic	< 3 mg/kg	0.89		1.0
Cadmium 1	lower limits not established	0.22		0.47
			6 upper limit	
Chromium	< 25 mg/kg	7.2	to	8.4
Copper	< 25 mg/kg	17	to	24
Nickel	< 20 mg/kg	26 mg/gm to 43 mg/gm (20 to 50 mg/gm = moderately polluted)		



Soil Profile—Warroad Littora
At Channel Alternate-A

WARROAD SMALL-BOAT HARBOR

CHANNEL PARAMETERS

I. Lake levels

Lake levels	1912 datum	1929 datum
Recorded high (1950)	1064.0	1063.5
Treaty high	1061.25	1060.8
Median	1060.0	1059.5
Treaty low	1056.0	1055.5
Recorded low (1930)	1055.75	1055.25

II. For design purposes use (1929 datum)

High - 1062.0 (exceeded twice since treaty)

Low - 1056.0 (exceeded twice since treaty)

III. Boat parameters

Maximum length	-	30 feet
Maximum beam	-	11 feet
Maximum draft	-	3 feet
Maximum height above water	-	12 feet

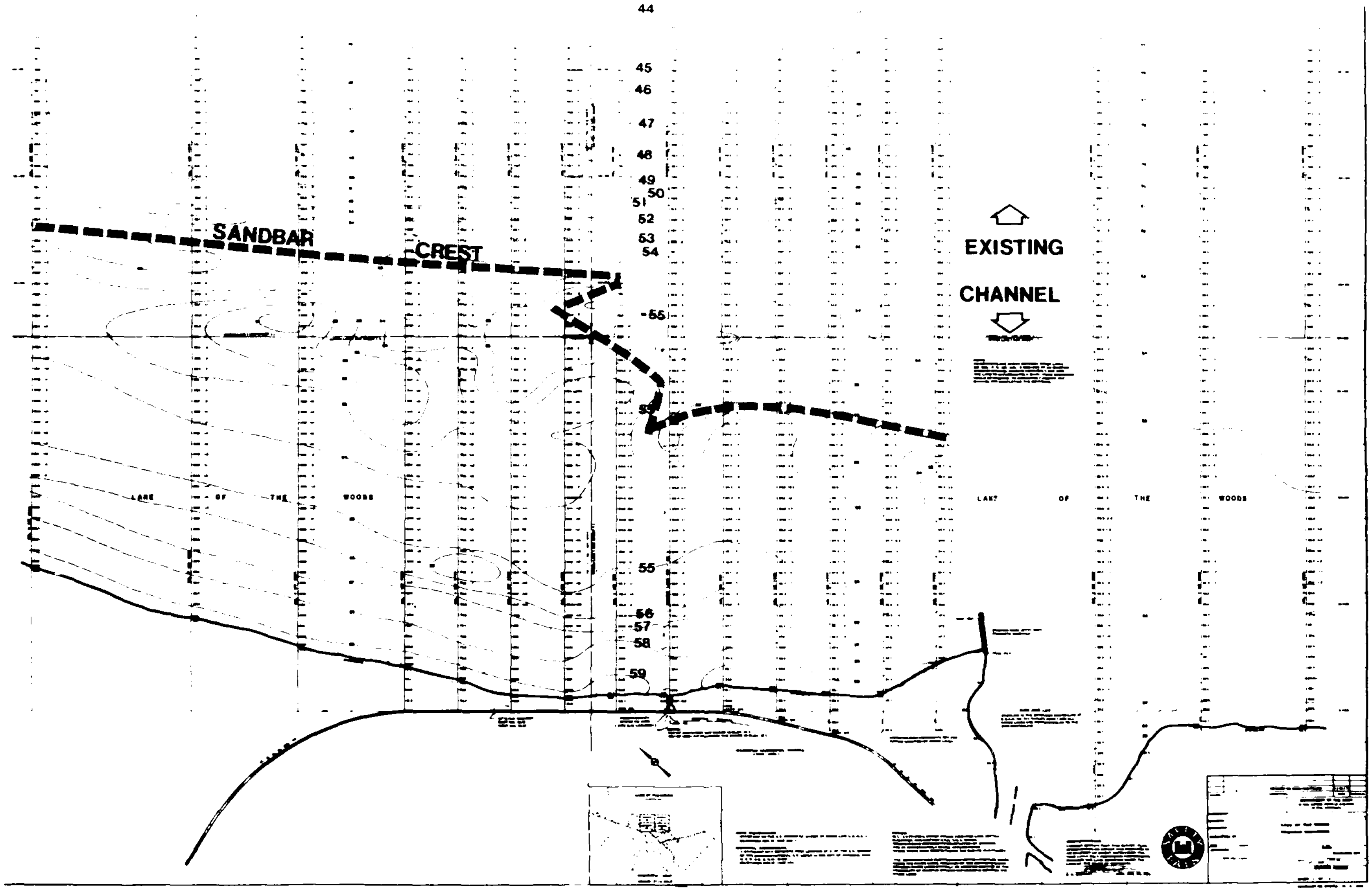
IV. Channel parameters

Channel width	-	55 feet
Channel minimum radius	-	60 feet
Minimum channel depth (below low water)	-	6.5 feet
Channel bottom	-	1049.5

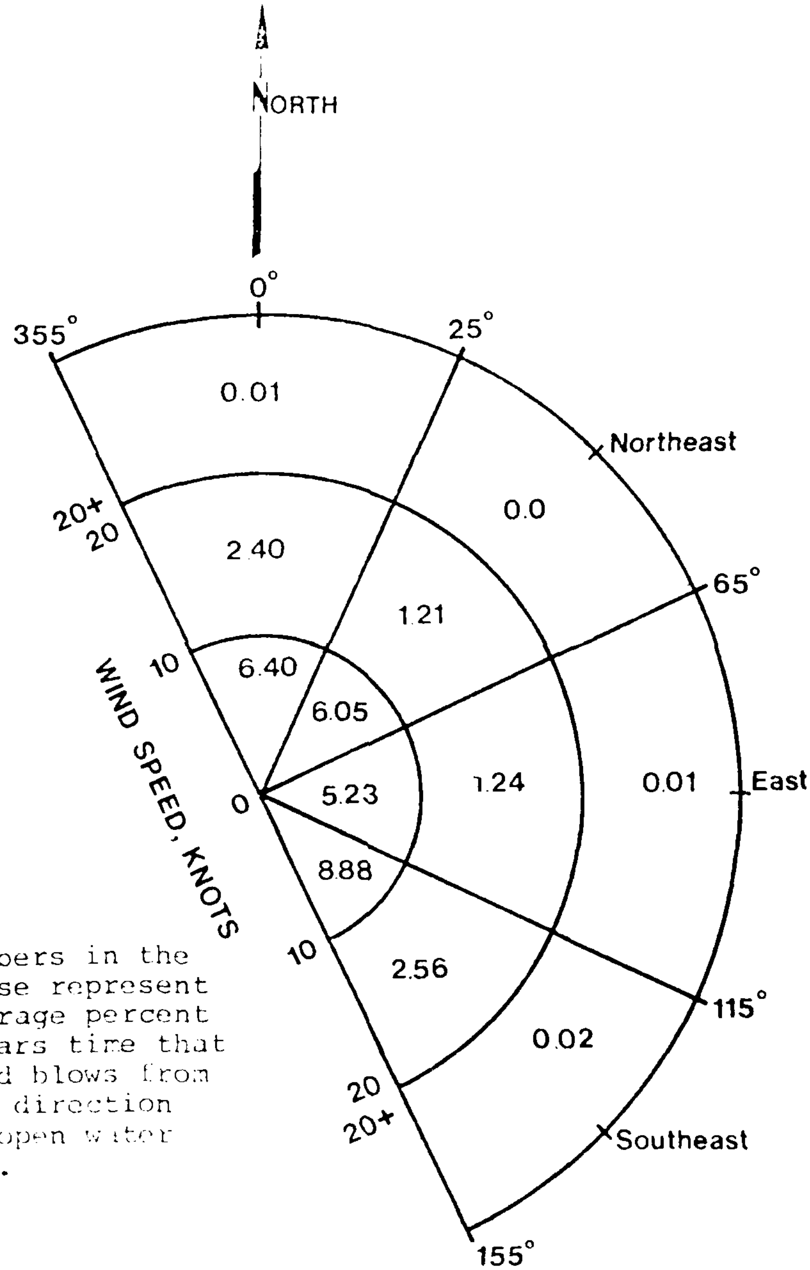
V. Bridge parameters

Horizontal clearance	-	55 feet
Vertical minimum clearance	-	12 feet
Low steel minimum elevation	-	1074 feet

OFF-SHORE SAND BAR, 1958

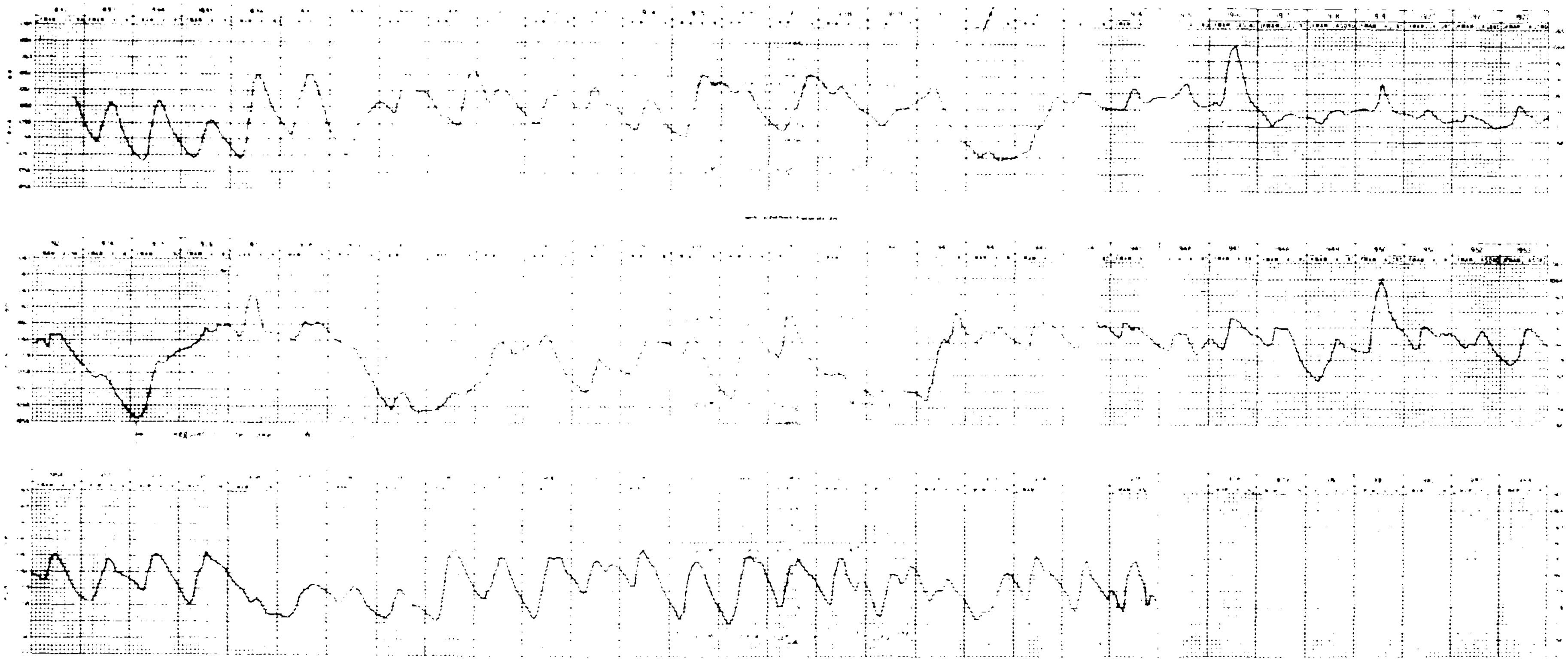


Lake Bottom Contour Map
Muskeg Bay at Warroad



Note: The numbers in the wind rose represent the average percent of a years time that the wind blows from a given direction during open water periods.

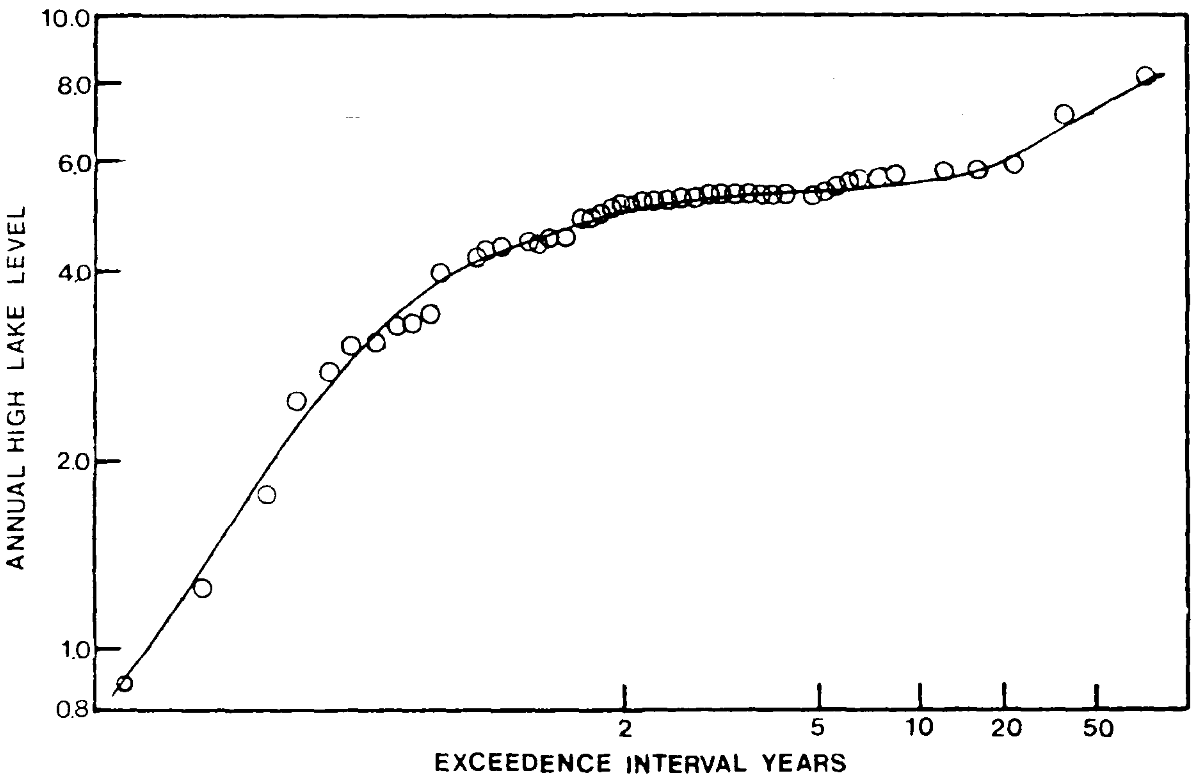
ONSHORE WINDROSE – WARROAD, MN.



Source: Canadian Department of the Environment
Lake Control Board
Elevations to Mean Sea Level
Lake of the Woods
Mean Monthly Levels

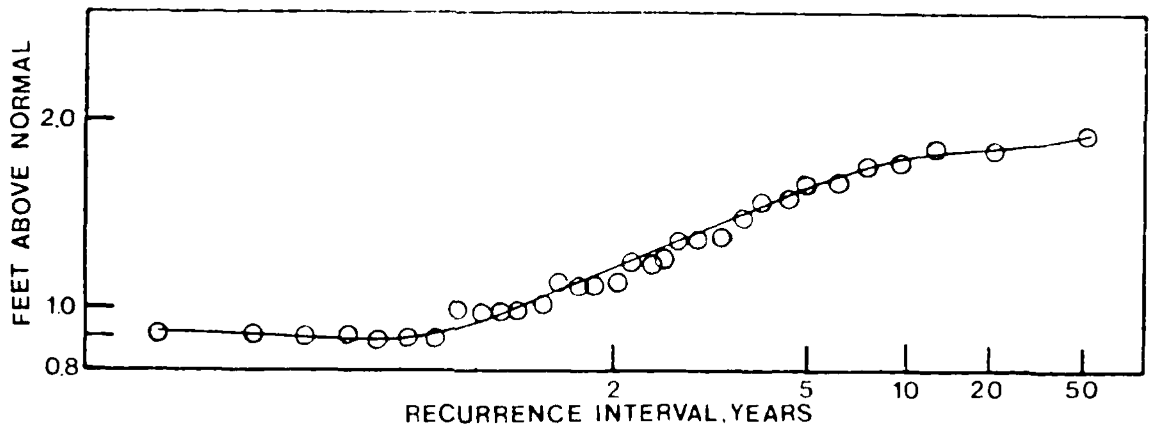
	1912	1929
Height - high	1061.25	1060.5
Height - low	1090.0	[illegible]

MEAN MONTHLY LAKE LEVELS



Note: The plotted levels are the height of the lake surface above 1056.0 MSL

MAXIMUM LAKE LEVEL FREQUENCY CURVE FOR LAKE OF THE WOODS 1925–1976



NOTE: Data was collected from 1925 to 1931 during ice free months

INFLUENCE OF WIND ON LAKE LEVELS

Warroad small-boat harbor access channel - alignment A and B

	Unit	Quantity	Unit cost	Total estimated cost
Federal first costs				
Channels				
Channel excavation (dredge)	CY	62,700	$3.50	$219,450
Breakwater	CY	58,000	25.00	1,450,000
Riprap	CY	300	25.00	7,500
Disposal basin and dikes	CY	62,700	0.50	31,350
Contingencies				256,700
Total channels				1,965,000
Engineering and design				177,000
Supervision and administration				
Supervision and inspection				88,000
Overhead				32,000
Total Federal first costs				2,262,000

Warroad small boat harbor access channel - alignment C

	Unit	Quantity	Unit cost	Total estimated cost
Federal first costs				
Channels				
Channel excavation	CY	64,200	$3,50	$224,700
Breakwater	CY	58,000	25.00	1,450,000
Riprap	CY	300	25.00	7,500
Disposal basin and dikes	CY	64,700	0.50	32,350
Contingencies				
Total channels				1,972,000
Engineering and design				178,000
Supervision and administration				
Supervision and inspection				89,000
Overhead				32,000
Total Federal first costs				2,271,000

WARROAD SMALL-BOAT HARBOR ACCESS CHANNEL-ALIGNMENT D

Item	Unit	Quantity	Unit cost	Total Estimated cost
Federal first costs				
Channels				
Excavation	CY	70,000	$1.67	$117,000
4-foot fabric formed pavement	SF	105,000	2.00	210,000
Remove settling basins	Job	Sum	-	8,000
Landscaping	Job	Sum	-	10,000
Contingencies (15%)				52,000
Total channels				397,000
Engineering & design (10%)				40,000
Supervision & administration				
Supervision & inspection (5%)				20,000
Overhead (2%)				8,000
Total Federal first costs				465,000
Non-Federal first costs				
Boat launching facilities				
Excavation	CY	5,000	1.67	8,000
Boat ramps	Each	2	6,000.00	12,000
Steel pile wall	SF	9,000	12.00	108,000
Less 4-foot fabric formed pavement	SF	(9,000)	2.00	(18,000)
Contingencies (15%)				17,000
Total boat launching facilities				127,000
Engineering & design (10%)				13,000
Supervision & administration				
Supervision & inspection (5%)				7,000
Overhead (2%)				3,000
Total Non-Federal first costs				150,000
Total Federal & non-Federal first costs				615,000

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

PUBLIC VIEWS AND RESPONSES

APPENDIX

C

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCSED-PB	Warroad Navigation Project - Section 107 Study

TO Memo for Record

FROM Planning Branch
Engineering Division

DATE 8 Sep 76

CMT 1

Mr. Jukins/jv/5502

1. On 1 September 1976, Fred Kelley and I represented the Corps of Engineers at the initial public meeting held at the Village office, Warroad, Minnesota. A list of those who were in attendance is attached.

2. The purpose of this meeting was to present to the people of Warroad the status of the section 107 small-boat harbor study including the following topics:

   a. History of the small-boat harbor project.

   b. Study funding.

   c. Discussion of problems and needs.

   d. Discussion of the purpose of the current study.

   e. Discussion involving the concept of diked disposal facilities.

   f. Public involvement program - role and functions.

   g. Local cooperation agreement.

3. A second meeting was tentatively arranged for the latter 2 weeks in November 1976.

David Jukins

1 Incl
as

DAVID JUKINS
Civil Engineer
Planning Branch
Engineering Division

CF:
ED-PB/Mr. Kelley
Reading file

DA ... 2496 ... REPLACES ... FORM ... WHICH IS OBSOLETE.

ATTENDANCE LIST

NAME	POSITION	REPRESENTING
Dick Roberts	Mayor	Warroad
Dick Myers	Businessman	Warroad
Dale Telle	Launch Service	Warroad
Doug Johnson	Salesman	Warroad
Dean F. Hennin	Auto Parts Salesman	Warroad
Hal Bakke	President	Christian Brothers, Inc.
Hank Henderson	Owner	Wayward Wind Charters
Willard Krahn	Manager	Marvin Marine
Harold P. Olimb	City Clerk	Warroad
David Brewster	Commercial Fisherman	Warroad
Robert Moyer		Warroad
Doug Eckes	Editor	Warroad
Earl Cypher	Owner	Warroad
D. Grafsten	Owner	Warroad Estates
Gordon M. Hampton	Engineer	Warroad Estates
R. A. Marvin	Marina Operator	Warroad
D. H. Johnston	Commercial Fisherman	Warroad
Ernie Franklin	Resort Owner	Warroad
Fred Kelley	Planning Engineer	Corps of Engineers
David Jukins	Civil Engineer	Corps of Engineers

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCSED-PB	Warroad Small-Boat Harbor Study, Section 107 Lake of the Woods, Warroad, Minnesota

TO Memo for Record FROM Planning Branch Engineering Division DATE 19 May 1977 CMT 2d Lt. Abdoo/11/59

1. A public information meeting was held 17 May 1977 at 7:30 p.m. to discuss the several alternative channel alignments presently being considered for the subject study, search for any further alternatives, and to update the timetable for the project. A copy of the attendance roster is attached.

2. Mr. Frederic Kelley of the Corps opened the meeting and called on Mr. John Holmquist of Hickok & Associates to review the alternatives he had presented in his March 1977 report of their channel study (Contract No. DACW37-76-C-0[illegible]). Mr. Holmquist recommends Alternative D, stating that first cost and long term operating and maintenance costs are lower than for any of the other alternatives. He felt we might want to look at placing the required new bridge at a higher elevation as well as ensuring more draft than now exists at the present bridge to the marina. One problem mentioned was the necessity to relocate the present launching ramp from near the jetty base to a point westerly of the proposed channel mouth/inlet.

3. General comments from the floor highly favored Alternative D. A local marina operator asked if it would be possible to locate the channel farther lakeward to avoid a group of trees. Both Messrs. Holmquist and Worley (Architectural Resources) responded that this would be no problem and stressed that the present alignment was only a schematic and that a final alignment in that general area could be settled on after further study.

4. The Assistant County Engineer Orris Rasmussen addressed potential problems with Alternative D's required new bridge. He pointed out that a 30 MPH design speed requires 750 feet of approach ramp on each side of the bridge to make the approximate 4.5-foot increased grade, which would then create grade problems at intersections of County Road 74 with Steenerson and Mackenzie Streets respectively. This grade problem could be alleviated by moving the channel access point and bridge further north and northwest because the grade is already higher there, probably within 1 foot of required grade. Kent Worley wondered if it wouldn't be possible to live with a lower design speed and some traffic control measures allowing a steeper approach slope to the new bridge. Mr. Rasmussen felt that these types of solutions were feasible and would require further study. When asked about cost of the bridge, county funding and construction timetable, Mr. Rasmussen responded that the cost could approach $300,000 and felt it would be at least $100,000. He further stated the county wouldn't be able to fund the work for 5 to 10 years. Mayor Roberts then commented that the village would seek other means of funding the bridge construction. Doran Horner, a local county official, attested that it would be a financial hardship for the county to put in the new bridge. General comments

DA FORM 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE.

at this point indicated everyone felt that the existing bridge is not wasted as two bridges will aid circulation and possibly relieve congestion, however it was felt that mechanical circulation may yet be required.

5. Another alternative not previously discussed was presented by the local advisory committee. This new alternative (hereafter referred to as Alternative E) is also an overland route which uses the existing bridge but turns sharply to the south/southeast with a second 90° turn immediately past the bridge (outbound) to return to the jetty area along a channel on the lakeward side of CSAH 74 parallel to the existing marina channel. The advantage of this compromise is that it avoids the additional expense of the proposed second bridge yet enjoys most of the advantages afforded by Alternative D. Numerous problems are associated with Alternative E. It was felt that two 90° turns at a blind corner in a channel at a bridge point would present a severe navigational hazard. It is doubtful that there would be sufficient space to provide a necessary bermed channel protection lakeward without encroaching on the wetlands area (1,061 msl). One further advantage, though somewhat remote, is the possibility of incorporating this channel with a deep-draft basin along the shore. Orris Rasmussen stated that the county's right-of-way extends from the road (CSAH 74) to the lake.

6. A question was raised as to whether the higher grade at the bridge approaches would cause an objectionable obstruction of the lake view from the park and campground. Assistant County Engineer Rasmussen pointed out that an effort was made in constructing the present roadway and bridge to avoid any such obstruction. The consensus did not perceive any problem with the obstruction mentioned.

7. The navigability of the existing channel in and extending from the Warroad River was brought up during the meeting. Local Department of Natural Resources Conservation Officer Markovich stated that a navigation hazard presently exists at the sandbar, with no more than a 5- by 50-foot channel. Markovich felt that only 1/2° error can get a boater in trouble and that the channel should be marked. The sandbar encroaches from the north and is a problem only 3 years after dredging. It was pointed out that a request should be made to the Corps to survey this situation as it is not now contingent in this investigation. Mr. Kent Worley commented that the confluence of Alternative D with the Warroad River may assure keeping the existing channel open. A Hatteras cruiser about 30 feet in length and docked in Warroad River Harbor has frequent difficulty (4- to 4.5-foot draft) negotiating the channel.

NCSED-PB 19 May 1977

SUBJECT: Warroad Small-Boat Harbor Study, Section 107, Lake of the Woods, Warroad, Minnesota

8. Bill Atkins of the State of Minnesota Planning Agency was asked if he saw any problems with Alternative D. His response indicated a possible Bureau of Outdoor Recreation (BOR) conflict in that the channel would occupy land included in prior parks and recreation funding, but that he would review the situation with the BOR and have a clarification issued.

9. Mayor Roberts noted that Alternative D is definitely the route of choice but wants to look hard at Alternative E also. He further wanted assurance that the Corps would not recede from the summer of 1978 completion date given him some time ago. It was pointed out that that would be a very optimistic time frame, especially in view of recent developments. We feel there is a great deal of work left to do on investigating Alternative D.

10. Hank Henderson asked about the possibility of using aluminum sheet piling in lieu of riprap and sloped banks in the channel proper. John Holmquist responded he had considered that but abandoned it in the name of safety considerations involved with children in a park setting.

11. The meeting concluded at 9:30 p.m. with a suggestion that we meet again in 1 month on the 14th of June to discuss progress toward coordination of Alternative D with BOR (Atkins); alternate funding for new bridge (Roberts); to look at an optimizing channel alignment for Alternative D (Worley) and to review general planning progress (Abdoo). It was suggested that we attempt to bring together additional resource people from the State Department of Natural Resources, Pollution Control Agency, and Corps hydrologists and environmentalists, to effect a meaningful exchange.

1 Incl
as

Vern J. Abdoo

VERN J. ABDOO
2d Lieutenant
Small Projects Section
Planning Branch
Engineering Division

CF:
Reading File

ROSTER	DATE May 17, 1977

TOPIC [illegible] Committee Meeting

PLEASE PRINT

NAME	POSITION	ORGANIZATION
[illegible]	Civil Engineer	Corps of Engineers
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Corps [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	Gen. Engineer	[illegible]
[illegible]	Citizen Committee	Citizen Comm
[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	WARROAD
[illegible]	[illegible]	[illegible]
[illegible]	Citizen [illegible]	"
[illegible]	[illegible]	"
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	Citizen Comm	Warroad [illegible]
[illegible]	Cons. Officer	Warroad
[illegible]	Assist Co. Eng.	[illegible]
[illegible]	Mayor	Warroad
C. J. [illegible]	[illegible]	[illegible]
[illegible]	Cit.	Warroad
[illegible]	[illegible]	[illegible]
[illegible]		

C-6

NCD FORM 56 (Previous editions are obsolete)

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCSED-PB	Section 107, Warroad Small-Boat Harbor Study, Lake of the Woods, Warroad, Minnesota

TO Memo for Record FROM Planning Branch, Engineering Division DATE 27 June 1977 CMT 2Lt. Vern Abdoo/[illegible]

1. A public information meeting was held at Warroad, Minnesota, on 22 June 1977 at 8:30 p.m. to review alternative alignments for the proposed access channel, discuss new developments and information received from other Federal and State agencies, and attempt to settle on the final channel alignment proposal. An attendance list is attached.

2. Warroad Mayor Richard Roberts opened the meeting and asked me to present the current status of the Corps study. I reported that several State and Federal agencies had provided input for the study and all favored alternative D, an overland channel. None of the agencies presented any new problems. Two areas of concern have not been resolved at this time: (1) funding for the new bridge and (2) the archeological/cultural site investigation along the alignment of the channel under alternative D. Because of these open questions, we have requested that the dates for our Checkpoint II Conference and Draft Report be delayed from June to August.

3. Mr. Hank Henderson asked what the objections were to alternative E, since it would avoid the problems of a new bridge associated with alternative D or the dredging problems associated with alternative A. I stated that the navigation hazards inherent with alternative E are very objectionable, as pointed out by the Coast Guard. Further, the channel at alternative E would encroach on the shore area wetlands, presenting environmental concerns.

4. Mr. Doug Stewart questioned the reason for the 5- to 10-year timetable given by the county engineer for construction of the new bridge with alternative D, wondering if the county officials had investigated the possibility of bonding against their State Aid funds. Mayor Roberts will check with the county on this matter.

5. Mr. Henderson alluded to the chicken/egg analogy in that the prospective funding agencies seem hesitant to provide monies until the channel is approved by the Corps and the Corps needs assurance that the local share of all project costs will be available for the respective alternatives before settling on a practicable proposal.

6. Mr. Fremont Jewell was asked to discuss some of the hydrologic considerations of the study. Alternative A would be a large and costly undertaking, initially, and over time. Preliminary estimates indicate that the dredging costs would be $250,000 at a minimum and could reach $500,000. Maintenance problems are also a critical factor as a smaller channel would fill in very quickly and be difficult to navigate safely. A protective jetty on one or both sides would be a higher first cost trade-off for maintenance costs;

DA FORM 2496

however, project costs would approach $1.2 million. Responding to Mr. Kent Worley's question on more precise jetty costs, Mr. Jewell pointed out that the exact length and height of the jetty or jetties have not been determined because it is obvious that alternative A is much more expensive than alternative D and has many other problems associated with navigation, maintenance, and dredged material disposal sites. Maintenance considerations could dictate construction of two parallel jetties running out past the bar. Also, although a jetty would project the channel for much of the project life, it would eventually cause other hydrologic problems as it continues to modify the natural cycle. The data that Mr. Jewell is working with support selection of alternative D. Any disadvantages are temporary. There may be a possibility of avoiding the immediate construction of a new bridge. A few additional comments concerning design standards indicated that a 30-foot boat requires a minimum 60-foot radius, requiring a bulb or turning basin at the base of channel A just west of the existing Taylor Road (74) Bridge. Channel width should be five times the average beam or 50 feet minimum. Alternative D should be provided with a flushing action, either mechanical or natural. Also, Mr. Jewell referred to a density design standard of 20 boats per acre and noted that the planned 180 slips constitute 25 boats per acre which is within an acceptable range.

7. Mr. Henderson asked about the possibility of a large-boat facility in channel D. This feature is not included in alternative D as there will be more adaptable areas in the existing channel to serve large craft as well as recent and possible future developments in the private sector to serve this class of boat. Mr. Worley also noted a shortage of space suitable to develop such a feature within alternative D.

8. Mr. Bruce Atwater raised some specific design questions about alternative D. Mr. Worley responded, pointing out the features of alternative D. Several specific items such as bridge height, amounts of riprap or sheet piling will not be determined until the actual design phase, recognizing that the architect is, as yet, developing the schematic phase.

9. General comments from the floor strongly favor alternative D. The community likes the concept of an added amenity to the park. Watching the boats pass by will provide enjoyment for many people.

10. Mayor Roberts related the great congestion over the past weekend and the continued and increasing demand and great need for the facilities. [illegible] winds have blown boats onto the beach, sandbar, and road. We observed the congestion during our day at Warroad.

11. General discussion on the floor indicated a belief that the present shoreline meander was moved more than 4,000 feet inland as a result of the raising of the water level 3 to 6 feet when the dams were placed in the outlets from Lake of the Woods prior to 1900. Thinking this information valuable to cultural resource personnel searching for remains of a reported Indian village near the mouth of the Warroad River, I asked Mr. Harold Olimb and Mr. Atwater to gather available local information and forward their findings to the Corps. A later search of the International Joint Commission's Lake of the Woods reference - 1917 - substantiated their belief to some degree.

12. I asked those attending if it would be possible to route County State Aid Highway (CSAH) 74 to the west of the park area, so that (Taylor Road) the present 74 alignment could become a park road thereby qualifying the required new bridge in alternative D for Bureau of Outdoor Recreation funding. A discussion of the benefits vs hazards of allowing a major thoroughfare to be routed through a park/recreation area followed. Mayor Roberts stated the road was an absolute necessity and that everyone wanted it to remain in its present location. Also, relocation would be quite expensive and would pass through a residential area. Other very temporary solutions were also discussed but did not receive much support. One of these involved a wooden temporary bridge, another proposed temporarily discontinuing through traffic between channel construction and the earliest date the county could fund and construct the new bridge.

13. Senator Marv Hanson questioned the classification of the park. Mr. Bill Atkins responded that it was a regional park as the benefits go far beyond local interests. The Senator then asked if an allocation of other State monies had been or could be made. This question will be answered later by Mr. Atkins or Senator Hanson.

14. Mr. Louis Kowalski, Chief, Small Projects Section (ED-PB) had called earlier and left a message for me regarding other Federal funds proprietary to a section 107 project. I shared this message with those attending the meeting. In essence, the village may obtain funding for the bridge from a Federal agency or program. This statement is not an official Corps policy statement (will follow later) but is the most reliable interpretation Mr. Kowalski could obtain within the limited time.

15. Mayor Roberts asked me when section D of the draft detailed project report would be completed. August was the reply.

NCSED-PB 27 June 1977
SUBJECT: Section 107, Warroad Small-Boat Harbor Study, Lake of the Woods, Warroad, Minnesota

16. I stated that the cost of the proposed launch ramp shown in alternative D would be a local cost in accordance with present Corps policy.

17. Response to a question on the availability of riprap indicated that a full size range of field stone is readily available throughout the area and is stockpiled in farm fields. As a general rule this rock is given to anyone wanting it so that the cost is that of loading and hauling to the site. This cost may be considerable due to the wide dispersion of such rock piles; however, it may be difficult to estimate. No conventional limestone quarries exist in the immediate vicinity.

18. Mayor Roberts pointed out that this project has been in the planning stage for many years and many people are tiring of the process and anxious for construction to begin. If no action occurs in the near future, he anticipates the community will tire of the bureaucratic processes and return the entire project to a private sector developer. This would result in a quite different complexion for the end product. These sentiments were later echoed by other local people.

19. The following morning Mr. Jewell and I inspected the bay area immediately offshore between the Warroad River channel and the bridge on CSAH 74 (Taylor Road) and the alignment of the proposed channel under alternative A. Our observations were that:

a. The existing channel is filling in the area of the sandbar. We estimate the channel to be 5 feet deep by 45 feet wide, then rising quickly to a 2-foot depth.

b. The general bay area and proposed channel alignment under alternative A are very shallow now - 18 inches deep in many areas and only 1 foot deep for approximately 800 feet lakeward from the bridge. Weed beds and bogs are numerous.

c. Alternative A would be very difficult to implement and maintain, even more so than we had thought previously. Further, an earlier mention of providing a very limited channel at A (the bridge) for use by very small boats and flushing action for the harbor was deemed an impractical plan in view of our findings. To be even marginally effective, the minimum channel would be 4 feet deep by 50 feet wide by 2,500 to 3,000 feet long, which would be expensive to implement and maintain especially relative to benefits provided.

Vern [illegible]

1 Incl
as

VERN [illegible]
Small Projects Section
Planning Branch
Engineering Division

CF:
Pending File

Mark Kamm...	Hallock
Doug Eckes	Warroad
Bill Atkins	Park Rapids...
Fremont Jewell	Planning Agency St. Paul
	Corps of Engineers
Kent Gwerley	Architectural Resources, Inc.
Vern Abdoo, 2 LT	Corps of Engineers
Doug Stewart	Consulting Eng... Thief River Falls

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT		
NCSED-PB	Section 107, Detailed Project Report for a Marina Access Channel at Warroad, Minnesota, Citizens Advisory Committee Meeting		
TO	FROM	DATE	CMT 1
Memo for Record	Planning Branch Engineering Division	26 March 1979 Forsberg/bq/5902	

1. A marina access channel citizens advisory committee meeting was held in Warroad on 22 March 1979. A Warroad City Council meeting was held immediately following the advisory committee meeting. The attendance list is attached.

2. The purpose of the advisory committee meeting was to review the subject study's progress and to solicit community input on channel design.

3. I described the preliminary channel alignment, channel cross sections, slope protection requirements, and excavated material placement considerations. I also reviewed the study schedule, and stated that we anticipate completing the Detailed Project Report the summer of 1979, and channel construction the fall of 1980. The preliminary channel alignment layout and study schedule are attached.

4. I stated that we needed resolution of two channel design items before the study could proceed further: 1) location of the boat launching ramp, and 2) a solution to the CSAH 74/channel conflict. We reviewed tables describing the merits of three alternative boat launching ramp locations and comparing two alternatives for resolving the CSAH 74/channel conflict. Both tables are attached. Mr. Kent Worley of Architectural Resources described how the alternatives affect the recreational park complex master plan they have developed for the city. Mr. Walter Forney of Stewart and Walker, described how the alternatives affect the Warroad street reconstruction project they are designing and administering for the city.

5. After a discussion of the relative merits of the alternatives, the committee unanimously recommended that: 1) the boat launching ramp be constructed in the marina basin, and 2) CSAH 74 be abandoned in the area of the proposed channel and a new CSAH 74 alignment be provided by extending a north/south street from Lake Street to the existing CSAH 74.

6. Immediately after the citizens advisory committee meeting, the Warroad City Council unanimously passed a resolution adopting the advisory committee's recommendations. Mr. Harold Olimb, City Clerk, stated that a copy of the resolution and meeting minutes will be mailed to us.

Alan Forsberg

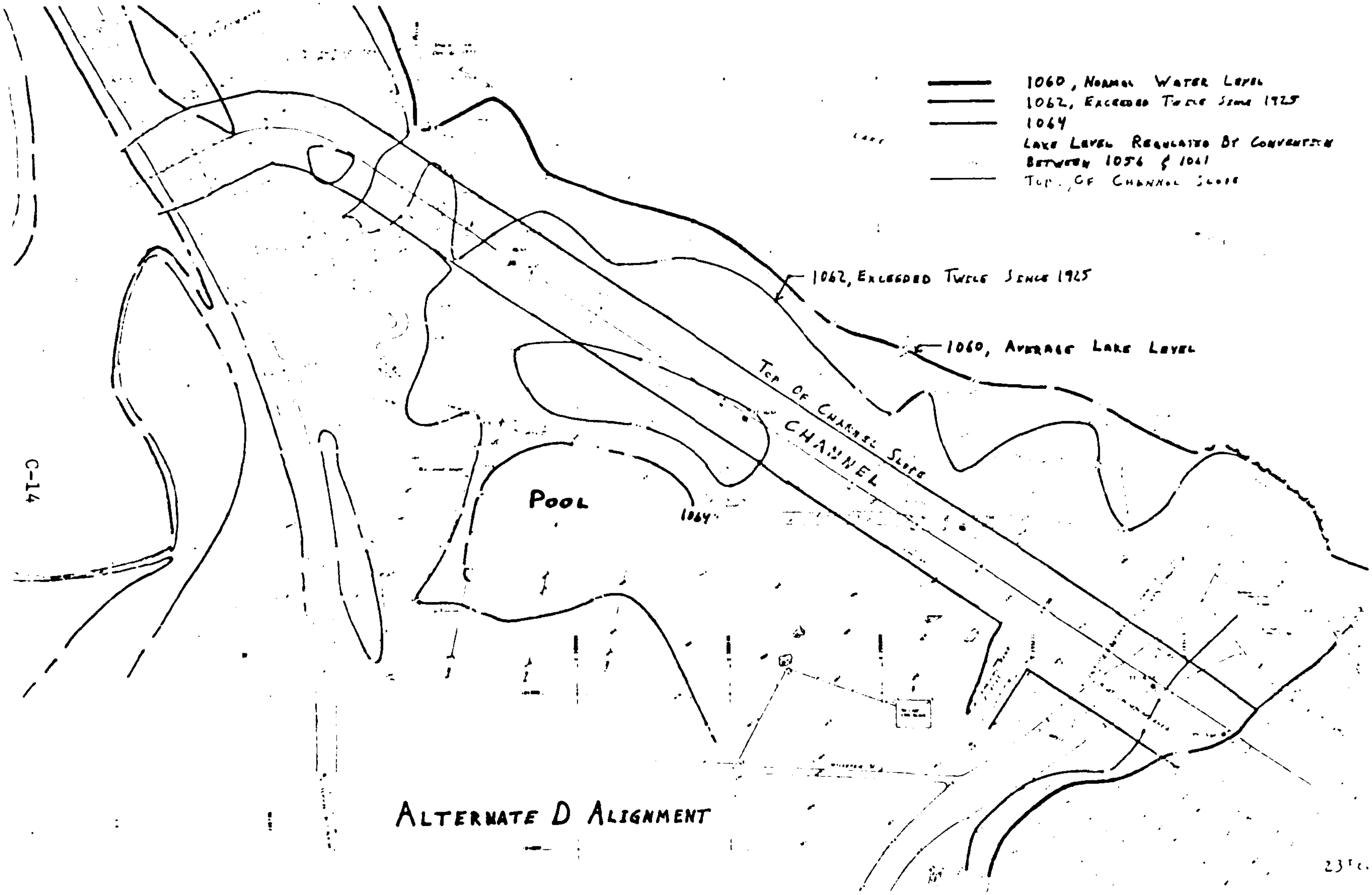
5 Incl
as

ALAN FORSBERG
Civil Engineer
Planning Branch
Engineering Division

CF:
Reading file

CITY OF WARROAD
22 March 1979 - Fire Hall Meeting Room

Name	Firm	Address
Harold P. Olimb	City Clerk	Warroad
Loren C. Fints	City Council	Warroad
Donald W. Burress	City Supt.	Warroad
Joe Koenig	City Council	Warroad
Dick Johnson	City Council	Warroad
Willard Krahn	Marvin Marine	Warroad
Stan Ehrenstrom	Hayes & Fulton	Warroad
Harvey Kimbe	City	Warroad
Dean K. Heinen	Advisory Board	Warroad
Gary Hendrickson	Council	Warroad
Dick Roberts	Mayor	Warroad
C.J. Mergans	Attorney	Warroad
Kent Worley	Landscape Architect, Arch. Res.	Duluth
Walter Forney	Stewart & Walker	Thief River Falls
Orrin Rasmussen	Asst. County Engineer	Roseau
Hank Henderson	Advisory Board Chairman	Warroad



ALTERNATE D ALIGNMENT

CSAH 74/Channel Conflict
Comparison of Solutions

Bridge over channel	Extend 1st Avenue; Close segment of CSAH 74
Recreational/Park Complex	
* CSAH 74 divides park - Safety - Pedestrian accessibility - Park atmosphere, noise * Bridge limitations - Boat clearances - Channel width at curve & entrance restricted	* CSAH 74 park access road * Marina could accommodate sailboats & larger motorboats * Marina entrance could be flared
Channel Construction	
* CSAH 74 may be closed during construction	* Possibly no interruption of CSAH 74
Traffic Flow	
* Does not affect existing traffic patterns	* Directs CSAH 74 closer to downtown * Small increase in traffic on 1st Ave. * Provides access to development land
Construction Cost	
* Higher channel cost * Bridge and embankment cost comparable or perhaps greater than road extension cost	* Lower channel cost

Boat Launching Ramp

Comparison of Alternate Sites

Boat launching ramp in channel	Boat launching ramp in Warroad River Recreational/park complex	Boat launching ramp in marina
* Auto and boat trailer conflict between park and ramp users * Ramp remote from marina contact station * Vertical wall could be safety hazard * Not convenient for marina users	* Auto and boat trailer conflict between park and ramp users * Ramp remote from marina contact station * Not convenient for marina users	* Fits marina parking and city street system well * Controlled by marina contact station
	Channel Construction	
* Complicates design and construction of channel * Vertical wall may not be technically feasible	* Simplifies design and construction of channel * River dredging required at ramp	* Simplifies design and construction of channel
	Boat Operations	
* Boat launching and channel traffic may conflict	* River bay could provide boat launching, maneuvering and merging space	* No conflict between boat launching and through traffic

	Boat launching ramp in channel	Boat launching ramp in Warroad River	Boat launching ramp in marina
Construction cost	* Ramp, widened channel, vertical wall increase channel cost $140,000 * Ramp, widened channel, sloped bank increase channel cost $35,000 * Questionable Corps participation in ramp, vertical wall costs, possibly could result in additional excavation cost	* Ramp constructed at less cost, requires river dredging * Ramp could be included in marina funding	* Ramp constructed at less cost * Ramp could be included in marina funding package

(oan)

293-3992

16500
Ser 148
23 April 1979

From: Commander, Ninth Coast Guard District
To: District Engineer, U. S. Army Corps of Engineers, St. Paul District, 1135 Post Office & Custom House, St. Paul, Minnesota 55101

Subj: Navigation Aids for Small Boat Harbor Access Channel, Warroad, Minnesota

Ref: Your letter NCSPD-PB dated 3 April 1979

1. This letter is in response to reference (a).

2. The Coast Guard will establish one minor light structure. The approximate construction cost would be $11,000 with an annual maintenance cost of $300.00.

3. We would also establish two plastic buoys, one can and one nun. The cost of these buoys is $155.00 for the nun, and $145.00 for the can, with an annual maintenance of $25.00 for each buoy.

4. The approximate position of these aids is indicated on your preliminary channel alignment layout enclosed.

5. If you have questions or require additional information, please contact Mr. Bob Casior or QMC Pope of our planning section, telephone (216) 522-3991/3992 or FTS 293-3992.

C. A. MILLRADT
By direction

Encl: (1) U. S. CofE Preliminary Channel Alignment Layout

Copy to: CDR CG GRU Duluth
CCGD9(ocv)

MINNESOTA HISTORICAL SOCIETY

690 Cedar Street, St. Paul, Minnesota 55101 • 612 296 2747

3 August 1979

Colonel William W. Badger
District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

RE: NCSED-ER Review of the preliminary draft of the Environmental Assessment for the Warroad, Minnesota, Small Boat Harbor, Channel Construction project. Roseau County

MHS Referral File Number: I 879/B 58

Thank you for the copy of the above referenced report. As stated on page 17 and appendix A-2, no archaeological resources were discovered during the course of the cultural resource survey conducted at this location. Consequently, there are no sites of historic, architectural, cultural, or archaeological significance in the area which are on the National Register, and, therefore, none which may be affected by the above proposal.

Thank you for your participation in this important effort to preserve Minnesota's cultural resources.

Sincerely,

Russell W. Fridley
State Historic Preservation Officer

RWF/fr

NorthWest Regional
Development Commission

425 Woodland Avenue • Crookston, Minn. 56716 • 218-281-1396

December 6, 1979

William W. Badger
Colonel, Corps of Engineers
District Engineer
Department of the Army
1135 U.S. Post Office
& Custom House
St. Paul, MN 55101

Re: Warroad Channel Project, Detailed Project Report

Attention: NCSED-PB

Dear Colonel Badger,

We have done a staff review of the above referenced project and support the conclusions of the Detailed Project Report.

Sincerely,

Eugene E. Abbott

Eugene E. Abbott
Executive Director

dc

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA STATE AND PRIVATE FORESTRY
370 REED ROAD — BROOMALL, PA 19008
(215) 596-1672

1950
December 26, 1979

William W. Badger
Colonel, Corps of Engineers
District Engineer
Department of the Army
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Refer to: NCSED-PB, Project
Report and Environmental
Assessment Small-Boat Access,
Warroad, Minnesota

Dear Colonel Badger:

We agree with several other agencies that Alternate D would have the least adverse environmental impact of the five alternatives.

We trust that the 800 cubic yards of excavated material (P. 46) placed in the wetlands area will not have a significant effect on wetland vegetation.

Where material excavated from the channel is placed above the high water mark (P. 21 Appendix J), revegetation can be facilitated where appropriate by first removing topsoil and placing it on the excavated material.

Thank you for the opportunity to review this Statement.

Sincerely,

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

UPPER GREAT LAKES
REGIONAL COMMISSION

OFFICE OF THE FEDERAL COCHAIRMAN

Re: NCSED-PB

January 3, 1980

Mr. William W. Badger
Colonel, Corps of Engineers
District Engineer
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minn. 55101

Dear Mr. Badger:

The Federal office of the Upper Great Lakes Regional Commission has received your letter of December 17 concerning the proposed Warroad River channel project. This office has no objections. I am sending a copy of your letter to the Minnesota state office of the Commission in Duluth.

Please note that I have replaced Raymond Anderson as Federal Cochairman of the Commission.

Sincerely,

William R. Bechtel
Federal Cochairman

cc: Minnesota State UGLRC office

ROOM 2091 U.S. DEPARTMENT OF COMMERCE 14th & E STREETS N.W. WASHINGTON D.C. 20230
TELEPHONE Area Code 202 [illegible]

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
175 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60604

ER 79/1123

21 January 1980

Colonel William W. Badger
District Engineer
U.S. Army Engineer District, St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This responds to a request for the Department of the Interior's comments on the Draft Detailed Project Report and FONSI for Marina Access Channel Project at Warroad, Roseau County, Minnesota.

The subject documents adequately address the concerns of this Department. We have no further comment on this project.

Sincerly yours,

Franklin Stearns
Acting Environmental Review Officer

STATE OF

DEPARTMENT OF NATURAL RESOURCES
[illegible], St. Paul, MN [illegible]
(61[illegible]) [illegible]

January 25, 1980

Louis E. Kowalski
Chief, Planning Branch
U.S. Corps of Engineers
St. Paul District
1135 U.S. Post Office Building
St. Paul, Minnesota 55101

Dear Mr. Kowalski:

RE: SECTION 107, DETAILED PROJECT REPORT, WARROAD CHANNEL PROJECT, WARROAD, MINNESOTA

The Minnesota Department of Natural Resources supports the findings of the Section 107 detailed project report Warroad Channel Project, Warroad, Minnesota, and concurs with the recommendation that detailed plan D for construction of an overland channel from the marina to the base of the jetty, be considered the selected plan.

The DNR, in a letter of December 18, 1979, enclosed herewith, advised the City Clerk, City of Warroad, that a permit from the Commissioner of the DNR will be required. One of the issues to be considered in permit review will be the existence, if any, of navigable channels connected directly to the inland harbor.

It is recommended that you contact Gerald Paul, DNR Region I Hydrologist (218) 755-3973, regarding present status of the DNR actions on any permit proposals.

Yours very truly,

DIVISION OF WATERS

Larry Seymour
Director

LDS/GHH:ls
Enclosure
cc: City Clerk, City of Warroad
MN Legislators - Rep. Myron Nysether
Sen. Marvin Hanson
Senator Durenberger
Senator Boschwitz
Representative Stangeland
Kermit McRae

February 18, 1980

Mr. John E. Hensel
Minnesota Pollution Control Agency
1935 West County Road - B2
Roseville, Minnesota

RE: City of Warroad Interim Wastewater Treatment
Corp. of Engineers Marina Project
Project No. 36403.00

Dear John:

We have prepared the attached drawings for "Interim Wastewater Treatment" for the City of Warroad and are submitting it for review by MPCA and EPA. This is being done to enable EPA to issue a Finding of No Significant Impact which will, in turn, enable Corps of Engineers to proceed with design of the Warroad Channel Project.

The existing sludge handling consists of sand beds with underdrains that discharge to the eight inch effluent line. The proposed sludge pond improvements would eliminate this problem and, thus, improve the final effluent quality.

The existing discharge point is at the edge of a jetty and boat landing that is used for sport and commercial fishing. This public recreation area includes a new public swimming pool, small store, and a short distance up the shore from the point of discharge, is the original public beach.

The hydraulic characteristics of the effluent line are not adequate, and under some conditions, the manhole at the plant and the clean out in the public recreation area discharge effluent over the ground.

The following points make the proposed plan a more desirable alternate than the existing situation:

1. The new effluent line would not intercept the sludge drainage and, therefore, the effluent quality would be improved.

2. It is located in an area of the shore line that is presently being used for concrete and street excavation waste dump, and doesn't have any public access.

3. The nearest shoreline residence to the new discharge point is approximately 25 miles northwest and the boat landing and the store is 1300 feet east instead of immediately adjacent to it.

4. The outlet ditch will maintain submergence of the effluent line outlet and protect it from ice breakup in the spring.

Very truly yours,

STEWART & WALKER, INC.

William D. Bloemen

William D. Bloemen, P.E.

WDB/als
c: Al Forsberg
Corp of Engineers

STEWART & WALKER INCORPORATED
ENGINEERS AND ARCHITECTS
324 E. SECOND ST. BOX 387 THIEF RIVER FALLS, MINN.
TELEPHONE (218)

March 13, 1980 Ref: 36402.00

Mr. Tom Hadden
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, MN 55113

Re: City of Warroad
Interim Wastewater Treatment

Dear Tom:

This letter is a response to your telephone request for an operation plan on sludge disposal for the Warroad Wastewater Interim Treatment Plan that Stewart & Walker, Inc. has proposed for your consideration.

The present sludge production of the digestor at the Warroad plant is the equivalent of twelve yards of dry sludge once in the spring and once in the fall. This sludge is removed from the existing sand beds and hauled to a landfill site.

The proposed pond would have a watertight clay seal. It would be cut in half by a wooden dike that would allow the sludge to be deposited in one of the two cells and facilitate dewatering by seepage through the wooden dike. This process would retain the solids in one cell at a time and still utilize the entire pond area for evaporation. This would allow drying in the event that the sludge would have to be removed. The design, however, anticipates total retention of the sludge for three years operation.

At the end of three years, the accumulated dry sludge would only fill the pond to a depth of 0.65 feet. Each digestor discharge into one of the two cells would require 2.14 feet of depth, leaving a freeboard of 0.21 feet in the worst case situation (i.e., after three years of use and using only one of the two cells for the complete discharge). We do not, therefore, anticipate the need for ever having to remove sludge from this facility during its three year design life even though this could be accommodated if it was necessary to use the pond for a longer period of time.

Sincerely,

STEWART & WALKER, INC.

James E. Walker, P.E.

C-27

JEW/als

NCSED-PB

Section 107, Detailed Project Report for a Marina Access Channel at Warroad, Minnesota - Public Information Meeting

Memo for Record

Planning Branch
Engineering Division

14 March 19[illegible]

1. A public information meeting for subject study was held in Warroad, Minnesota on 28 February 19[illegible]. The meeting took place in the Warroad Firehall at 7:[illegible] p.m. Attachment 1 is the meeting notice and its mailing list. Attachment 2 is the attendance list for the meeting.

2. The purpose of the meeting was to present information contained in the Warroad channel project draft detailed project report to the public. After being introduced by the mayor, I presented this information using an overhead projector and transparencies. Attachment 3 is a copy of the transparencies. Plates showing the channel alignment, channel cross section, and other design information were also available for public review. These plates are retained in the Planning Branch office.

3. Several people expressed support for the recommended plan and a desire to have the channel constructed as soon as possible. No one expressed opposition to the plan. Several people stated that the existing boat launching ramp on the Warroad River should remain in operation as long as possible during construction of the channel. The ramp is located on the east end of the channel alignment, and limited alternative boat launching sites are available.

3 Incl
as

ALAN FORSBERG
Civil Engineer
Planning Branch
Engineering Division

Minnesota Pollution Control Agency

MAR 21 1980

Colonel William W. Badger
U. S. Army Corps of Engineers
St. Paul District
1135 U. S. Post Office and Customshouse
St. Paul, Minnesota 55101

Re: City of Warroad
Interim Wastewater Treatment
Corps of Engineers Marina Project
Project Number 36403.00

Dear Colonel Badger:

We have reviewed the enclosed information regarding the change in the effluent discharge location and proposed sludge pond improvements at Warroad, Minnesota and have no objections to the interim plan at this time. However, National Pollutant Discharge Elimination System (NPDES) regulations require permit modifications of any proposed change in discharge location. Since the Minnesota Pollution Control Agency (MPCA) Permits Section is currently drafting new permits for Warroad's existing and proposed wastewater treatment facilities, the proposed interim change in sludge pond location and effluent pipe location will also be public noticed. We will inform you of the status of the permit issuance.

If you have any questions regarding this matter, feel free to contact Tom Hadden at (612)296-7383.

Sincerely,

John E. Hensel, P.E.
Senior Engineer
Facilities Section
Division of Water Quality

JEH/TBH:pah

Enclosures

cc: Mr. James E. Walker, P.E.; Stewart & Walker, Incorporated
The Honorable Richard Roberts, Mayor, City of Warroad
Warroad City Council, c/o Harold Olimb, Clerk-Treasurer

1935 West County Road B2, Roseville, Minnesota 55113

March 31, [illegible]　　　　　　　　　　　　　　　　　　　　　　　　　　　　[illegible]

Mr. Al F[illegible]
Corp of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

RE: City of Warroad Interim
Wastewater Treatment
Project No. 36403.00

Dear Al:

The reasons we chose the location and type of effluent discharge design that we proposed is explained in detail in our February 18, 1980 letter to John E. Hensel. I have enclosed a copy of this letter for your convenience.

You mentioned the possibility of effluent surfacing in the winter at the discharge point, and flowing over the ice at Lake of the Woods. This is a possibility but the proposed plan is considerably more desirable than the other options for the following reasons:

1. We do not think it will freeze because the 150,000 gpd flow should keep a channel under the ice open.

2. The point of effluent discharge must be removed from its present "public access" location. To extend the effluent line 2500 feet out into Lake of the Woods at the proposed location would involve disruptive construction on the lake bottom and would probably be torn out with the first ice movement. This would mean extensive cleanup of pipe debris in Lake of the Woods.

3. If the proposed outlet did freeze it would still be more desirable than the existing situation which allows effluent to overflow the cleanout and manhole and flow overland before it reaches the ice cover at Lake of the Woods.

4. The effluent is now and will continue to be chlorinated.

Sincerely,

STEWART & WALKER, INC.

James E. Walker, P.E.

JEW/als
Enc.

CITY OF WARROAD

Box 50

WARROAD, MINNESOTA 56763

Telephone 218-386-1454

Mayor
Richard B. Roberts

Councilmen --
Loren Fish
Gary H[illegible]ckson
Dick Johnson
Joe Ko[illegible]ig

City Clerk-Treas. --
Harold P. [illegible]

April 18, 1980

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This is a letter of intent for the Warroad, Minnesota, channel project.

Local interest have been involved in the planning process for the project, and have reviewed information contained in the draft detailed project report. The city of Warroad supports construction of the recommended overland channel plan. The city is legally constituted and has the financial capabilities to satisfy all requirements of local cooperation.

In accordance with Section 221 of Public Law 91-611, approved 31 December 1970, as amended, the city of Warroad as local sponsor of the project would agree to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project and subsequent maintenance of the project and of the Government jetty, including suitable upland areas for placement of excavated materials, in accordance with project right-of-way and excavation material placement plans.

b. Accomplish all alterations and relocations of buildings, streets, sewers, utilities and other structures and improvements made necessary by project construction.

c. Contribute 50 percent of the total first cost for construction of general navigation facilities.

d. Contribute all cost in excess of the Federal cost limitation of $2,000.000.

e. Hold and save the United States free from damages due to the construction, operation and maintenance of the project, not including damages due to the fault or negligence of the United States or its contractors.

f. Insure that expenditure of Corps funds will result in a project that is integrally complete and fully effective by providing and maintaining:

(1) An adequate public landing with provisions for dispersing potable water and disposing of boat sanitary wastes, available to all on equal terms.

(2) Piers, slips, floats, and similar marina and mooring facilities as needed for transient and local boats, including necessary dockage, police, and fire protection services, open to all on equal terms.

(3) Access roads, parking areas, boat launching ramps, and other necessary public use shore facilities.

The improvements described above are to be provided without material deviation from the Lake of the Woods Beachfront Development at Warroad plan.

g. Establish a competent and properly constituted body empowered to regulate the use, growth, and development of the marina facilities and insure that the facilities shall be open to all on equal terms.

h. Establish regulations prohibiting the discharge of untreated sewage, garbage, and other pollutants in the waters of the harbor by users thereof, which regulations shall be in accordance with applicable laws or regulations of Federal, State, and local authorities responsible for pollution prevention and control.

i. Comply with the provisions of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970," Public Law 91-646, approved 2 January 1981, in the acquisition of lands, easements, and rights-of-way necessary for the construction and subsequent maintenance of the project.

I understand that these requirements will be included in the final detailed project report and the local cooperation agreement (Section 221 agreement). I also understand the Section 221 agreement is the final written contract between the City and the Corps. The Section 221 agreement follows approval of the final detailed project report and precedes issuance of construction funds, based on availability of funds.

I understand that the final project cost will be determined after final payment to the construction contractor is made. After the final project cost is determined, the local share will be adjusted to reflect actual rather than estimated costs.

Sincerely,

Richard B. Roberts

Richard B. Roberts
Mayor
City of Warroad

23 MAY 1980

Colonel William W. Badger
District Engineer
U.S. Army Engineer District, St. Paul
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

RE: NCSED-ER

Dear Colonel Badger:

We have reviewed the additional information provided in your correspondence of 16 April 1980, regarding secondary impacts of the proposed Warroad Channel Project in Warroad, Minnesota.

Our letter of 9 January 1980, expressed our concerns over potential secondary impacts related to the destruction of the sludge dewatering tanks at the Warroad sewage treatment plant. Our major concerns included the disposal location for sludge contaminated soil which surrounds the tanks, as well as interim sludge disposal plans to be employed until a new sewage treatment plant has been constructed.

We find that your letter and the enclosures (revision of paragraphs 4.20 and 4.21 of the Environmental Assessment, letters from a private consulting engineer, preliminary drawing of the proposed modifications, and a letter from the Minnesota Pollution Control Agency) provide the necessary information to assess the secondary impacts of the proposed project. The close coordination you have maintained throughout the planning of this project with the concerned local and State interests should allow you to proceed without further impedients to your planning process.

We appreciate your attention to our expressed concerns. Please contact me at FTS 886-6089 for any additional matters regarding this project.

Sincerely yours,

Rick Pitorak

Rick Pitorak
Soil Scientist
Environmental Impact Review Staff
Office of Environmental Review

Minnesota Pollution Control Agency

JUN 19 1980

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Colonel William W. Badger
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Re: STATE DISPOSAL SYSTEM PERMIT # MN D051659
and Section 401 Certification (hereinafter the Permit)
Warroad River, Harbor Access Channel

Dear Colonel Badger:

Enclosed is a copy of the final State Disposal System Permit covering your facilities at the above referenced location. This Permit has been drafted pursuant to Minnesota Statutes, Chapters 115 and 116 as amended and Minnesota Pollution Control Agency Regulation WPC 36. All comments submitted in writing during the public notice comment period, pursuant to WPC 36, Section (h) (4) and the hearing record, where a hearing was held pursuant to WPC 36, Section (k) have been considered in the formulation of final determinations and recommendations on the State Disposal System Permit.

Compliance with the terms and conditions of this Permit is required as of the date of issuance.

If you have any questions regarding this Permit, please contact Mr. Louis Flynn of my staff at (612) 296-7225.

Yours truly,

Richard Svanda

Richard A. Svanda, P.E.
Chief, Permits Section
Division of Water Quality

RAS/LF:cs

Enclosure

cc: U.S. Environmental Protection Agency
U.S. Fish and Wild Life Service
See attached list

1935 West County Road B2, Roseville, Minnesota 55113
Regional Offices • Duluth / Brainerd / Detroit Lakes / Marshall / Rochester / Roseville
Equal Opportunity Employer

cc: Minnesota Pollution Control Agency, Region I
Al Forsburg, Corps of Engineers, Planning Branch

Permit No: MND 051659

PERMIT FOR THE CONSTRUCTION AND OPERATION

OF A DISPOSAL SYSTEM

Under the State Disposal System Permit Program
and Section 401 Certification (hereinafter the Permit)

The U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55113

In compliance with the provisions of Minnesota Statutes Chapters 115 and 116, as amended, and Minnesota Regulation WPC 36 (hereinafter WPC 36) the above Permittee is authorized by the Minnesota Pollution Control Agency (hereinafter the Agency) to construct and operate a disposal system in accordance with limitations, monitoring requirements and other conditions set forth herein.

This permit is issued for the discharge of dredged and excavated material required for the construction of an access channel from an existing small boat harbor to deep water channels on the Warroad River providing access to Lake of the Woods.

The permit shall expire at midnight, December 31, 1983. The Permittee is not authorized to operate after the above date of expiration. In order to receive authorization to construct and operate a disposal system beyond the above date of expiration, the Permittee shall submit no later than 180 days prior to the above date of expiration such information and forms as are required by the Agency pursuant to WPC 36.

Dated: JUN 19 1980

Barry C. Schade
Director
Division of Water Quality

For Terry Hoffman
Executive Director
Minnesota Pollution Control Agency

A. PROJECT DESCRIPTION:

Deep water access to Lake of the Woods will be obtained by the excavation of a channel from the existing harbor to the Warroad River. The channel will be 1700 feet long and will be constructed overland. The channel will interest the existing CSAH (74) turn northerly, parrallel to the shoreline to connect with the Warroad River approximately 100 feet upstream of the protective jetty at the mouth of the river. Approximately 58,000 cubic yards of material will be excavated to create the channel. Material from the channel excavation will be used to construct a protective berm on the lakeward side of the channel. Materials which have been determined to be contaminated, from the Warroad River bank and from the sewage sludge dewatering tanks, will be disposed of in a manner to be specified in the special conditions (PART I.C.). This project is to be conducted in accordance with the requirements of NPDES Permit No: MN 0025194.

B. EFFLUENT LIMITATIONS: No Discharge

C. OTHER CONDITIONS AND REQUIREMENTS

1. The Permittee shall dispose of wastewater or solids and sludge removed from or resulting from treatment or control of wastewaters in a manner which would prevent any such pollutant from entering waters of the state. In disposing of such materials, the Permittee shall comply with all applicable water, air, and solid waste statutes and regulations. When requested, the Permittee shall submit a plan for such disposal for approval by the Director.

2. This permit has not been reviewed by the U.S. Environmental Protection Agency and is not issued pursuant to Section 402 of the Clean Water Act of 1977.

3. The Director shall review and comment upon engineering reports and construction plans and specifications which provide the basis for this permit solely for the limited purpose of determining whether such reports, plans, and specifications will enable the permitted facilities to reasonably comply with the regulations and criteria of the Agency.

4. Material from the sludge beds and surrounding material will be excavated to a depth of four feet beneath the beds and four feet outside the perimeter of the beds. Further excavation may be required if visual observation indicates that contamination has proceeded to greater depths. This material shall be disposed of in accordance with the interim sludge plans approved by the Minnesota Pollution Control Agency (MPCA).

5. Material within 100 feet of the Warroad River will be placed inland from the channel above ground levels 1062 and will be covered with a impermiable layer of clay or asphalt.

6. The lakeside berm will be constructed of clean material, and shall be properly protected from erosion.

7. Demolition material such as concrete rubble will be disposed of in a manner to be approved by the MPCA Division of Solid Waste.

8. As far as feasible and prudent, the excavation shall be from landward to water with breakthrough to water occurring at the last possible moment.

9. This project must be conducted in accordance with requirements of the Minnesota Department of Natural Resourses.

10. Authorizations in this permit are based on information submitted with the application. Changes or further authorizations may be granted by the MPCA if such changes are requested in writing and the authorization is granted before such changes or authorizations are commenced.

SDS-(4/79) 941197

D. MONITORING AND REPORTING

1. The Permittee shall notify the appropriate MPCA office at least 72 hours prior to conducting work or disposing of materials. The notification shall indicate the date and time work will commence.

   Notify: Mr. John Pegors
   Regional Director
   1015 Torrey Building
   Duluth, Minnesota 55802
   (218) 723-4660

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

COASTAL ENGINEERING ANALYSIS

A

P

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APPENDIX D

TABLE OF CONTENTS

PLATES

COASTAL ENGINEERING ANALYSIS

The design conditions for the subject harbor channel were analyzed in three separate categories: (1) small-craft waves within the harbor channel, (2) waves from the lake affecting the top of the channel embankment, and (3) waves from the lake entering the Warroad River channel and affecting the proposed harbor entrance. The above wave conditions were calculated for different elevations of the water surface (high and low water), the design probability being a 20-year recurrence combination of events.

THE WAVE CLIMATE

No weather station of record exists at Warroad; consequently, wind conditions for the proposed harbor were determined primarily from weather data gathered at the International Falls, Minnesota, Airport. It is apparent that the predominant storm direction (wind velocities in excess of 15 mph) is N80°E. Storms from this direction occur 10.4 percent of the time. The critical direction for storm winds at Warroad (see plate D-1) is the sector (Muskeg Bay) bounded by N23°E and N79°E. The annual occurrence frequency for storm winds from this sector is 2.4 percent. During the month of July the frequency drops below 0.5 percent in Muskeg Bay. Wind summaries for Kenora Airport show a much different orientation. The data for all months corresponding to the International Falls data for sectors 1, 2, and M are S at 13.7 percent, NW at 12.3 percent, and Muskeg Bay at 5.7 percent. See plate D-2. This does not appear to be compatible with Warroad weather; consequently, International Falls record is used as the weather data source for the subject harbor. See plates D-1, D-2, and D-8.

The USAFETAC wind summaries, which are the source of weather data for International Falls, indicate the percentage of time the wind blows from any direction (16 compass points) for any given range of velocities. The wind rose on plate D-8 may be used to determine the percentage of time the wind blows from any sector by summing up the figures included in that sector. Plate D-4 contains wind velocity curves for Kenora, Ontario, and International Falls, Minnesota. A 20-year recurrence velocity for either city is 52 mph and 22 mph, respectively. The wind curves are derived from the USAFETAC wind summaries and include only the winds above 11 knots. The resultant curve includes all directions.

Lake of the Woods, specifically the southern and open portion from Warroad to Bigsby Island, is shallow, the greatest depths rarely exceeding 35 feet. The longest fetches (2 and 3) average 22½ and 18 feet in depth, respectively (see plates D-1 and D-2). The maximum shallow water wave, representing a 20-year occurrence, developed over these fetches is a 5.3-foot wave of 5.2 seconds occurring offshore beyond the influence of vegetation. These waves are then modified by bottom conditions varying from sandy soil to heavy stands of weed growth. Wind setup occurs at Warroad, raising the water surface a maximum of 1.92 feet, which represents a return interval of 50 years (see plate D-7).

From the foregoing wind-wave climate analysis, it is evident that the design conditions derived for this project would be quite conservative. This will ultimately influence any decision to build a protective dike along the east side of the proposed inlet channel.

LAKE LEVELS

Lake of the Woods is supplied primarily by the Rainy River, which is regulated by hydroelectric power requirements upstream of the river mouth. The lake is drained by the Winnipeg River, which is also regulated by power needs. Because power regulation is unable to exert control over unusual events, the lake elevation has varied from a low of 1054.63 during the period 27 February through 8 March 1925 to a high of 1063.50 on 1-21 July 1916. Regulation of the lake levels is prescribed by the

International Joint Commission to maintain levels between 1056.0 and 1061.25 (1929 adjustment) by the agreement of 1925. Because there have been many exceptions to this rule since its establishment, it is considered necessary to derive a frequency curve which will order these events in a manner acceptable for use in this report (see plate D-3). This is the annual curve based on the highest mean monthly level for each year from 1909 through 1978. A separate curve, representing the short-term rise effects, largely setup, is shown on plate D-7. The combination of these two curves is demonstrated in the following examples.

Water Levels (selected from plate D-3, curve of maximum mean monthly stages)

High	1063.5	(1929 Adj.)
Median	1060.3	"
Low	1055.5	"

Determine 20 year design w.s. elev. (1912 Adj.)

20 year max. monthly mean	1062.80
1 year short term rise (S.T.R.)	0.92
	1063.72
10 year m.m. mean	1062.15
2 year S.T.R.	1.18
	1063.33
5 year m.m.m.	1061.65
4 year S.T.R.	1.40
	1063.05

For 10 year design

10 year max. m.m.	1062.15
1 year S.T.R.	0.92
	1063.07
5 year m.m.m	1061.65
	1.18
	1062.83
2 year m.m.m.	1060.87
5 year S.T.R.	1.57
	1062.44

Use a design water surface elevation of 1063.06 - 0.55 = 1062.51 (1929 Adj.)

This represents both a 10 year and a 20 year level, depending upon the combination of m.m.m. with S.T.R.

Low Water

1 year m.	=	1056.00	(1912)
1 year STR	=	0.92	
		1056.92	
	-	0.55	
Low water design water surface level		1056.37	(1929 adj.)

Because the maximum recorded stages may include (prior to 1967) certain short-term rise effects, a judgment is made to use a 5-year lake level with a 4-year setup to achieve the 20-year design water surface level of 1062.5. This level is more in accordance with local experience, which has not known flooding above an elevation of 1063.0 (1929 adj.) in the channel site area. This is the water surface level used to design the protective dike on the east side of the harbor channel. It is also the high water design level for the channel entry on the Warroad River. The low water level (river) is taken as 1056.37 which is the sum of a 1-year maximum annual level plus a 1-year setup. It is noted that elevation 1062.5 can represent a 10-year or 20-year occurrence, depending upon the choice of short-term and long-term combinations.

DESIGN WAVES

Design waves are computed for three different wave conditions: small craft derived waves, lake waves approaching over the shore reach just north of the jetty, and lake waves moving down the navigation channel toward the proposed marina channel entry in the Warroad River. For a boat traveling at 8 knots, a wave of 1.3 feet and period of 3.0 seconds is generated. This is the design wave. Runup will be 2.1 feet maximum. Because waves may be generated at high water, it is recommended that slope protection be carried to the top of the channel slope for the entire length of the channel.

For the berm protection at the top of the channel on the lakeside, the design wave is a 2.9-foot 4.8-second wave. The computations on page D-6 and D-7 show the derivation of this design wave. Maximum runup is 4.5 feet on a 1 on 2 slope. The recommended top of berm elevation is 1065.0. (Zero overtopping would be 1067.0.) See plate D-6.

A wave may also make its way from the lake to the proposed marina entry via the Warroad River navigation channel when storm wave direction is similar to the channel alignment. Given the elevation of the channel bottom at 1050.0 (msl 1929) at the marina entry, a water surface elevation of 1056.4 and moderate vegetative growth in the channel for 1,500 feet, a 3.7-foot 5.1-second wave is developed, which may be refracted toward the entry. Acting upon a 1 on 1½ slope, the above wave will produce 4.1-foot runup. It is recommended that riprap protection be constructed to the top of the slope on both sides of the entry. The berm at the top of the bank should also be protected for at least 5 feet back of the top of the slope. See channel plan, plate D-5; range line profiles, plate D-6; and channel profiles, plate D-6.

COMPUTATIONS

Ship Generated Wave

speed 8 knots $H = 1.3'$, $T = 3$ secs., $H'_o = 1.3$

channel slope 1 on 1½ $H'_o/gT^2 = .0045$

At low water 1056.4 depth is 6.4', bottom is level

$d_s/H'_o = 6.4/1.3 = 4.9$ Use fig. 3 (STOA), $R/H'_o = 1.85$

corr. factor = $k = 1.14$ $R/H'_o(\text{curr}) = 1.14 \times 1.85 = 2.1'$

Top of runup @ 1056.4 + 2.1 = 1058.5 @ low water

When water level is @ 20 yr. level ; elevation w.s. = 1062.5

$d_s = 11.1$ $d_s/H'_o = 11.1/1.3 = 8.5$ use fig. 4 (STOA)

$R/H'_o = 1.15$ Add correction $1.14 \times 1.15 = 1.3'$

Top of runup = 1062.5 + 1.3 = 1063.8

Construction of slope protection is with fabriform. Runup calculations therefore assume smooth condition.
Construction protection to top of slope.

Design Wave for Protective Berm

Average pt. to pt. distance for fetches 2 and 3 is 30 miles = 158,400 ft.
Probable distance across vegetated area = 1500 ft.
Average depth = 6.25'
U = 52 m.p.h.

$$\frac{gd}{U^2} = \frac{32.2 \times 6.25}{(72.27)^2} = .039$$

Reference: CETA -77-6

$$\frac{gH}{U^2} = 0125$$

$$H_{sm} = \frac{.0125U^2}{g} = \frac{.0125 \times (72.27)^2}{32.2} = 2.03'$$

(EQ 10) $H_m = .78d = .78 \times 6.25 = 4.9'$

(EQ 9) $R_i = \frac{H_m - H_i}{H_m - H_{sm}}$ where $H_i = 4.0'$, $T = 4.8$ sec.

Reduction factor:

$$R_i = \frac{4.9 - 4.0}{4.9 - 2.0} = \frac{0.9}{2.0} = 0.45$$

$$H_{ie} = R_i H_{sm} = .45 \times 2.03 = 0.91'$$

$$gH/U^2 = \frac{32.2\ (.91)}{(72.27)^2} = .00561$$

$$gd/U^2 = \frac{32.2 \times 6.25}{(72.27)^2} = .0385$$

$$gF/U^2 = 3.75 \quad \therefore \quad F = 608 \text{ ft.}$$

F_e = 608' (Equivalent fetch)

Bottom Friction:

from fig. 13, $f_f = 0.35$

Curve B

$(.0385)\ \frac{f_f\ H_i \Delta x}{d^2} = \frac{.35 \times 4.0 \times 1500}{6.25^2} = 53.76$

$(.01)\ \frac{f_f\ H_i \Delta x}{d^2} = \frac{.01 \times 4 \times 1500}{6.25^2} = 13.96$

$T = 4.8$ sec. $\quad 2\pi d/gT^2 = \frac{6.283 \times 6.25}{32.2 \times 4.8^2} = .050$

from fig. 14

$K_{f_{.01}} = .28, \quad K_{f_{.35}} = .09$

EQ. #6

$$\alpha_r = \frac{1 - .09}{1 - .28} = \frac{.91}{.78} = 1.167$$

Adjusted Fetch: $F_\alpha = \alpha \Delta_x = 1.167 \times 1500 = 1750'$

Total Fetch: $F = F_e + F_\alpha = 608 + 1750 = 2358'$

For $U = 52$ mph & $F = 2358$

$gd/U^2 = .0385$

$gF/U^2 = \frac{32.2 \times 2358}{5223} = 14.54$

from fig. 1, $gH/U^2 = .0085$

Equivalent Wave Height:

$H_e = \frac{.0085\ U^2}{g} = 1.38'$

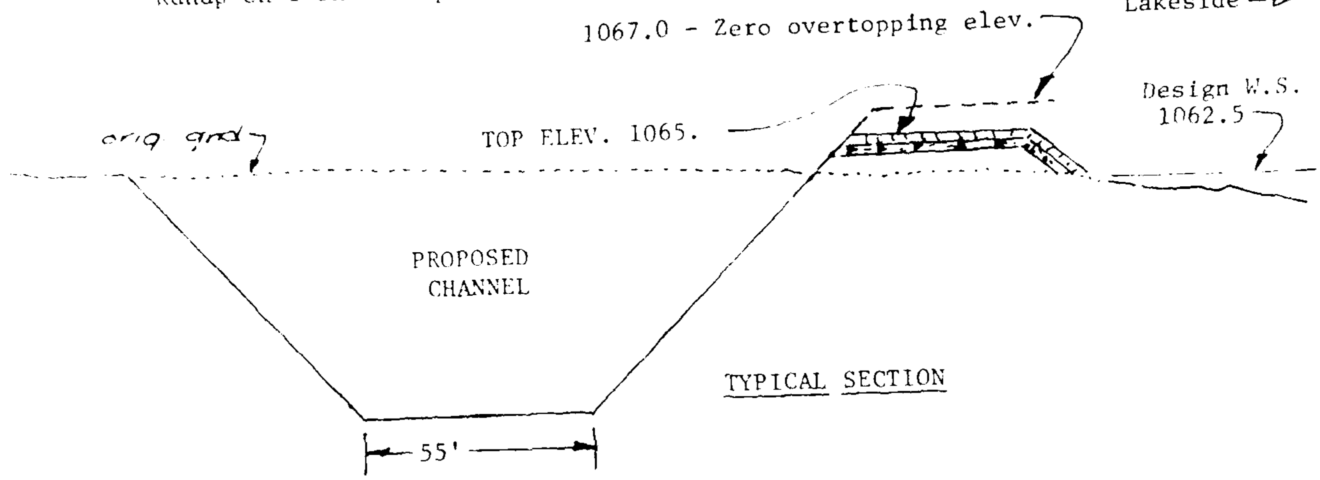
from eq. 12 $\quad G_i = \frac{H_e}{H_{sm}} = \frac{1.38}{2.03} = 0.679$

Decayed wave ht $= H_D = H_m - G_i\ (H_m - H_{sm}) = 4.9 - .679(4.9 - 2.0) = 2.9'$

$\underline{H_D = 2.9'}$

$\underline{T = 4.8 \text{ sec.}}$

Runup on 1 on 2 slope of Protective Dike



Design Wave $H = 2.9'$, $T = 4.8$ sec., $L_o = 118'$ $d/L_o = 4/118 = .034$

$H/H'_o = 1.098$ $H'_o = 2.9/1.098 = 2.6'$ $H'_o/gT^2 = .0035$

Rubble Slope $R/H'_o = 1.03$, $R = 2.7$ } 1 on 2 slope
Smooth Slope $R/H'_o = 2.10$, $R = 5.5$ }
$1.03/2.10 = 0.49$ $R_c = .49 \times 5.5 = 2.7$

$d_s/H'_o = 2/2.6 = .77$ $R/H'_o = 1.65$ { Riprap Slope 1 on $1\frac{1}{2}$
Riprap $R = 1.65 \times 2.6 = 4.3'$
$R_c = 4.3 \times 1.15 = \underline{4.9'}$
Smooth 1 on $1\frac{1}{2}$, $R/H'_o = 3.4$, $R = 3.4 \times 2.6 = 8.8'$ { Smooth
fig. 7-10 SPM $R_c = 1.15 \times 3.4 = 3.9$, $R_c = \underline{10.1}$
$4.9/10.1 = .49$

Smooth 1 on 2, $R/H'_o = 3.1$ $R = 3.1 \times 2.6 = 8.1 \times 1.15 = 9.3$
Riprap Slope 1 on 2 $R = 9.3/10.1 \times 4.9 = \underline{4.5'}$
Top Elev. Zero Overtopping = $4.5 + 1062.5 = \underline{1067.0}$

Breaking Wave

Bottom Slope - Lakeward .0045

$H_b/H'_o = 0.90$ $H_b = .9 \times 2.6 = 2.3'$

$H_b/gT^2 = .0031$ $\beta = 1.27$ min. = 2.9
$\alpha = 1.50$ max. = 3.5

EQ. 4-44 SPM $Q = 2 \times 10^5 H_b^2 = 2 \times 10^5 \times 2.3^2 = 1{,}058{,}000$ c.y./yr./mi.

$$\frac{1{,}058{,}000}{5280} = 200 \text{ c.y. /ft./yr.} = 0.548 \text{ c.y./day/ft.}$$

Length of Channel Affected = 1500'
Quantity of Drift/Day in Channel = $1500 \times .548 = 822$ c.y.

Conclusion: It appears possible that during one storm occurring under the given conditions that up to 800 cubic yards of materials per day could be deposited in the channel due to wave action. These conditions assume that no berm protection has been constructed. Such a volume would fill the channel bottom with sediment to a depth of 1 foot for a length of 400 feet. This event would represent a 20-year storm from any direction. The chance of a storm of this velocity blowing from the critical direction, N53°E, is 14% in any given year. In July, this drops below 7%. Thus, only infrequent overtopping of the protective berm will occur, and the combined deposition in the proposed channel from wave overtopping and sediment from currents through the channel is expected to be less than 100 cubic yards per year.

Design Wave - Channel Entry

Design for W.S. Elev. = 1055.5 + 0.92 = 1056.4

Water depth varies:

at lakeward edge	-	8.0' d_i	
at channel entry	-	6.4'	Length = 3750'
AV.		7.2'	Δd = 1.6'

Wind @ 52 mph H_i = 4.9'
T = 5.1 sec.

$0.25\ d_i = 2.0'$ $\quad \Delta d < .25\ d_i$ $\quad$ o.k.

Assume that channel has minor marsh grass and weed growth, ie. something less than curve B, fig. 13, - about ½, (CETA 77-6, Camfield)

$$gd/U^2 = \frac{32.2 \times 7.2}{(76.27)^2} = \frac{231.84}{5817} = .0399$$

fig. 1 - $gF/U^2 = 300$, $gH/U^2 = .013$

$F = 54{,}196'$ $\quad H_{sm} = 2.35'$

$H_m = 0.78 \times 7.2 = 5.6'$

$$\text{Reductions} = R_i = \frac{H_m - H_i}{H_m - H_{sm}} = \frac{5.6 - 4.9}{5.6 - 2.4} = \frac{0.7}{3.2} = 0.219$$

$H_{ie} = R_i H_{sm} = .219 \times 2.4 = 0.53$ (Equiv. wave ht.)

to fig. 1. for $gH_{ie}/U^2 = \frac{32.2 \times 0.53}{5817} = .0029$

$gd/U^2 = .0399$

$gF_e/U^2 = 0.65$ $\quad F_e = \frac{.65 \times 5817}{32.2} = 117.4'$

Equivalent Fetch

$f_f = 0.3 \times ½ = 0.15$ for d = 7.2'

for $f_f = .01$, $\frac{f_f\ H_i\ \Delta x}{d^2} = \frac{.01 \times 4.9 \times 3750}{7.2^2} = 3.54$

$f_f = .15, \qquad = \frac{0.15 \times 4.9 \times 3750}{7.2^2} = 53.1$

For T = 5.1 sec. & d = 7.2 feet

$$\frac{2\pi d}{gT^2} = \frac{2\pi \times 7.2}{32.2 \times 26.01} = .054$$

from fig. 14

$K_{f_{.01}} = 0.610 \qquad \alpha_r = \frac{1 - K_{f\alpha}}{1 - K_{f_{.01}}}$

$K_{f_{.15}} = 0.095$

$$\alpha_r = \frac{1 - .610}{1 - .095} = \frac{.390}{.905} = .431$$

$$F_\alpha = \alpha \Delta x = .431 \times 3750 = 1616 \text{ ft.}$$

Total Fetch: $F = F_e + F_\alpha = 117 + 1616 = 1733$ ft.

$gd/U^2 = .0399$

$gF/U^2 = \frac{32.2 \times 1733}{5817} = 9.59 \quad \therefore \quad gH/U^2 = .0076$

Equiv Wave Ht, $H_e = \frac{.0076 \times U^2}{g} = \frac{.0076 \times 5817}{32.2} = 1.37'$

Fractional Growth $= \frac{H_e}{H_{sm}} = \frac{1.37}{2.35} = 0.583 = G_i$

Eq. 13 $\quad H_\eta = H_m - G_i \, (H_m - H_{sm})$

$H_\eta = 5.6 - .583\,(5.6 - 2.4) = 5.6 - 1.9 = 3.7'$

$\therefore \; \underline{H_\eta = 3.7'}$

$\underline{T = 5.1 \text{ sec.}}$

Runup $\quad L_o = 133 \qquad d/L_o = 7.2/133 = .054, \quad K_s = 1.01$

$H/H'_o = 1.01, \quad H'_o = 3.7/1.01 = 3.7', \quad H'_o/gT^2 = .0044$

on 1 on 1½ riprap slope $\quad d_s/H'_o = 7.2/3.7 = 1.95$

$R/H'_o = 1.12, \quad R = 1.12 \times 3.7 = 4.1$

for elev. of water surface @ 1056.4

4.1

zero overtopping elev.= 1060.5

Design Wave for Riprap Entry = <u>3.7 ft - non breaking</u>

Design Water S. Elev. = 1062.5 (20 yr) (1929 Adj.)

Water Depth Varies: lakeward - 14.1 $\quad L = 3750$

channel entry $\underline{13.5}$ $\quad \Delta d = 1.6$

AV = 13.3

Reference:
CETA 77-6 $\quad$ wind 52 m.p.h. $\quad H_i = 5.6'$

$F = 136{,}000 \quad T = 5.3$ sec. $\quad .25\, d_i = .25 \times 4.1 = 3.5'$

$d = 19.2 + 5.8 = 25'$ (Av.) $\quad \Delta d < .25\, d_i$ o.k.

Assume same condition of bottom as shown for low water.

$$gd/U^2 = \frac{32.2 \times 13.3}{5817} = .074$$

fig. 1: max. sig. wave ht: $gF/U^2 = 1000, \quad gH_{sm}/U^2 = .021$

$$H_{sm} = \frac{.021 \times 5817}{32.2} = 3.79'$$

$$H_m = 0.78d = .78 \times 13.3 = 10.4'$$

Reduction: $$R_i = \frac{H_m - H_i}{H_m - H_{sm}} = \frac{10.4 - 5.6}{10.4 - 3.8} = \frac{4.8}{6.6} = 0.73$$

$$H_{ie} = R_i H_{sm} = .73 \times 3.8 = 2.8'$$

fig 1: $gH_{ie}/U^2 = .0155, \quad gd/U^2 = .074$

$$\therefore\ gF_e/U^2 = 58 \quad \& \quad F_e = \frac{58 \times 5817}{32.2} = 10{,}478'$$

Friction factors:

$$f_f = 0.15 \quad \& \quad d = 13.3'$$

for $f_{.01}$ $$\frac{f_f\ \Delta \times H_i}{d^2} = \frac{.01 \times 3750 \times 5.6}{13.3^2} = 1.19$$

for $f_{0.15}$ $= 17.9$

For T = 5.3 sec, $\quad d = 13.3$

$$\frac{2\pi d}{gT^2} = \frac{2\pi \times 13.3}{32.2 \times 5.3^2} = \frac{83.57}{904.5} = .092$$

Decay Factors:

from fig. 14

for $f_{.01}$, $K_f = 0.857$

$f_{.15}$, $K_f = 0.240$

$$\alpha_r = \frac{1 - K_f}{1 - K_{f.01}} = \frac{.143}{.76} = .188$$

$F_\alpha = \alpha \Delta x = .188 \times 3750 = 705'$

$F = F_e + F_\alpha = 10,478 + 705 = 11,183$ ft

$gF/U^2 = \dfrac{32.2 \times 11,183}{5817} = 61.9$; given $gd^2/U^2 = .074$

$\therefore\ gH/U^2 = .0156$ & $H_e = \dfrac{5817 \times 0156}{32.2} = 2.8'$

$H_D = H_m - C_i\ (H_m - H_{sm})$ where $C_i = H_e/H_{sm} = 2.8/3.8 = .74$

$H_D = 10.4 - .74\ (10.4 - 3.8) = \underline{5.5'}$, $\underline{T = 5.3'}$

Compute Runup

$L_o = 5.3^2 \times 5.12 = 143.8$, $d/L_o = 13.3/143.8 = .0925$,

$H/H'_o = .9396$

$H'_o = 5.5/.9396 = 5.9'$ $\quad H'_o/gT^2 = 5.9/904.5 = .0065$

$d_s/H'_o = 12.5/5.9 = 2.1$

R/H'_o on smooth 1 on 2 slope =

$$\left.\begin{array}{l} d_s = 1.5,\quad R/H'_o = 2.20 \\ d_s = 3.0,\quad R/H'_o = 1.93 \end{array}\right\} \begin{array}{l} d_s/H'_o = 2.1, \\ R/H'_o = 2.02 \end{array}$$

R/H'_o on Rubble Slope (1 on 2) = 0.83

For riprap slope 1 on 2 $\quad R/H'_o = \dfrac{.83 + 2.02}{2} = 1.43$

$R = 1.43 \times 5.9 = 8.4'$ $\quad F = 1.39$ $\quad R = 1.35 \times 8.4 = \underline{11.3'}$

Compare Smooth vs Rubble with actual riprap slope : 1 on 1½

$$\left.\begin{array}{l} \text{for } d_s = 1.5,\quad R/H'_o = 2.44 \\ \quad d_s = 3.0,\quad R/H'_o = 1.90 \end{array}\right\} \text{where } d_s/H'_o = 2.1,\ R/H'_o = \frac{.83 + 2.02}{2}$$

$= 1.[illegible]$

Rubble slope of 1 on 1½ $\quad R/H'_o = 0.91$

$$R/H'_o \quad \frac{3.09 + 0.91}{2} = \underline{2.[illegible]}$$

Riprap slope of 1 on 1½, $R/H'_o = 0.88 \times 1.39 = 1.\underline{22}$

(k)

Apply correction of 1.22/[illegible].0 t[illegible] above figure

For 1 on 2 slopes as noted in preceding $R/H'_c = 1.43$

$K_e = 1.22/2.0 = 0.61$ $\therefore$ R/H'_o for 1 on 2 slopes =

$.61 \times 1.03 = 0.87$

$\therefore$ $R = 0.87 \times H'_o = .87 \times 5.9 = \underline{5.1}$

Zero overtopping @ $1062.5 + 5.1 = 1067.6$

Set top of dike at 1065.0 throughout project. With a top width of at least 10 ft., overtopping will be minimal and sedimentation of the channel is prevented. It should be noted that the frequency of occurrence of damaging storm winds (upwards of 11 knots) is only 2.3%, while winds of all velocity ranges occur a scant 11.2% of the time. This probability makes it evident that a protective berm may not be justified solely on the basis of a 20-year design frequency, the common small-boat harbor design standard. However, it will also provide pedestrian access to a park area as well as a use for some excavated material.

Assume Following Conditions:

1. Channel is newly dredged
2. No weed growth present
3. 20 yr. storm takes place
4. Storm direction N43 E

From previous computation is given:

a. $H_i = 4.9'$, $T = 5.1$ sec.
   $H_m = 5.6'$, $F = 3750'$

what reduction for a wave of 4.5' over 3750' and

$f_f = .01$

$$\frac{f_f H_i \Delta x}{d^2} \qquad \frac{.01 \times 4.9 \times 3750}{51.84} = 3.5'$$

$$2\pi d/gT^2 = .054 \quad \therefore K_{f\,.01} = 0.63$$

$$\alpha_{01} = 1 - K_{f\,01} = 1 - .63 = 0.37 \qquad = 1.000$$

$$F_\alpha = 1.000 \times 3750 = 3750$$

$$F = F_e + F_\alpha = 3750 + 3750 = 7500'$$

$$gd/U^2 = \frac{32.2 \times 7.2}{5817} = .0399$$

$$gF/U^2 = \frac{32.2 \times 7500}{5817} = 41.5$$

$$\therefore gH/U^2 = .013 \quad \& \quad H_e = \frac{5817 \times .013}{32.2} = 2.35'$$

$$G_1 = H_e/H_{sm} = 2.35/2.35 = 1.00$$

$$H_p = H_m - G_1(H_m - H_{sm}) = 5.6 - 3.2 = \underline{2.4'}$$

$T = 5.1$ sec.

Channel Design Criteria

a. Width of channel: five times beam of largest boat to use harbor = 5x11'=55' channel bottom at elevation 1050.0 (6-foot draft at low water level)

b. Radius of bend or turn = twice length of longest boat to use harbor

c. Maximum channel and berm slope = 1 on 2 to 1 on $1\frac{1}{2}$

References used

a. Shore Protection Manual, CERC, 1977

b. Small Craft Harbor - Design, Construction and Operation. Special Report #2, CERC, 1974

c. Warroad Small Boat Harbor Channel Study - March 1977 for NCS by Hickok and Assoc., Mpls.

d. Lake of the Woods Lake Levels - 1909-1978, St. Paul District COE

e. Wind Summaries, Kenora Ontario and International Falls, MN. USAFETAC Air Weather Service, 1976.

f. A Method for Estimating Wind-Wave Growth and Decay in Shallow Water with High Values of Bottom Friction, CETA 77-6, Camfield.

FLUSHING OF MOORING BASIN

Construction of a new channel entry to the Warroad River may aid in preventing mooring basin stagnation from taking place within the subject marina. Flushing may occur during times of storms, when wind and wave action may induce a current from the existing entry to the north to the proposed river entry on the south or vice versa. Groundwater conditions in this area may also aid natural flushing by causing water to flow from the land area around the marina toward the lake. Wind setup may cause the lake level around Warroad to drop over a short period, and this action would help drain the mooring basin.

Depending on the frequency of the above occurrences, flushing of the existing harbor basin may or may not be adequate to meet State of Minnesota standards. The situation should be observed and tested periodically to determine whether mechanical means of basin flushing may be required.

LITTORAL DRIFT AND SHORELINE CHANGES

Dredging records for the Warroad River channel indicate an average removal rate of 11,000 cubic yards per year throughout the channel length of 11,000 feet. The major portion of this amount is dredged from the channel beginning at the junction of the jetty with the land and continuing lakeward about 1 mile. The bulk of the dredged materials is probably lake sand moved into the channel by wave action. The Warroad River apparently makes a minor contribution of about 1,000 cubic yards per year.

A bar has formed about one-half mile offshore. The bar originates near Springsteel Point and continues southward beyond the Warroad River channel. It is probably the result of wave action and changing lake levels. Ice action apparently does not play an important part in the shore formation. Shoreline change does not appear to be significant as evidenced by aerial photo comparisons. Because the important wave action occurs a half mile offshore and because shoreline change is minor, littoral transport is a negligible factor affecting the Warroad River channel at or about the proposed new channel entrance. Very little longshore transport takes place between the offshore bar and the shoreline, the intervening area being heavily vegetated with aquatic plants.

In summary, the longshore movement of materials in the harbor site area is a minor phenomenon largely restricted to an area lakeward of the offshore bar noted in the previous paragraphs. It has little influence on the proposed channel project.

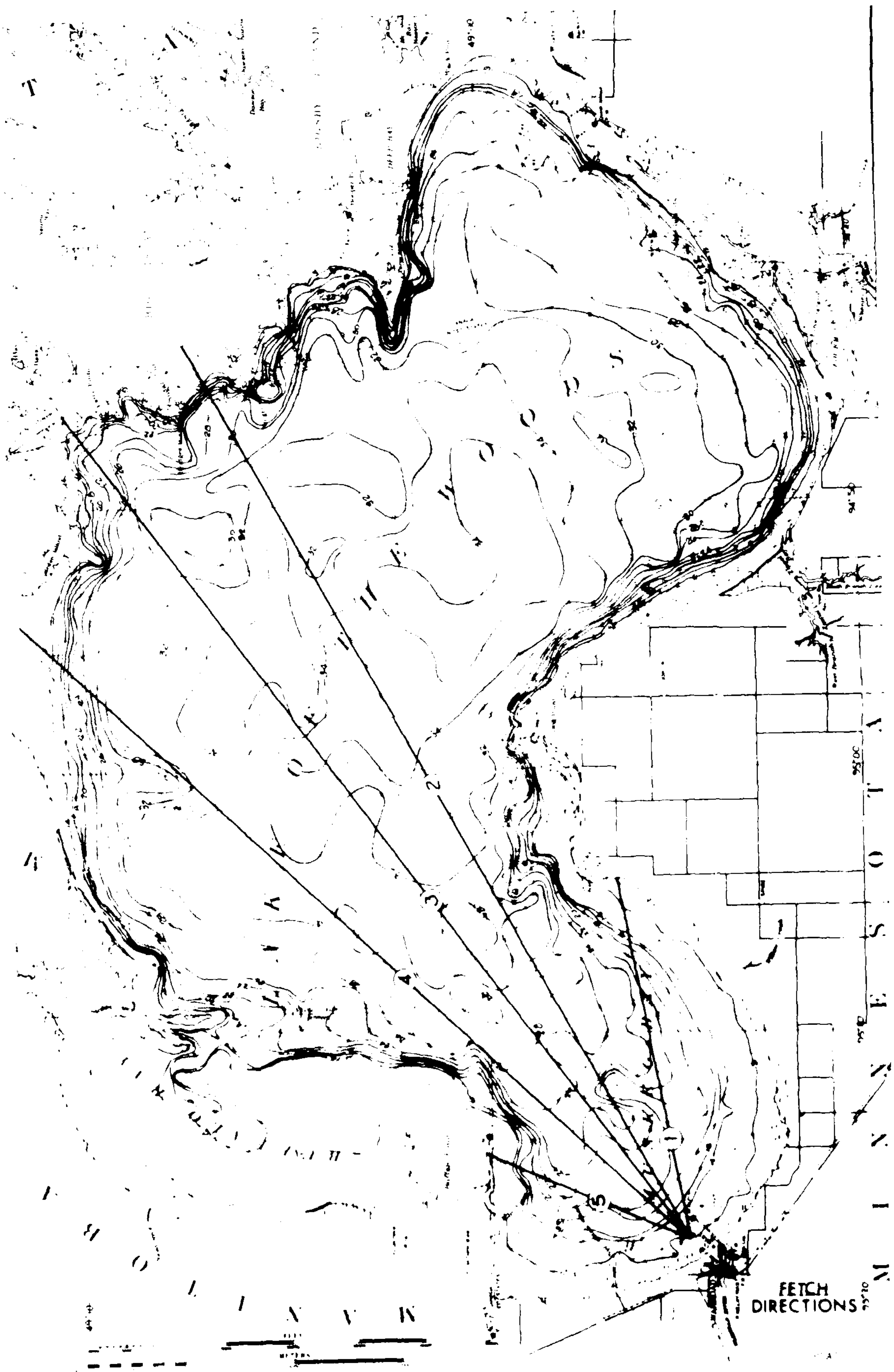

FETCH
DIRECTIONS

TABLE I
WIND-WAVE DATA

FETCH NO	FETCH DIRECTION	SIMPLE FETCH DISTANCE	AVERAGE DEPTH (ft)	WIND SPEED (mph)	SHALLOW WATER WAVE DATA		DECAYED WAVE AT STRUCTURE	
					H_i	T	H ①	T
1	N79°E	10.4 miles	14.3	52	3.7′	4.3sec		
2	N61°E	29.9 "	22.5	"	5.3′	5.2 "	2.9′	4.8sec
3	N53°E	30.5 "	17.7	"	4.7′	5.1 "	2.9′	4.8 "
4	N43°E	25.8 "	19.2	"	4.9′	5.1 "	3.7′	5.1 "
5	N23°E	6.4 "	14.1	52	3.6′	4.0 "		

① Decayed waves shown are derived from shoaling waves of H_i = 4.0′, T = 4.8sec. for fetches 2 & 3. Values of H_i (for 20yr occurrence) exceed values of H_m for this wave approach and fetch direction. See TP-77-6 by Camfield, CERC.

TABLE II
WIND SUMMARY

	ALL MONTHS						JUNE						JULY						AUGUST					
	DIRECTION			% TIME			DIRECTION			% TIME			DIRECTION			% TIME			DIRECTION			% TIME		
	1	2	M	1	2	M	1	2	M	1	2	M	1	2	M	1	2	M	1	2	M	1	2	M
ALL WINDS	W NW	S SE	NNE ENE	27.2	19.9	11.3	S SE	W NW	NNE ENE	24.9	22.0	12.6	W NW	S SE	NNE ENE	26.7	22.4	8.2	S SE	W NW	NNE ENE	24.8	22.3	8.9
STORM "	"	"	"	10.4	5.4	2.4	"	"	"	5.7	11.1	2.2	"	"	"	7.3	4.3	0.5	"	"	"	4.6	5.5	0.9
CALM				8.7						11.1						14.2						13.7		

1 is major direction of all winds (west to northwest, etc)
2 is secondary direction winds (south to southeast)
M is direction of winds for Muskeg Bay.
% time refers to percent of time wind blows from direction indicated.
Calm indicates percent of time of calm for all directions.
Source of data is USAFETAC, AIR WEATHER SERVICE, FEB. 1976 for International Falls, Mn.

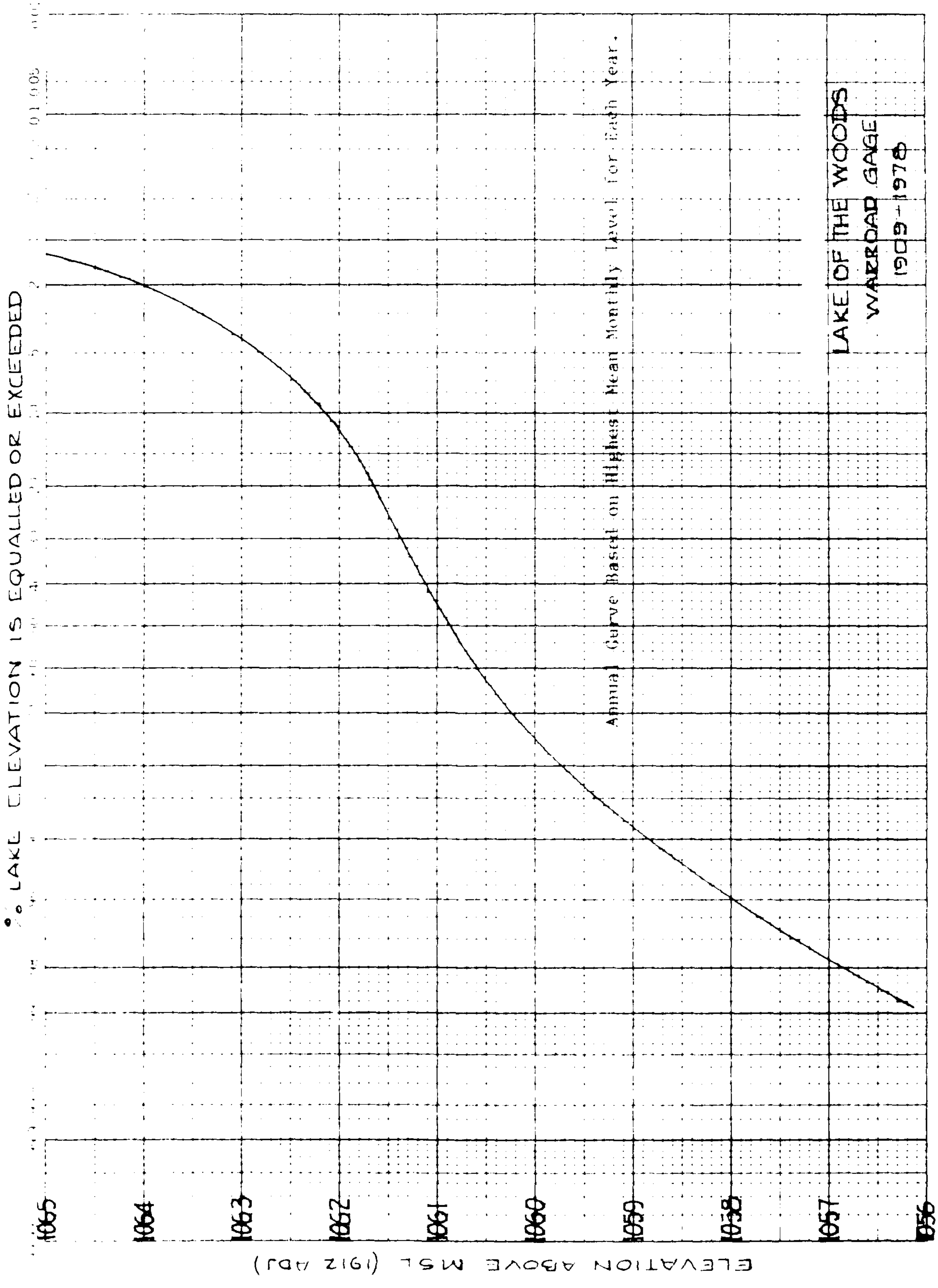

LAKE OF THE WOODS
WARROAD GAGE
1909-1978
Annual Curve Based on Highest Mean Monthly Level for Each Year.
% LAKE ELEVATION IS EQUALLED OR EXCEEDED
ELEVATION ABOVE MSL (1912 ADJ)
1065
1064
1063
1062
1061
1060
1059
1058
1057
1056

PLATE D-3

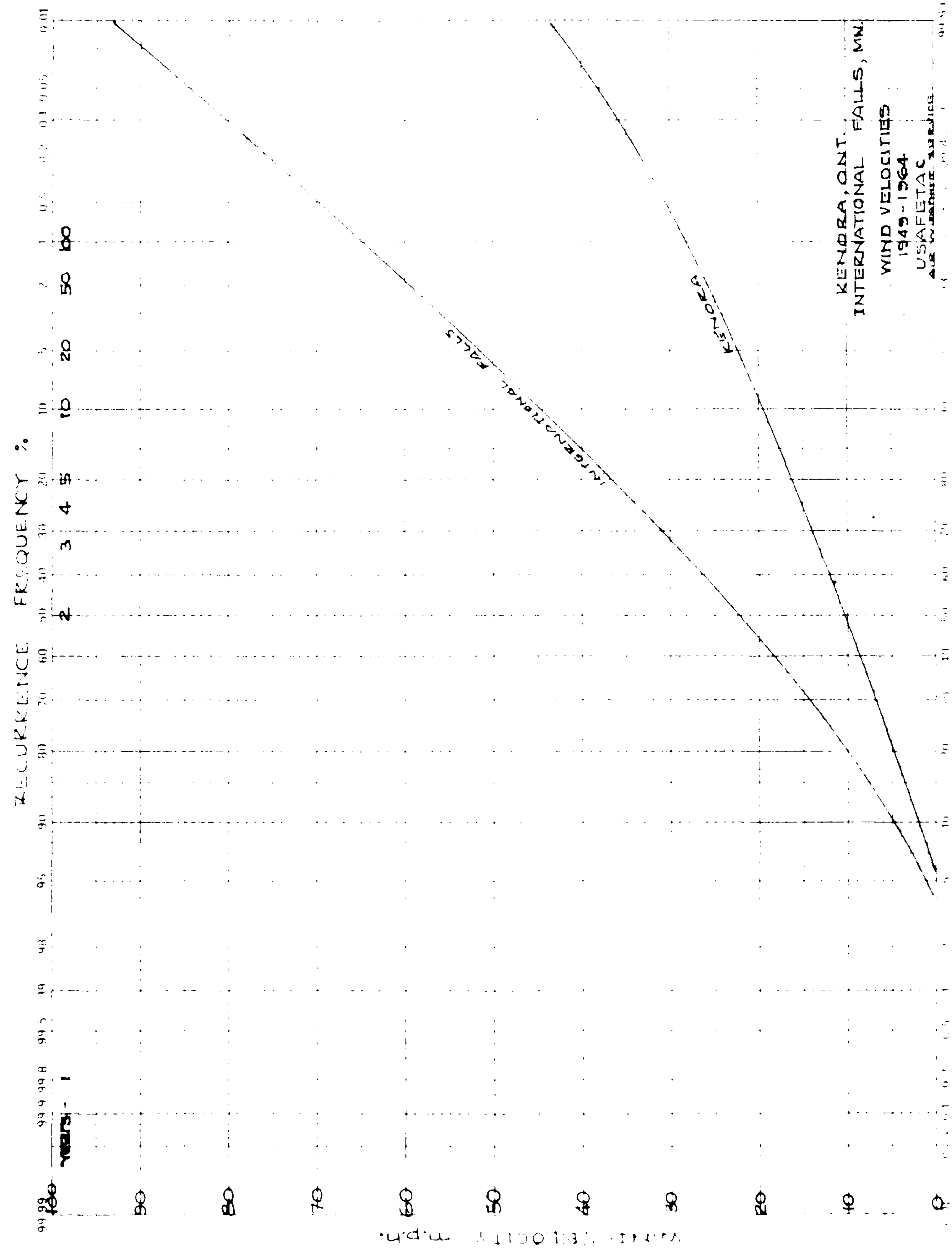
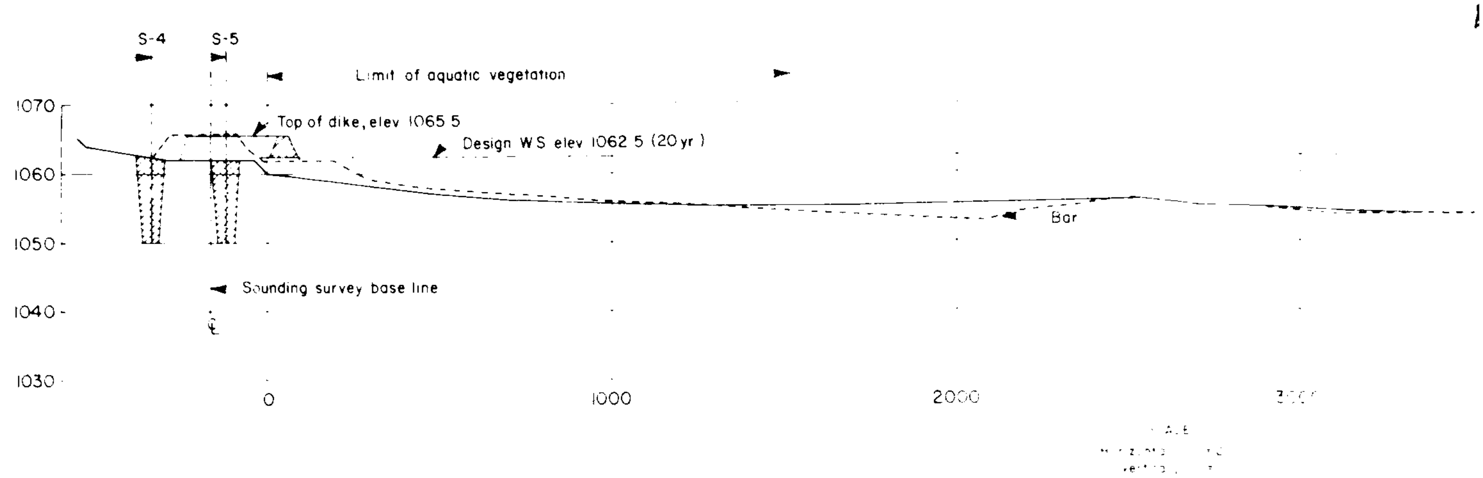

KENORA, ONT.
INTERNATIONAL FALLS, MN.
WIND VELOCITIES
1949-1964
USAFETAC
RECURRENCE FREQUENCY %
INTERNATIONAL FALLS
KENORA
m.p.h.

PLATE D-4

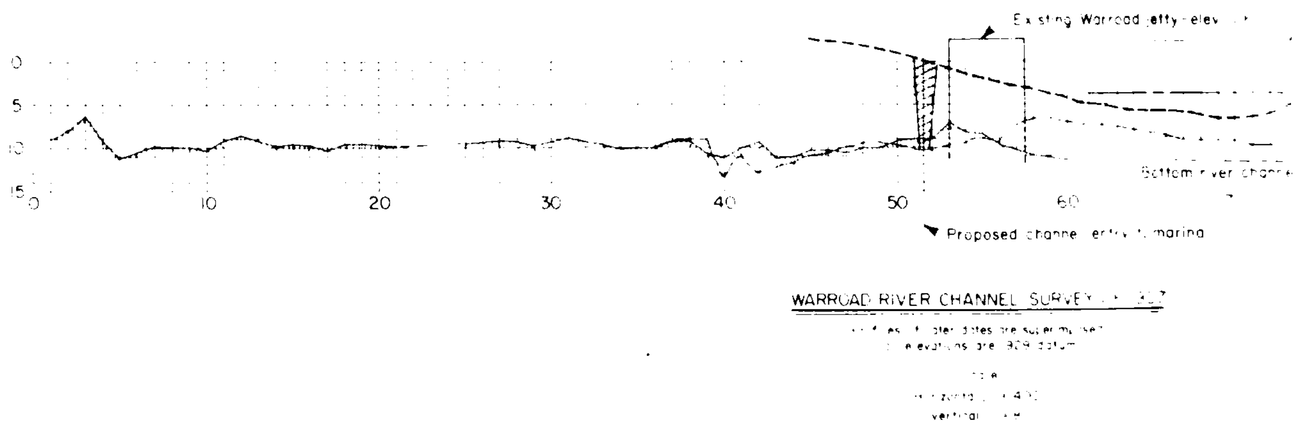
RANGE LINES

PLATE [illegible]

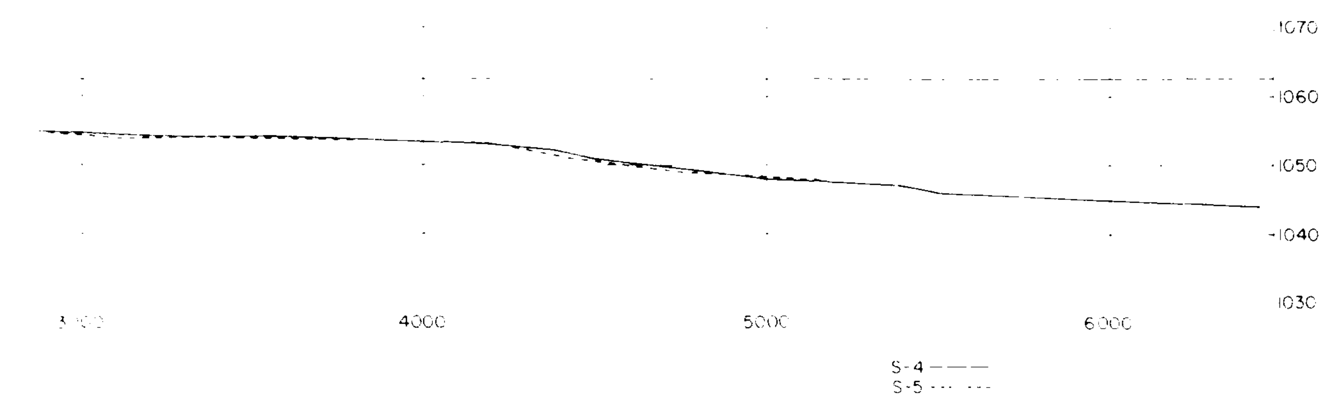
WARROAD SMALL BOAT HARBOR



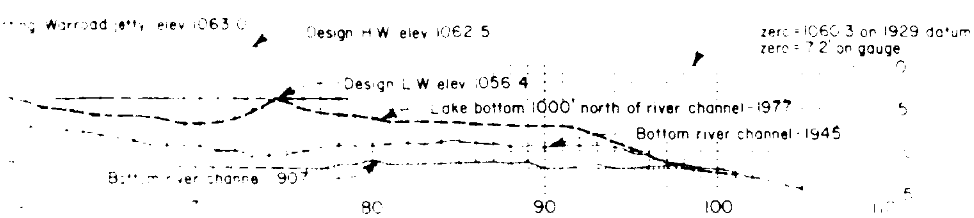
PROFILE OF CENTER LINE OF DREDGED CHANNEL

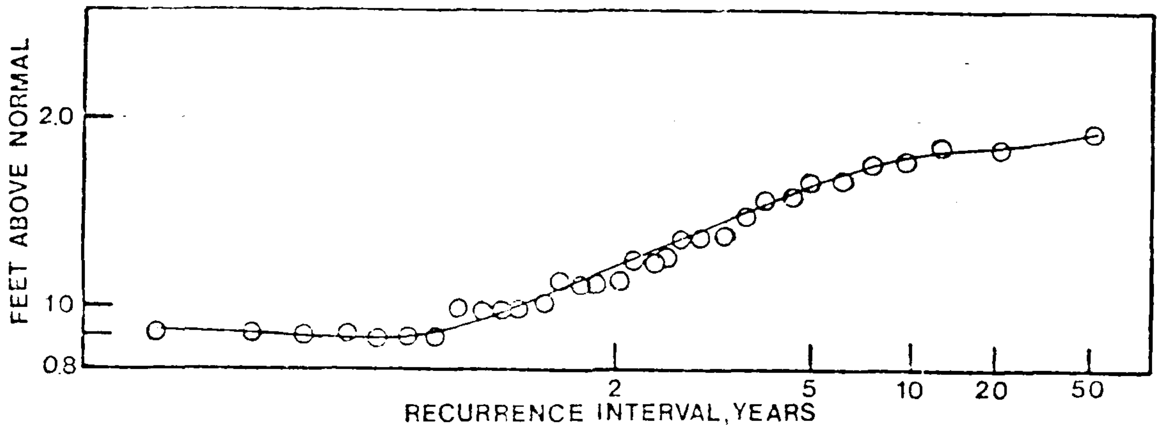


BOAT HARBOR



DREDGED CHANNEL



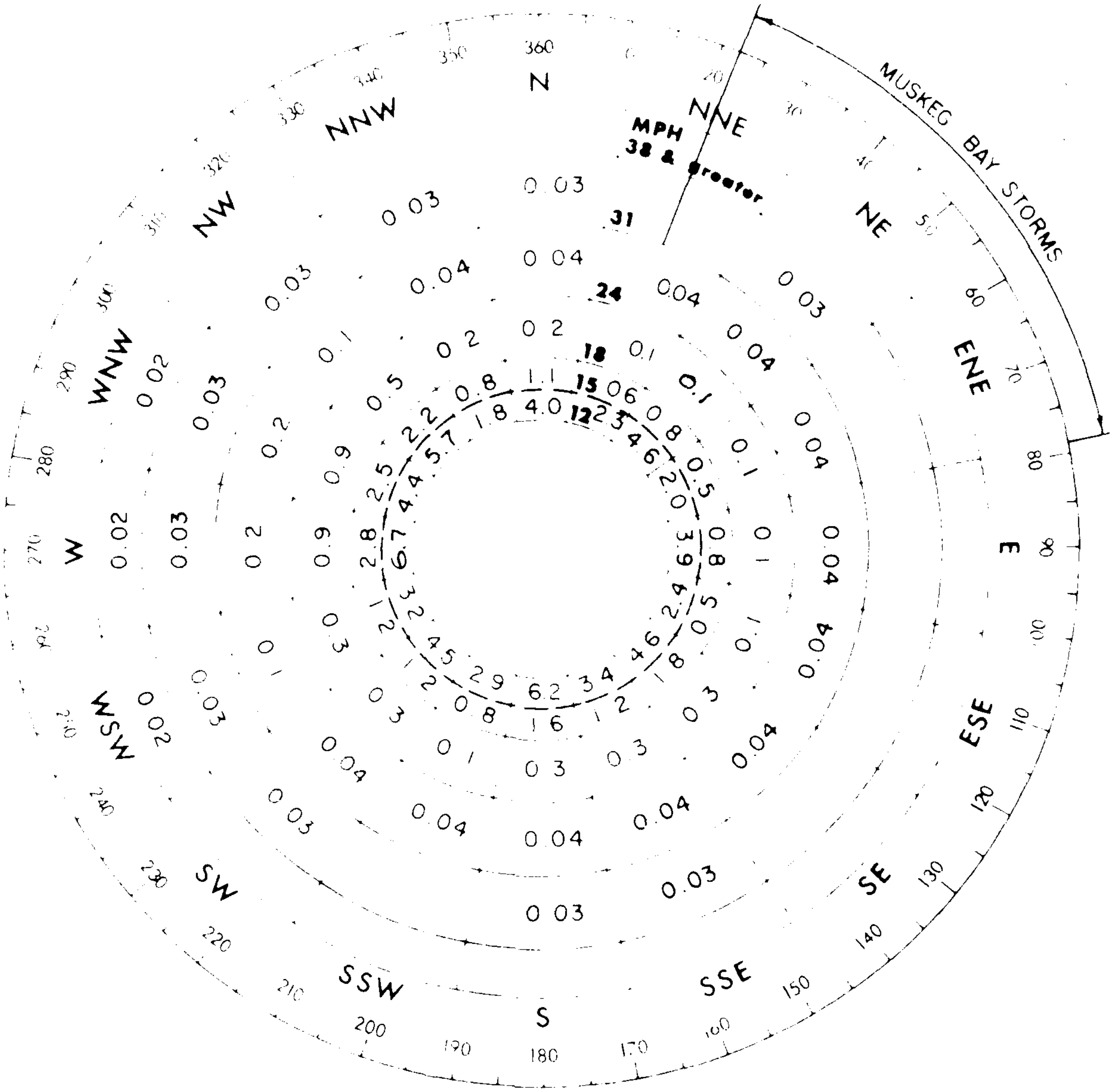


NOTE: Data was collected from 1925 to 1931 during ice free months

INFLUENCE OF WIND ON LAKE LEVELS

PLATE D-7

THE NUMBERS WITHIN THE SEGMENTS ARE THE PERCENTAGES OF TIME THE WIND BLOWS FROM THAT DIRECTION WITHIN THE INDICATED VELOCITY RANGES.



CALM 8.7%

WIND DATA PERIOD:
1949-1964

INTERNATIONAL FALLS, MINNESOTA

ALL MONTHS - ALL HOURS

USAFETAC AIR WEATHER SERVICE, FEB. 1976

PLATE D-8

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

A

P

P

E

N

D

I

X

E

TOPOGRAPHY, GEOLOGY, AND SOIL DATA

TABLE OF CONTENTS

PLATES

APPENDIX E

TOPOGRAPHY, GEOLOGY AND SOIL DATA

TOPOGRAPHY

Warroad is located on the flat lakebed of glacial Lake Agassiz. Local relief is typically provided by beach ridges which run east and northeast, marking successive Lake Agassiz shorelines. Many of these features rise abruptly about 50 feet above the surrounding plain. The closest notable ridges are 4 to 5 miles south of Warroad. One possible beach feature, Lone Pine Ridge, is located 2 to 3 miles west of Warroad.

The majority of the Warroad area consists of flat terrain, most of which was marsh and peat bog until drained and modified by man. Lake of the Woods marks the lowest local elevation at 1060± feet. The elevation at Warroad is about 1065. Lone Pine Ridge is one of the highest local areas at 1134 feet, using mean sea level as the datum.

GEOLOGY

Warroad and all of Roseau County are located along the eastern edge of glacial Lake Agassiz. This lake was formed when the regional, preglacial, northward drainage was blocked by the glaciers during the Wisconsin period of glaciation. Throughout its history, the elevation of Lake Agassiz varied with glacial advances, retreats, and various outflow levels. These changes are preserved in the beach ridges that define the numerous Lake Agassiz shorelines. Only remnants of Lake Agassiz exist today. Among these are Upper and Lower Red Lake, Lake Winnipeg, and Lake of the Woods.

The surficial materials at the project site consist of glacio-lacustrine and fluvial deposits, in addition to dredged material and other artificially placed materials. The borings indicate that lacustrine silts and clays, about 10 to 15 feet thick, overlie a glacial till in the western portion of the project area. To the east, the Warroad River or its ancestral version nas eroded the lacustrine material and deposited sands and gravels in their place. Numerous layers of peat occur intermittently in the lacustrine and fluvial sequences.

The till comprises a clayey sand overlying a sandy clay. The difference may be secondary, due to weathering, or primary, reflecting the initial composition.

Bedrock is not exposed in the Warroad area, though granitic bedrock occurs around elevation 975. This rock is veneered by a few feet of clayey, decomposed granitic material. The irregular bedrock surface slopes to the north and west. Some bedrock depressions contain outliers of possible Cretaceous sands and shales.

GENERAL

The proposed plan calls for a navigable route connecting the small-boat marina with Lake of the Woods. The proposed channel will connect the marina to the Warroad River. The Warroad River is an established and maintained navigation channel to Lake of the Woods.

The proximity of the proposed route to existing structures and wetlands requires a minimum total channel width from station 5+00 to the western end of the channel. The 55-foot navigable width plus side slopes constructed at 1V on 1.5H would be advantageous over this reach. From station 0+00 to station 4+50, where more area is available and foundation conditions are less desirable, side slopes of 1V on 2H are proposed.

SUBSURFACE EXPLORATION AND SOIL DATA

Subsurface exploration in the channel area consists of six machine borings taken between 29 November and 3 December 1977. Locations of borings are shown on plate 1 of the main report. Blow counts, moisture contents, and Atterberg limits are recorded on the boring logs. Boring logs are shown on plate E-1. Soil samples were tested by the Missouri River Division Laboratory.

Soils along the proposed channel can be categorized as three general types. The underlying material is composed of alternating strata of clays and sands free of organic material. On the eastern end of the project the inorganic clays and sands are overlain by a layer containing a majority of peat, organic silts, and clay. Dredged material makes up the surface over most of the area. Soil samples were visually classified and tested for moisture, mechanics, Atterberg limits, voids ratio, density, shear strength, and loss on ignition. These data are shown on plates E-2 through E-4.

SOIL ANALYSIS AND STRUCTURAL DESIGN CONSTANTS

Strength and other characteristics are sufficiently similar to justify grouping soil types into larger beds for the purpose of slope stability analysis. For example, the bed labeled PT on plate E-5 is a summation of layers made up of peat and soils with high percentages of peat and interspersed very thin strata of granular soils superior to peat. This bed was assigned a cohesive shear strength of 350 pounds per square foot. The strength was based on reports of testing and construction experience in Canada and California. These reports indicated a wide range of apparent strength for peat and peaty soils. The indicated design strength is conservative. The OL+PT bed where OL was the major constituent is assigned a cohesive shear strength of 250 pounds per square inch. This value is half of the lowest laboratory shear strength. See boring 77-14M on plate E-5 and sample 19 on plates E-2, E-3, and E-4. Granular material was assigned a very conservative shear angle of 25 degrees.

STABILITY ANALYSIS

Slope stability was investigated most intensely at the southeast end of the channel. Borings 77-14M and 77-15M show this area to have the poorest soil conditions. An elevation of 1054 was used for design low water surface. The piezometric surface was considered to be the same elevation as the lake. These are the most critical conditions. The stability analysis was performed by analyzing the end of construction case using the St. Paul District computer program No. 741-S8-5020 entitled "Noncircular Arc Slope Stability." The factor of safety was found to be 1.58. The results of the stability analysis are shown on plate E-5. Since the stability analysis was completed, the side slopes between station 0+00 to 4+50 have been reduced to 1V on 2H. This change adds to the factor of safety in the area considered the most critical.

A conservative check was made on the effects the swimming pool, sewage treatment plant, and proposed protective berm would have on slope stability. None of these structures was found to have any significant effect on the integrity of the channel.

SLOPE PROTECTION

Slope protection is required to prevent erosion of slopes by boat wakes. In addition, the peat and silt would be easily eroded by the small wind wave action and fluctuating water surface. This is especially true with the steep slopes required. The slopes will be protected by pavement formed in fabric. This method was chosen in part because it does not require dewatering. Pavement placed using this method conforms to irregularities in the excavated slope and will be used with a filter fabric. The finished surface will draw color from the surrounding environment. Mortar used for pavement will have a maximum final water-cement ratio of 0.4 and a compressive strength of not less than 4,000 pounds per square inch. The pavement will have a minimum average thickness of 3.5 inches and a minimum weight of 40 pounds per square foot. Except on the sidewalk and in the anchor trench, weep holes will be provided every 8 to 24 inches. A siphoning-type nonwoven filter cloth will be used under the pavement to facilitate drainage between weep holes and prevent piping through weep holes. The steep 1V on 1.5H slopes found over most of the channel make undesirable the use of conventional riprap. Because of the limited availability of riprap, the competitive price of pavement, and the more favorable unit price that can be expected with a larger quantity of pavement, riprap will be used only at the very ends of the channel to resist flanking (see plate E-6). The design detail for pavement is based partly on the experience of other Corps Districts that have successfully used this method for shore protection. Riprap of the following gradation is readily available and proposed for use:

Percent less than	Limits of stone weight in pounds
100	86-35
50	27-17
15	13-5

SETTLEMENT

Settlement will not be a problem. The only loading will be the protective berm which will require an average of approximately 2½ feet of fill and will be located a minimum of 15 feet from the channel.

DISPOSAL OF WASTE MATERIAL

All stripping unsuitable for use as topsoil, excavated material unsuitable as fill, and other waste material will be placed in disposal areas to be provided by local interests.

CLEARING AND STRIPPING

Structures and trees will be removed or cleared as necessary. All debris will be disposed of or stockpiled for removal prior to stripping. Where practical, existing topsoil will be stripped and stockpiled for landscape restoration.

TOPSOIL AND SEEDING

All areas within the construction limits except those areas covered by pavement, riprap, or crushed gravel will be covered with a minimum of 4 inches of topsoil and seeded. Topsoil will be salvaged from stripping where possible. Organic silts excavated from the southeast end of the project may be used as topsoil. Acquisition of topsoil will be the contractor's responsibility.

EXCAVATION PROCEDURE

Loads induced during construction will be strictly controlled. All material will be removed from the site as excavated. Except for fine grading and in the immediate vicinity of the marina, excavation equipment and equipment being loaded with material will operate on the center line of the channel. Excavation will proceed from the existing harbor to the marina where equipment cannot operate on the channel center line and where sliding damages would be minimized. Fine grading may be performed from the top of slopes provided the equipment used is only as heavy as needed to do the work.

CONCRETE AGGREGATE

Sand for use in grout can be processed from pits within a 15-mile radius of Warroad or from sources in the vicinity of Roseau. Pits tested and approved for concrete by the Corps of Engineers are located at Halma, Kittson County, Minnesota. Haulage distance is approximately 68 miles to the project. Following are the tested and approved sources:

a. Loeffler pit, SE¼ sec. 17, T 160 N, R 46 W, tested by MRD in March 1975 and used in construction of the Pembina, North Dakota, flood control project.

b. Steve Foerster pit, sec. 29, T 160 N, R 46 W, tested by MRD in January 1970 for the North Dakota Safeguard Missile Program.

At present, Warroad has two ready-mix plants. Both plants were inspected in 1974 by the Minnesota State Department of Transportation and the Department of Weights and Measures. Two other ready-mix plants are operating at Roseau, Minnesota.

STONE

An inspection for riprap-size stone was last made in March 1977. The best available source of 12-inch rock is the gravel pits at Halma, Kittson County, Minnesota. Haulage distance to the project is approximately 70 miles by truck. Other possible sources are fieldstone piles in the following areas:

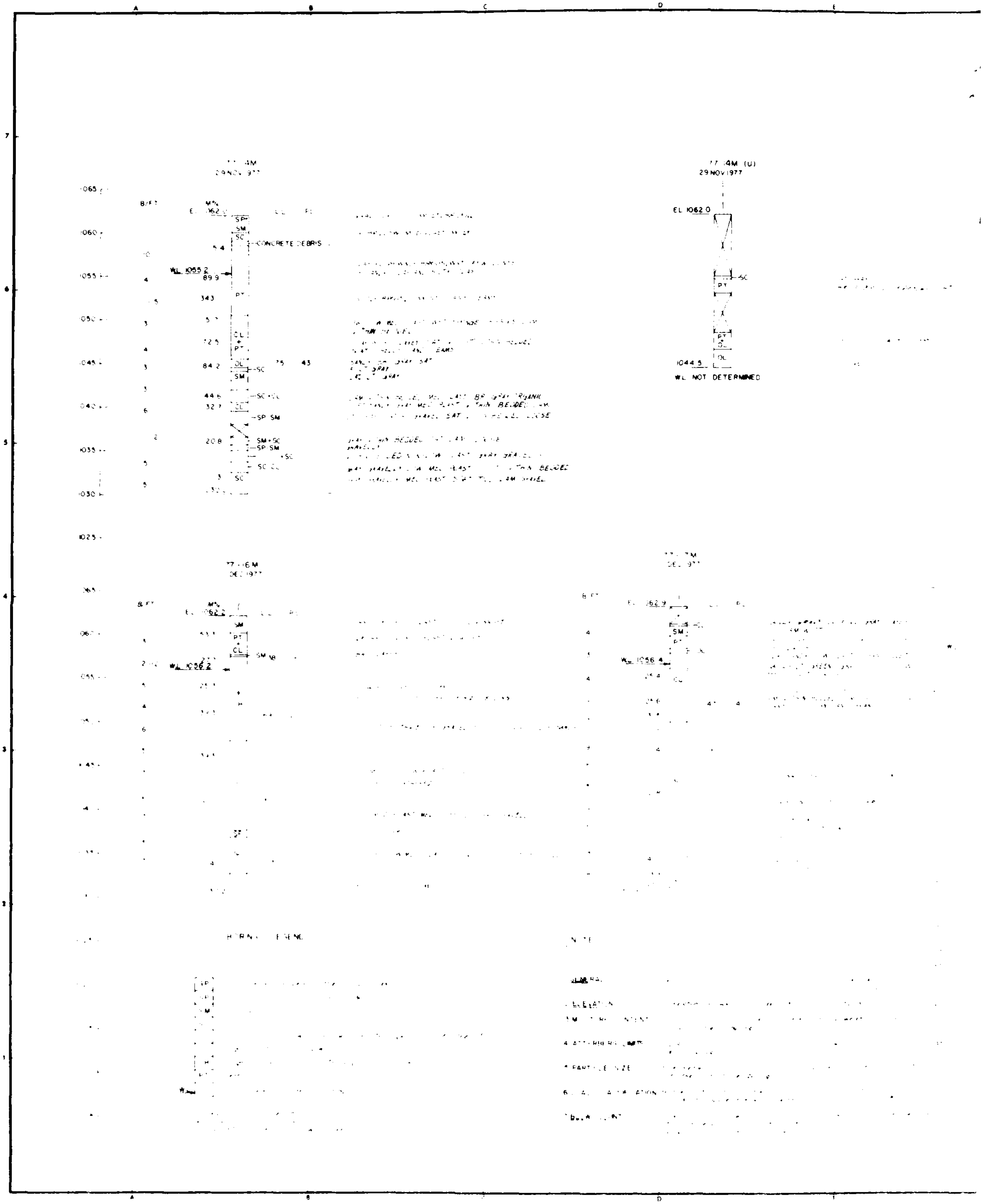
a. Along County Road 12, 5 miles south of Warroad. Average size of the rock is 3 to 6 inches with a 9-inch maximum size.

b. A glacial lake beach ridge located 13 miles south of Warroad. Numerous, small, 3- to 5-cubic yard piles lie along the north side of the beach ridge. The average size of the rock is from 3 to 6 inches with a maximum size of 9 inches.

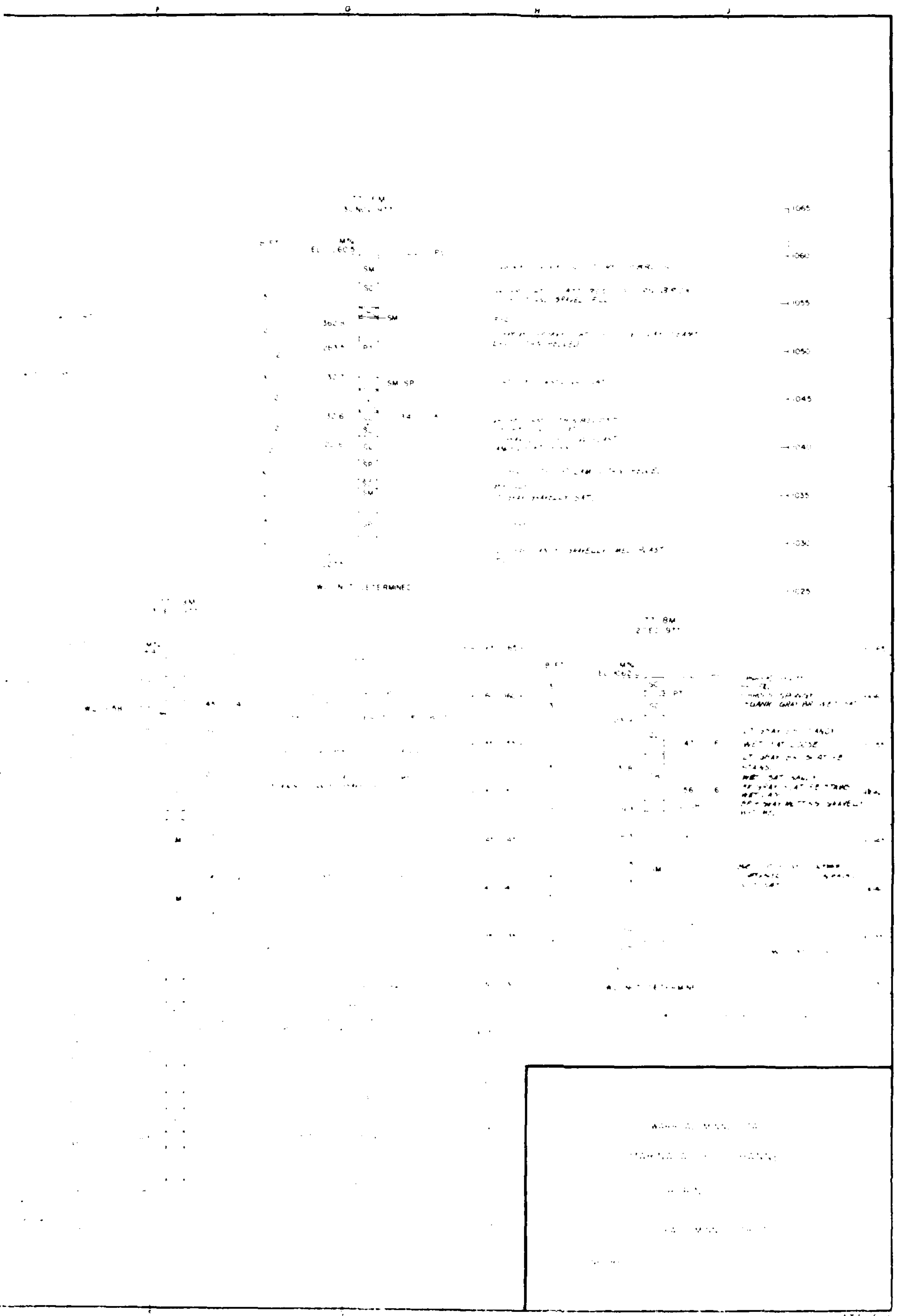
c. At Fox, along State Highway 89 and north of State Highway 11, where maximum size of rock is 12 inches. Haulage from Fox to Warroad is 30 miles.

d. At Greenbush, north of State Highway 11 and along County State Aid Road 7 for several miles. Maximum rock size is 12 inches. Truck haulage from Greenbush to Warroad is 48 miles.

For 3-inch gravel, 18 pits tested by the Minnesota Deprtment of Transportation lie within a 15-mile radius of Warroad. Several untested pits lie within the same glacial lake beach deposits. At Roseau, the Halverson pit, sampled by the District in 1969 and tested by Twin City Testing and Engineering, Inc., of St. Paul, conforms to Federal Specification SS-A-281b.



29 NOV 1977
EL 1062.0
WL 1055.2
CONCRETE DEBRIS
29 NOV 1977
EL 1062.0
1044.5
W.L. NOT DETERMINED
WL 1056.2
WL 1056.4
ELEVATION
PARTICLE SIZE



1065
1060
1055
1050
1045
1040
1035
1030
1025
SM
SC
SM SP

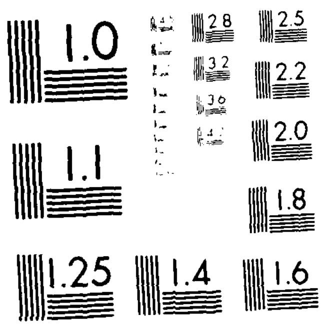
SOIL CLASSIFICATION RECORD SHEET

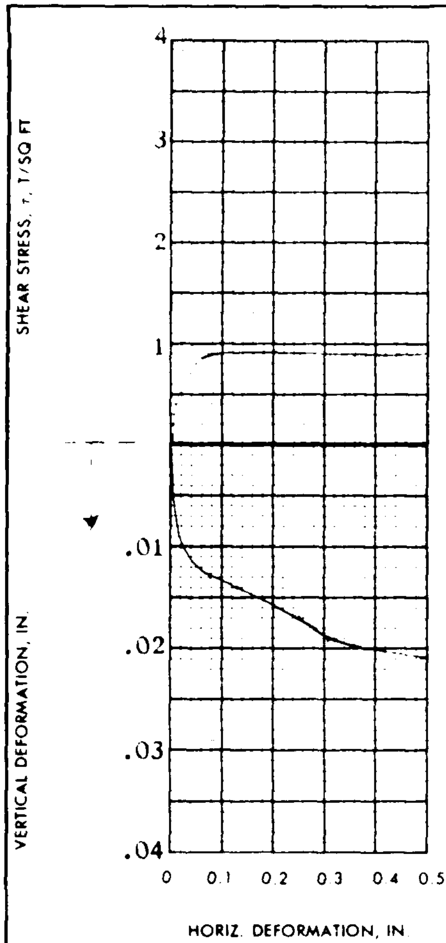
Project			Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

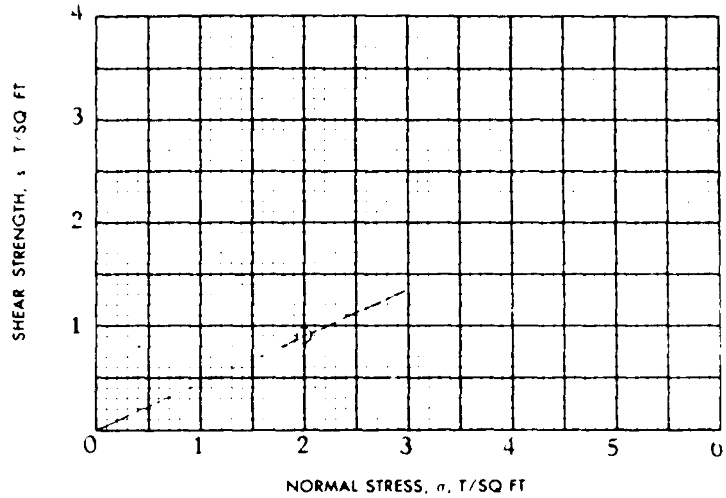
Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits)		Grading (Cumulative Percents Finer)					Gradation Curve Analysis					Classification Tech MEMO 3-357, May 67	Remarks
			LL	PI									C_u	C_c		

AD-A184 683 WARROAD CHANNEL PROJECT SECTION 107 DETAILED PROJECT REPORT WARROAD MINNESOTA(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JUL 80 3/4

UNCLASSIFIED F/G 13/2 NL


1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4
1.6





SHEAR STRENGTH PARAMETERS

φ = 24.2

TAN φ = 0.45

c = ______ T/SQ FT

[ ] CONTROLLED STRESS

[X] CONTROLLED STRAIN

TEST NO							
INITIAL	WATER CONTENT	w_o	43.2 %	%	%	%
	VOID RATIO	e_o	1.02			
	SATURATION	S_o	100 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	75.4			
VOID RATIO AFTER CONSOLIDATION		e_c	0.80			
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	38.8 %	%	%	%
	VOID RATIO	e_f	0.84			
	SATURATION	S_f	100+ %	%	%	%
NORMAL STRESS, T/SQ FT		σ	2.0			
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	0.90			
ACTUAL TIME TO FAILURE, MIN		t_f	400			
RATE OF STRAIN, IN./MIN		(x10^{-4})	3.8			
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	0.87			

TYPE OF SPECIMEN — 3.00 IN. SQUARE — 1.00 IN. THICK

CLASSIFICATION Clayey Peat, Pt (visual, 22% organic)

LL | PL | PI | G_s 2.44

REMARKS

PROJECT Warroad Harbor

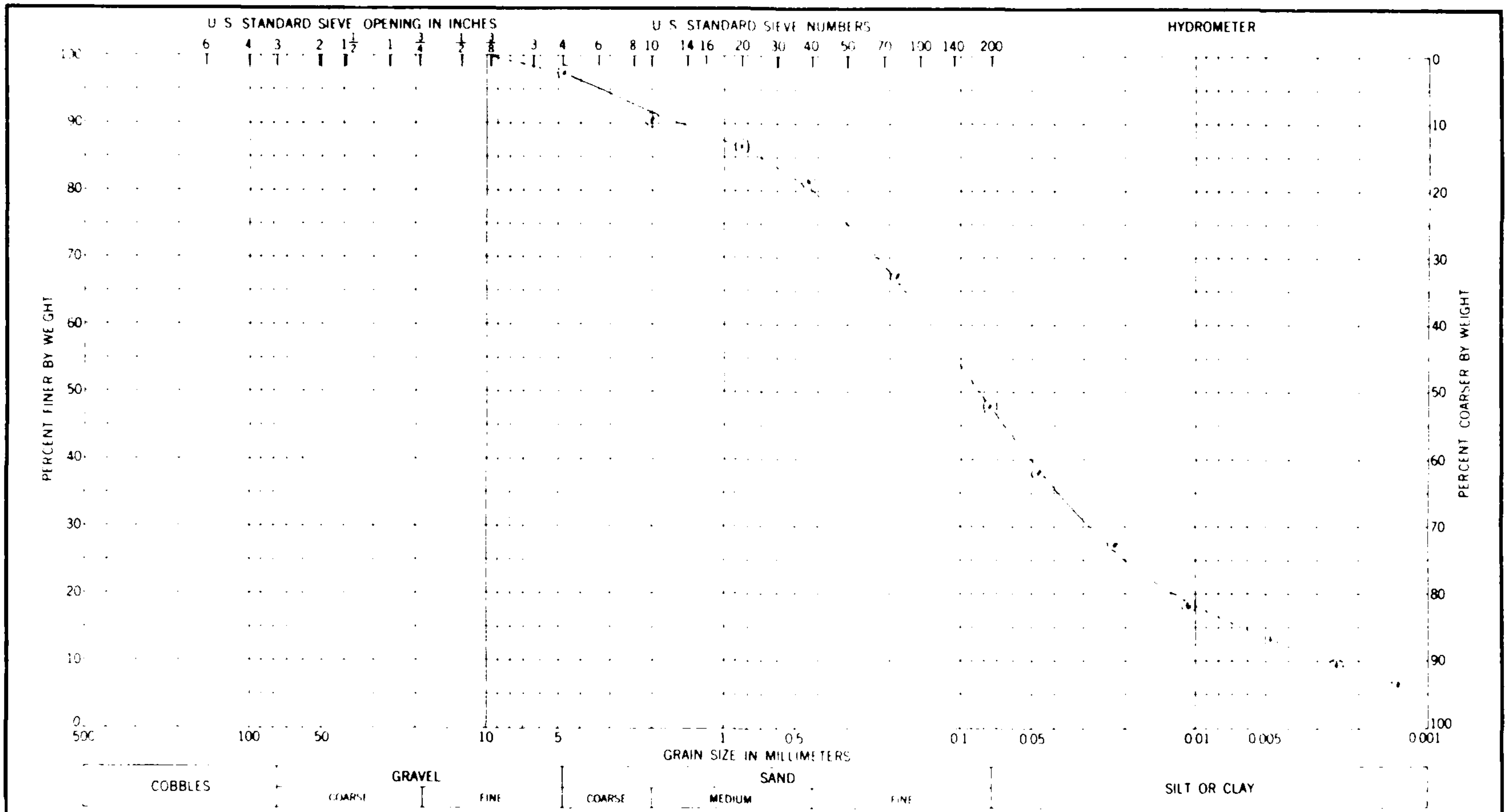
NCS-IA-78-21-ED-F

AREA MRD Lab. No. 78/12

BORING NO. 77-14M SAMPLE NO. 19

DEPTH 13.5 - 15.4 DATE 1? MAR '78

DIRECT SHEAR TEST REPORT



Sample No	Depth	Classification	Nat w %	LL	PL	PI
9	17.0 - 18.9	Clayey sand, SC-SM		17	11	0

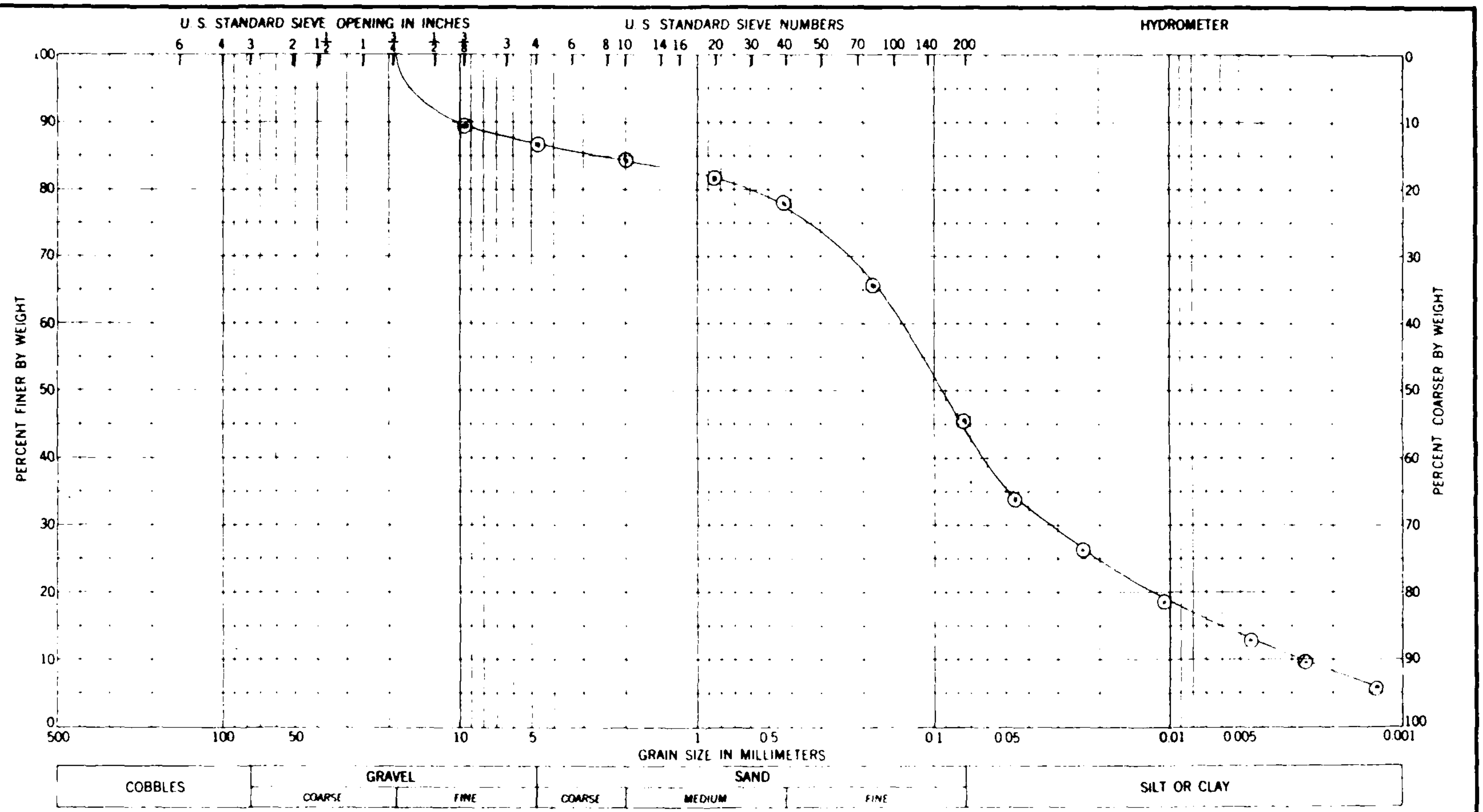
Project	Warroad Harbor NCS-IA-78-21-ED-F
Area	MRD Lab. No. 78 12
Boring No	77-19
Date	1 6 MAR 1978

GRADATION CURVES

ENG FORM MAY 2087

Figure 12

Plate E-2(c)



Sample No	Depth	Classification	Nat w %	LL	PL	PI
13	20.5 - 28.4	Silty sand, SM-SC		16	10	6

Project: Warroad Harbor
NCS-IA-78-21-ED-F

Area: MRD Lab. No. 78/12

Boring No: 77-19

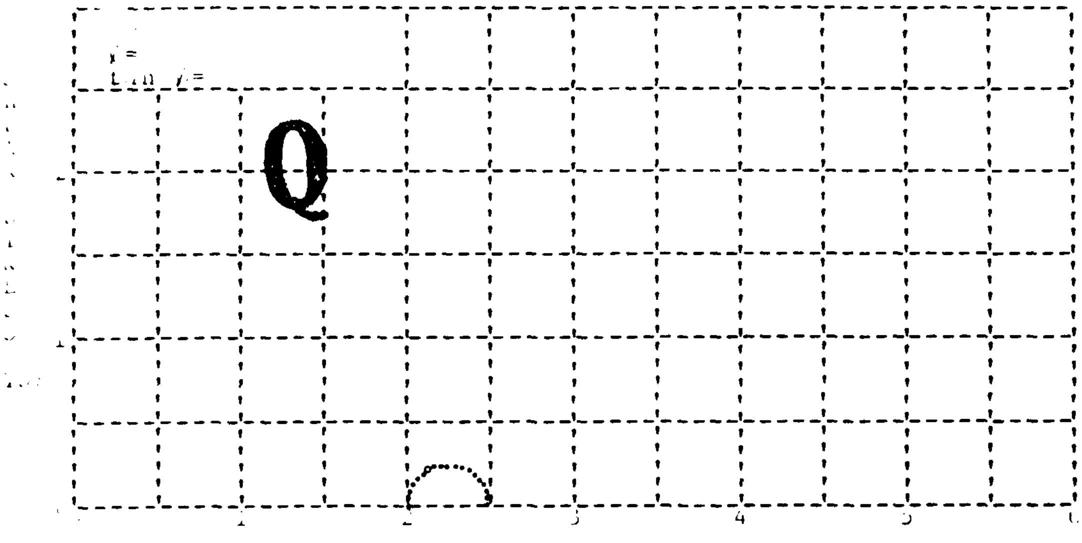
Date: 1 MAR 1978

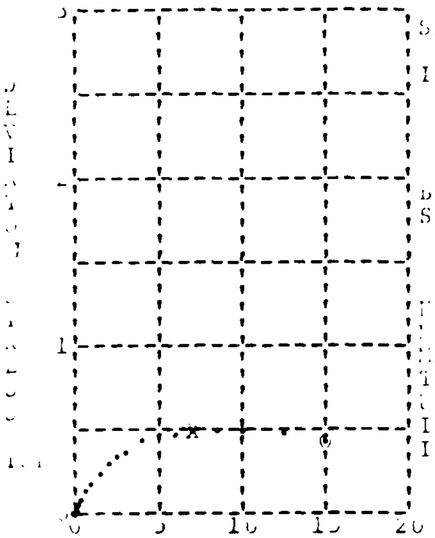
GRADATION CURVES

ENG FORM 1 MAY 63 2087

Figure 14

Plate E-2(d)





SPECIMEN NUMBER		1
INITIAL	WATER CONTENT,%	[illegible]
	DRY DENSITY,PCF	41.[illegible]
	SATURATION,%	97
	VOID RATIO	2.[illegible]
BEFORE SHEAR	WATER CONTENT,%	1[illegible]4.[illegible]
	DRY DENSITY,PCF	41.[illegible]
	SATURATION,%	[illegible]7
	VOID RATIO	2.[illegible]4
FINAL BACK PRESSURE,TSF		[illegible]
MINOR PRINCIPAL STRESS,TSF		2.[illegible]
MAX DEVIATOR STRESS,TSF		.4[illegible]
TIME TO MAX DEV, MIN		14
ULT DEVIATOR STRESS,TSF		.42
INITIAL DIAMETER,IN		1.3[illegible]
INITIAL HEIGHT,IN		2.[illegible]7

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Clayey Peat, Pt (visual, 22% organic)**

LL PL PI Gs= 2.44 TYPE SPECIMEN: [illegible] TYPE TEST [illegible]

REMARKS: MACHINE PRINT OUT
FORMAT AFTER ENG FORM 2089
DEVIATOR STRESS CORRECTED
FOR MEMBRANE RESTRAINT

Dark brown, soft consistency, slight odor. Direct shear specimen contained more clay than "Q" test.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-ED-F

BORING NO: **77-14M** SAMPLE NO: **19**

DEPTH: **13.5 - 15.4**

[illegible]: **78/12** DATE **16 MAR 1978**

TRIAXIAL COMPRESSION TEST REPORT

Plate E-2(e)

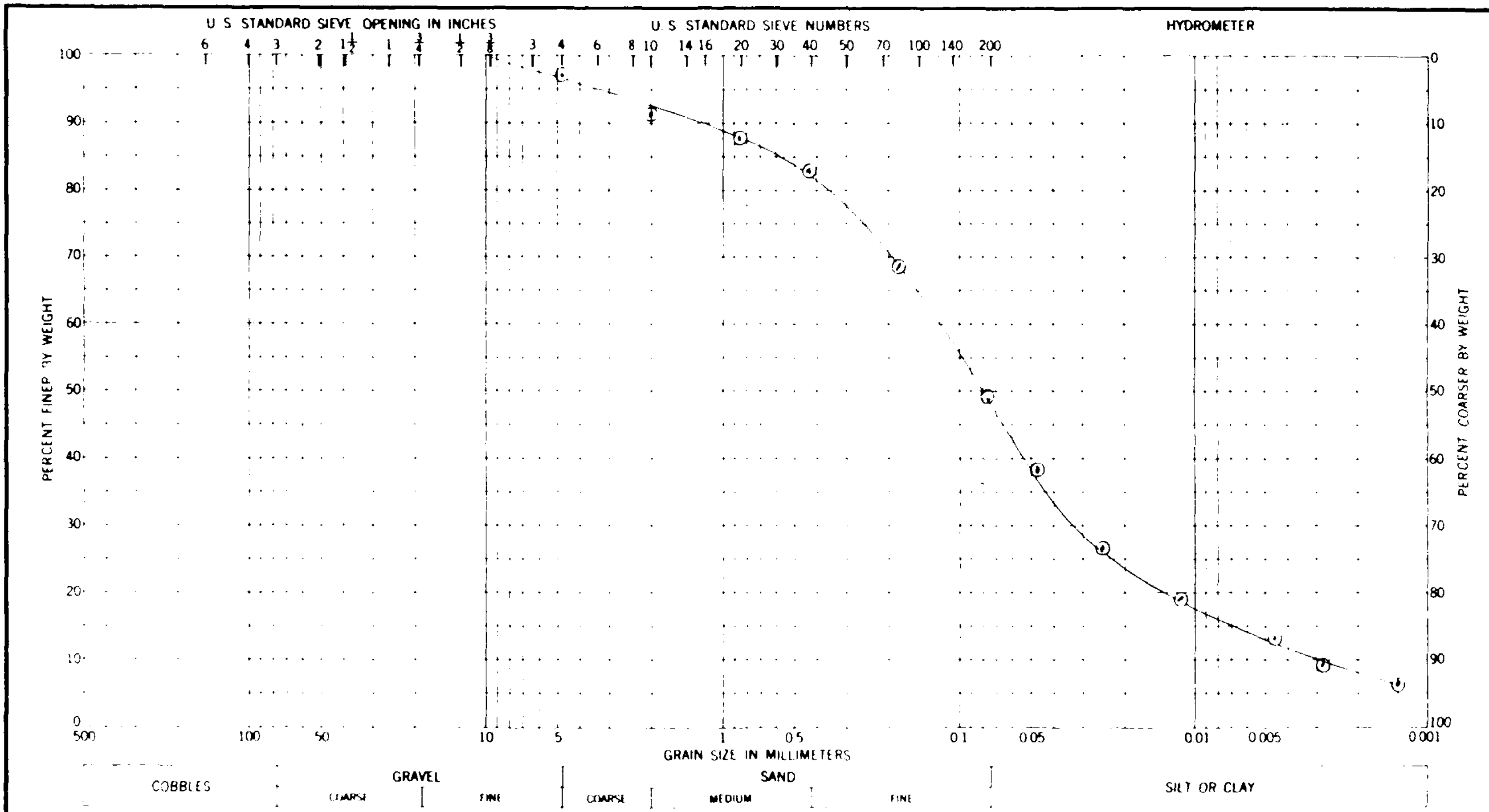
SOIL CLASSIFICATION RECORD SHEET

Project		Boring No	MRD Lab. No
[illegible]		77-17M and 77-18M	7[illegible] 12
Station: -	Range: -	Surf Elev: -	Depth To Water Table: -
			Bottom Of Hole: -

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	Plasticity (Att Limits) P I	Grading (Cumulative Percents Finer)	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks
Hole 77-17M												[illegible]
2	[illegible].7	25.4										
3	11.5	25.[illegible]	[illegible]7	[illegible]							Lean clay, CL. Gray-brown.	Tough at plastic limit. 14
[illegible]	15.[illegible]	31.5										
[illegible]	14.4	11.[illegible]										
[illegible]	1[illegible].7	11.4	1[illegible]									11
[illegible]	[illegible]	12.[illegible]										
10	[illegible].2	14.[illegible]										
11	31.1	13.3										
12	31.7	[illegible].1										
Hole 77-18M												
[illegible]	5.5	23.[illegible]			The soil [illegible]						Lean clay, CL. Light gray.	
[illegible]	1[illegible]	31.[illegible]	[illegible]	[illegible]								1[illegible]
[illegible]	11.1	11.3										
1[illegible]	17.2	11.3	1[illegible]	[illegible]								11
12	19.5	11.[illegible]										
13	21.5	11.3										
15	[illegible].5	7.[illegible]										
1[illegible]	2[illegible].4	1[illegible].										

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

Plate E-3(a)



Sample No	[redacted] Depth	Classification	Nat w %	LL	PL	PI
14	24.5 - 26.4	Clayey sand, SC-SM		17	10	7

Project: Warroad Harbor
NCS-IA-77-21-ED-F

Area: MRD Lab. No. 78/12

Boring No: 77-18M

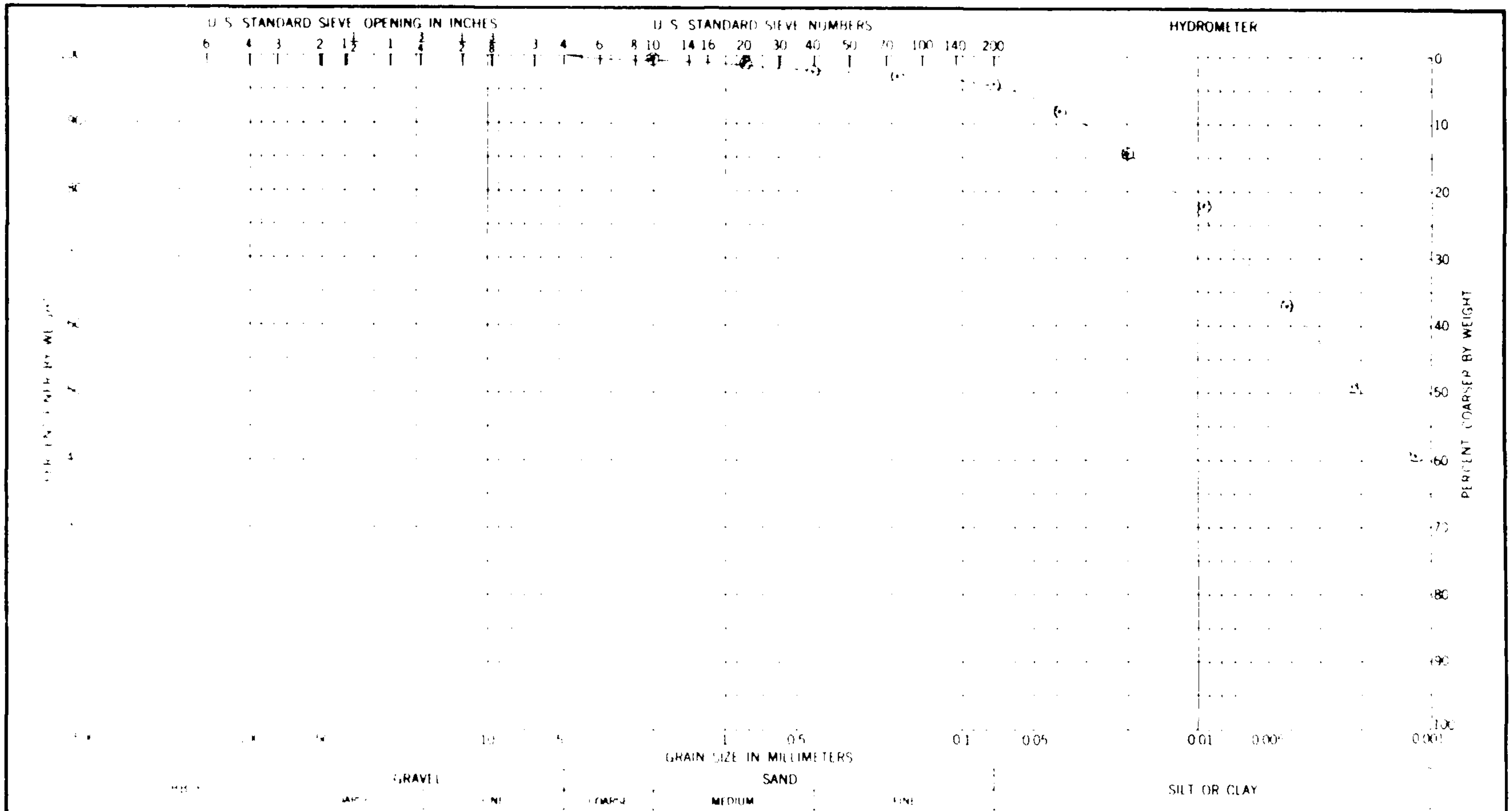
Date: 1[illegible] MAR 1978

GRADATION CURVES

ENG FORM 2087

Figure 6

Plate E-3(b)



Sample No	Depth	Classification	Nat w %	LL	PL	PI
6	10.5 - 12.4	Fat clay, CH		50	10	40

GRADATION CURVES

Project: Warroad Harbor
NCS-IA-78-21-ED-F

Area: MRD Lab. No. 78 12

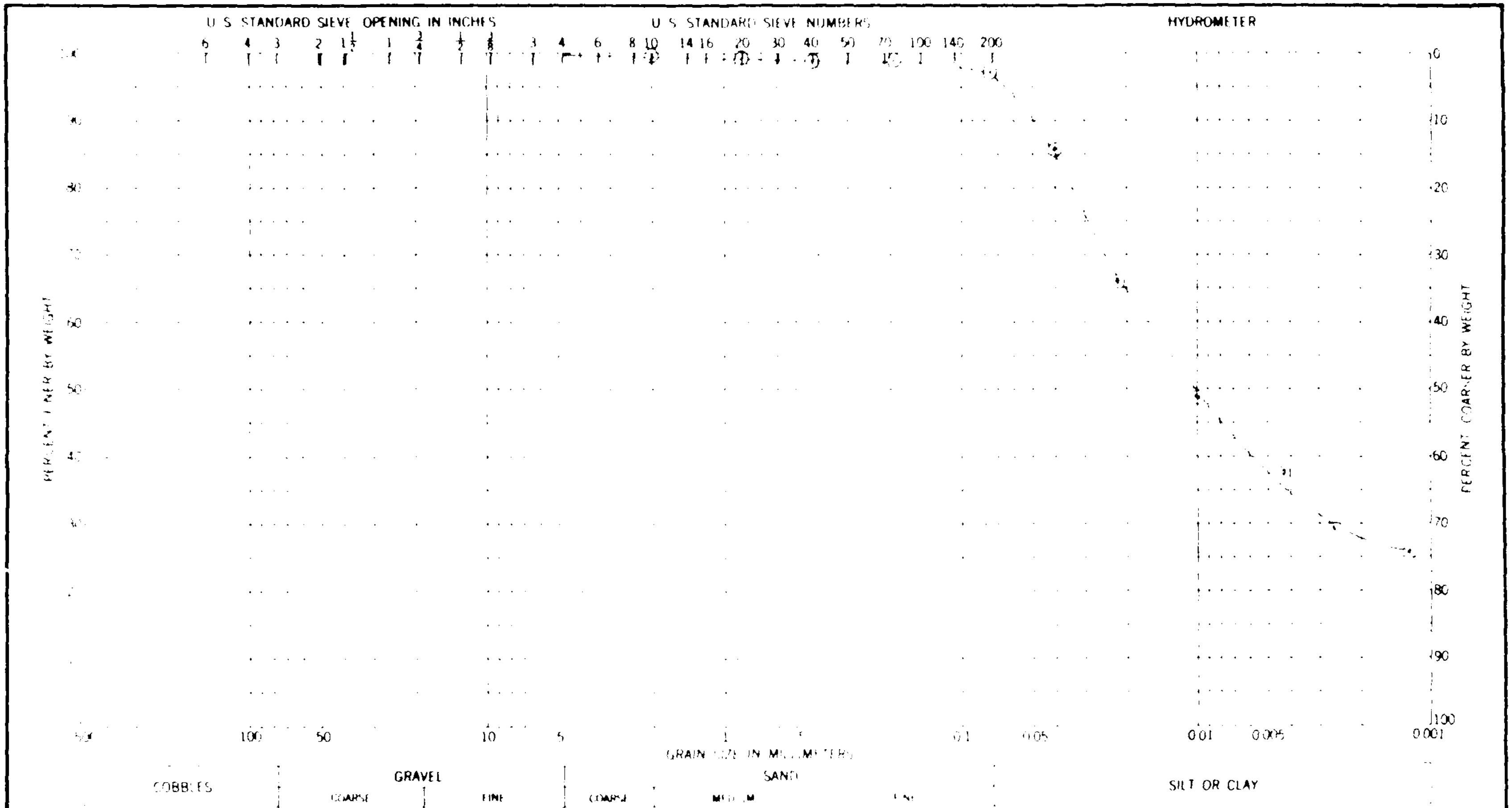
Boring No: 77-18M

Date: 1 MAR 1978

ENG 2087

Figure 4

Plate E-3(c)



Sample No.	Depth	Classification	Nat w %	LL	PL	PI
3	0.0 - 7.9	Lean clay, CL		47	16	31

Project: Warroad Harbor

NCS-IA-78-21-ED-F

Area: MRD Lab. No. 78/12

Boring No: 77-18M

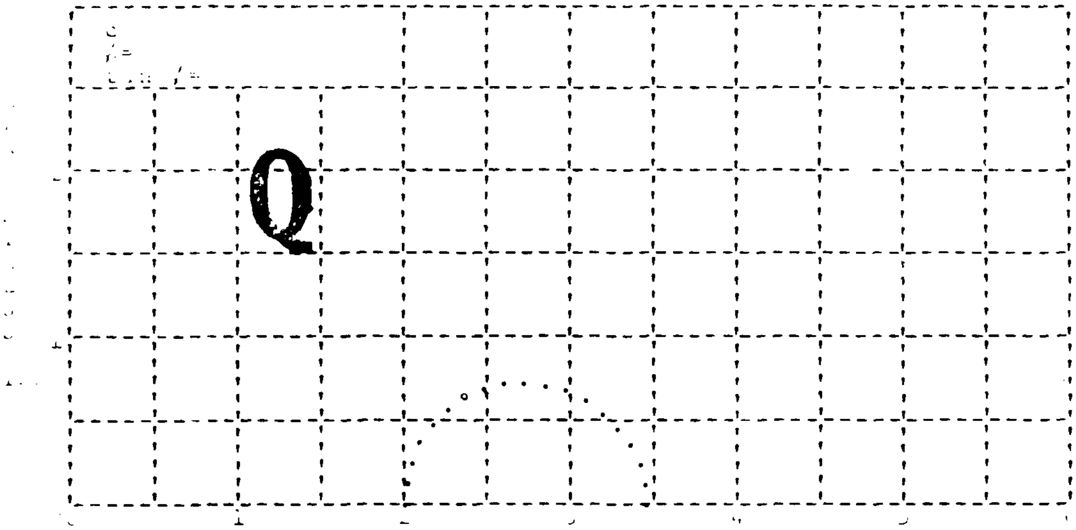
Date: MAR 1978

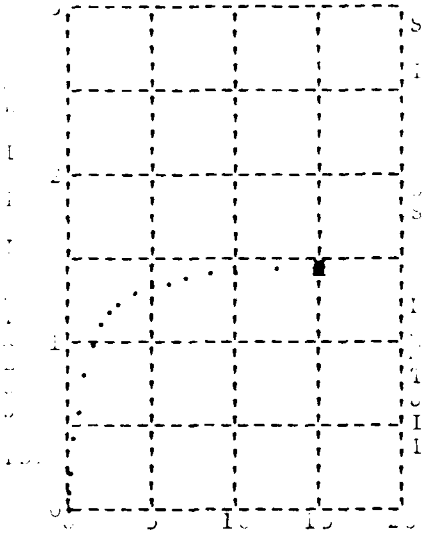
GRADATION CURVES

ENG FORM 2087

Figure 2

Plate E-3(d)





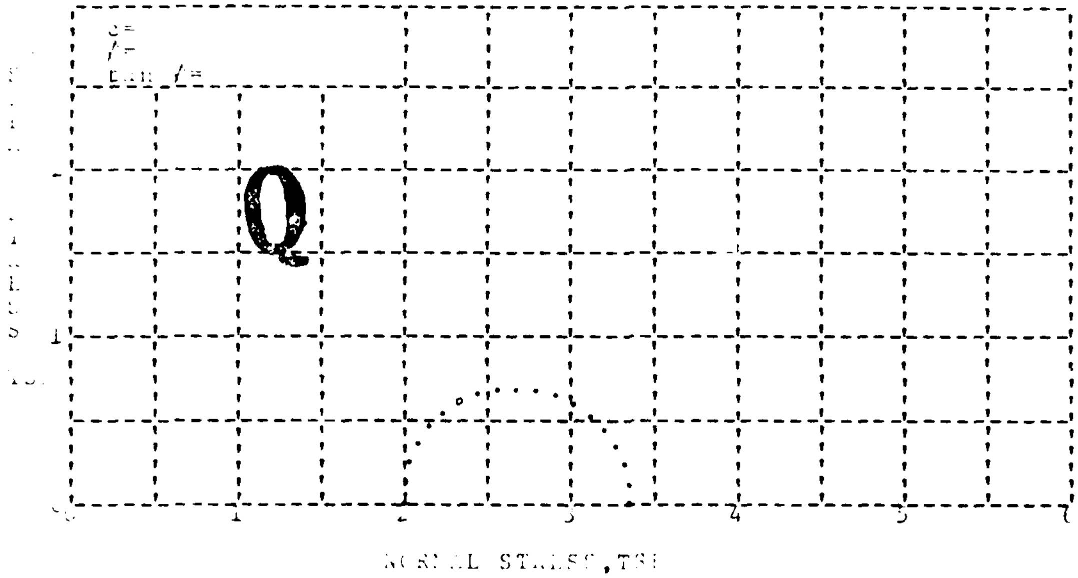
DESCRIPTION OF SPECIMENS: Lean clay, CL

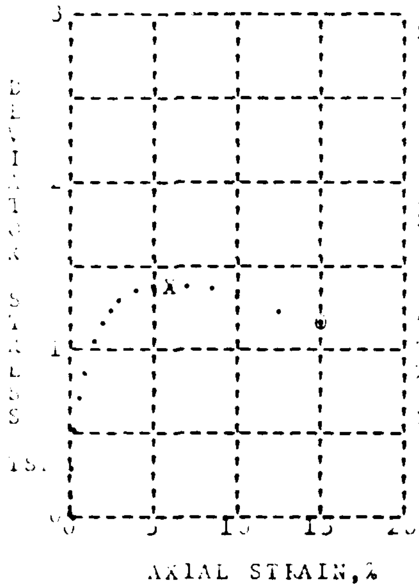
LL 47 PL 16 PI 31

Gray, rust stains, brittle, medium consistency, medium strength at PL, gloss shine, slow shake reaction.

	Warroad Harbor
	NCS-IA-78-21-ED-F
	77-18M — 3
	6.0 - 7.9
	78/12 — 16 MAR 1978

Plate E-3(e)





			1
SPECIMEN NO.			1
INITIAL	WATER CONTENT, [illegible]		3[illegible].1
	DRY DENSITY, [illegible]		[illegible]3.2
	SATURATION, [illegible]		9[illegible]
	VOID RATIO		.[illegible]3
BEFORE SHEAR	WATER CONTENT, [illegible]		2[illegible].[illegible]
	DRY DENSITY, [illegible]		[illegible]3.8
	SATURATION, [illegible]		10[illegible]
	VOID RATIO		.82
FINAL BACK PRESSURE, [illegible]			.[illegible]
MINOR PRINCIPAL STRESS, [illegible]			2.[illegible]
MAX DEVIATOR STRESS, TSF			1.37
TIME TO FAILURE, [illegible]			31
ULT DEVIATOR STRESS, TSF			1.15
INITIAL DIAMETER, IN			1.36[illegible]
INITIAL HEIGHT, IN			2.[illegible]2

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Fat clay, CH**

LL **56** PL **16** PI **40** Gs= 2.73 TYPE SPECIMEN: UNDISTURBED TYPE TEST Q

REMARKS: MACHINE PRINT OUT FORMAT AFTER ENG FORM 2089 DEVIATOR STRESS CORRECTED FOR MEMBRANE RESTRAINT
Gray, brittle structure, medium consistency, medium strength at PL, gloss shine, no shake reaction.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-ED-F

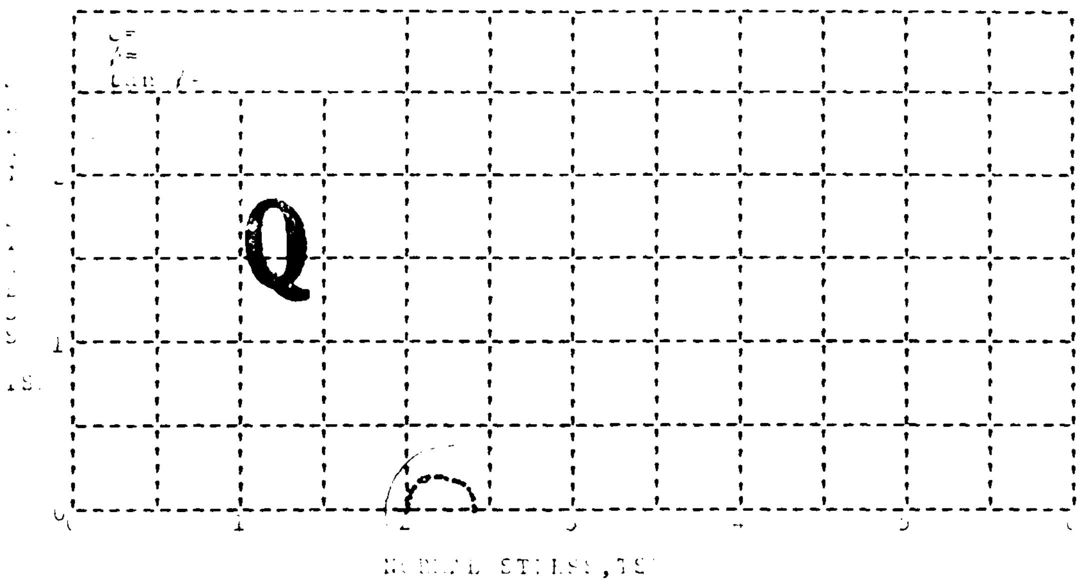
BORING NO: **77-18M** SAMPLE NO: **6**

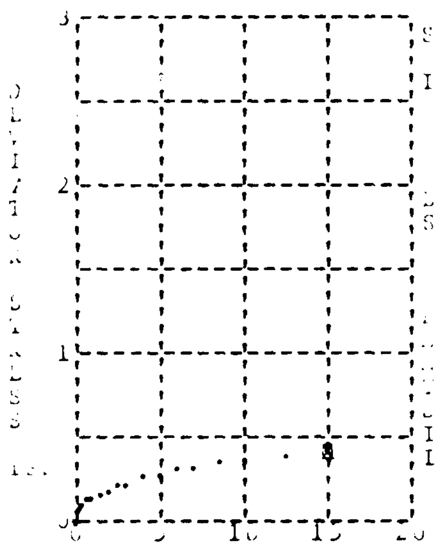
DEPTH: **10.5 - 12.4**

NCD LAB NO: **78/12** DATE **1[illegible] MAR 1978**

TRIAXIAL COMPRESSION TEST REPORT

Plate E-3(f)





SPECIMEN NO.		1
INITIAL	WATER CONTENT, %	12.
	DRY DENSITY, PCF	134.4
	SATURATION, %	1[illegible]+
	VOID RATIO	.2[illegible]
BEFORE SHEAR	WATER CONTENT, %	11.
	DRY DENSITY, PCF	134.[illegible]
	SATURATION, %	1[illegible]+
	VOID RATIO	.2[illegible]
MINOR PRINCIPAL STRESS, TSF		[illegible]
MAJOR PRINCIPAL STRESS, TSF		2.[illegible]
MAX DEVIATOR STRESS, TSF		.42
TIME TO FAILURE, MIN		.31
ULT DEVIATOR STRESS, TSF		.42
INITIAL DIAMETER, IN		1.3[illegible]
INITIAL HEIGHT, IN		2.[illegible]

AXIAL STRAIN, %

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Clayey sand, SC-SM**

LL **17** PL **10** PI **7** Gs= 2.72 TYPE SPECIMEN: UNDISTURBED TYPE TEST Q

REMARKS: MACHINE PRINT OUT
FORMAT AFTER ENG FORM 2089
DEVIATOR STRESS CORRECTED
FOR MEMBRANE RESTRAINT

Gray, brittle structure, soft consistency, slightly sensitive, very low strength at PL, no shine, fast shake reaction.

PROJECT: **Warroad Harbor NCS-IA-78-21-ED-F**

BORING NO: **77-18M** SAMPLE NO: **14**

DEPTH: **24.5 - 26.4**

NCD LAB NO: **78/12** DATE **16 MAR 1978**

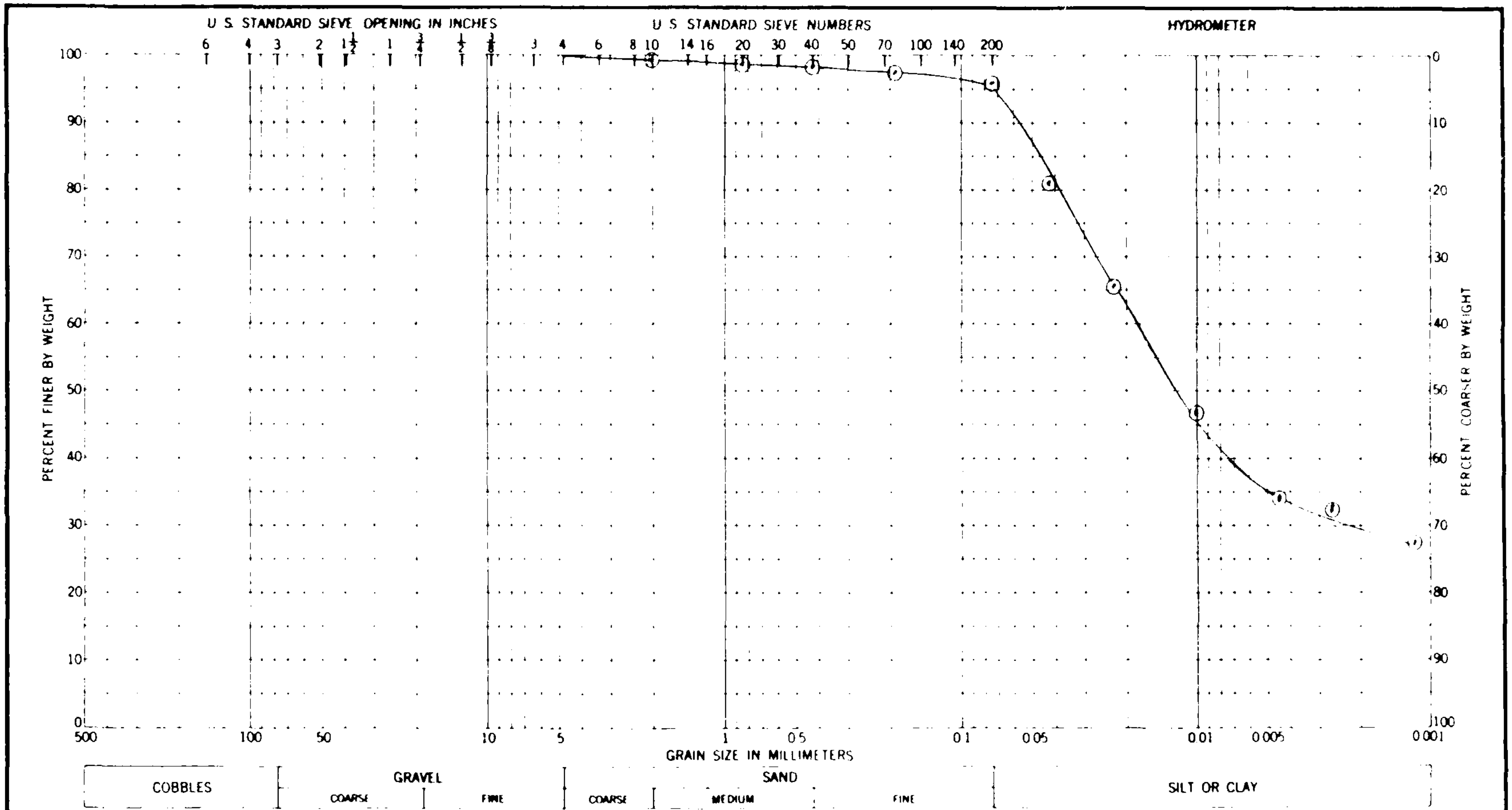
TRIAXIAL COMPRESSION TEST REPORT

Plate E-3(g)

SOIL CLASSIFICATION RECORD SHEET

Project																Boring No			MRD Lab No
Station					Range				Surf Elev							Depth To Water Table			Bottom Of Hole
Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits)		Grading (Cumulative Percents Finer)								Gradation Curve Analysis					Classification Tech MEMO 3-357, May 67	Remarks
			LL	PI									D_{10} (mm)	D_{30} (mm)	D_{60} (mm)	C_u	C_c		

MRD FORM 16
NOV 75 EDITION OF MAY 70 IS OBSOLETE



Sample No	Depth	Classification	Nat w %	LL	PL	PI
2	4.5 - 6.4	Lean clay, CL		45	14	31

Project Warroad Harbor

NCS-IA-78-21-ED-F

Area MRD Lab. No. 78/12

Boring No 77-19M

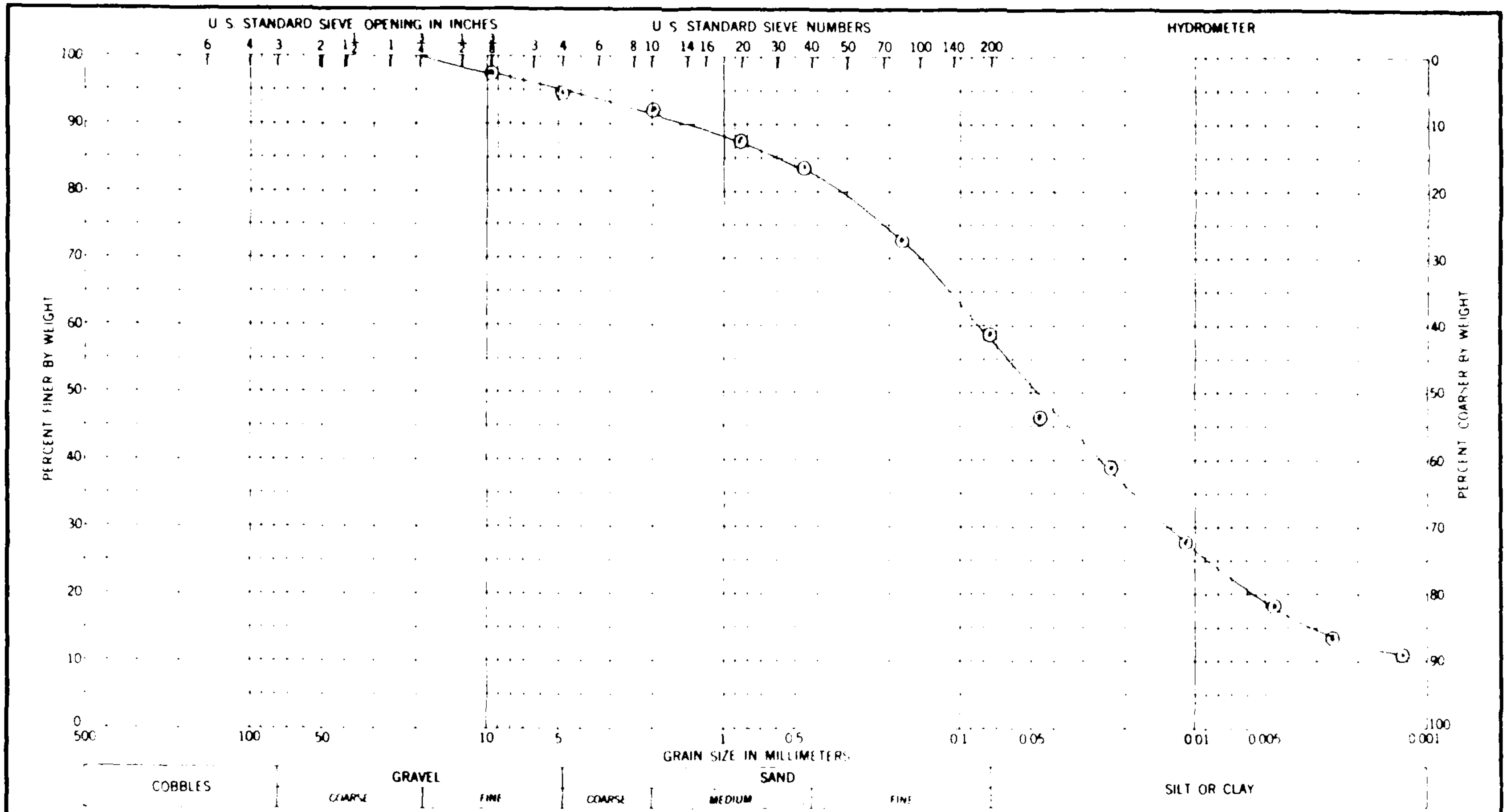
Date 1 MAR 1978

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Figure 8

Plate E-4(b)



Sample No	Depth	Classification	Nat w %	LL	PL	PI
6	11.5 - 13.4	Sandy clay, CL		20	10	10

Project: Warroad Harbor
NCS-IA-78-21-ED-F

Area: MRD Lab. No. 78 12

Boring No: 77-19M

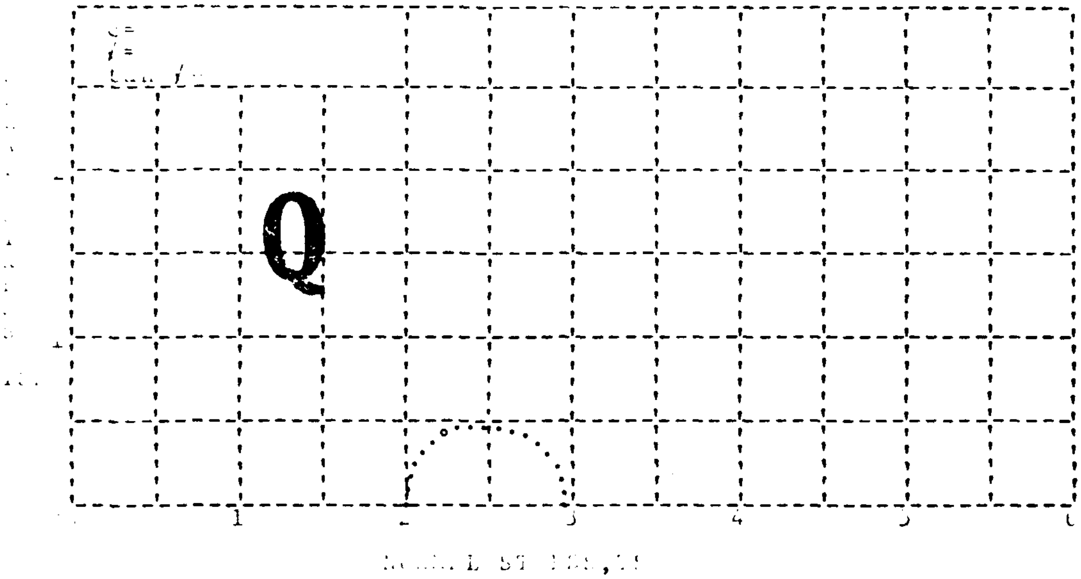
Date: 1 MAR 1978

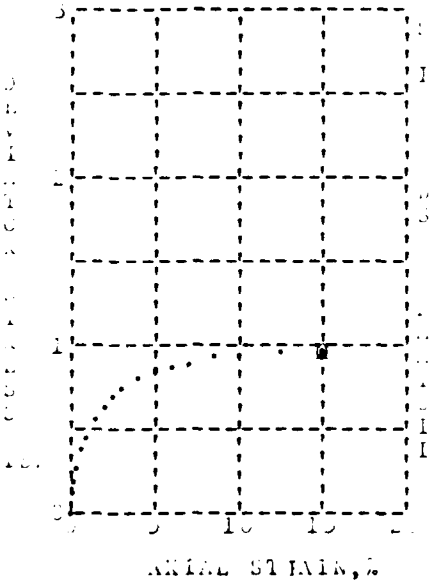
GRADATION CURVES

ENG FORM 1 MAY 63 2087

Figure 10

Plate E-4(c)





		1
INITIAL	WATER CONTENT,%	23.7
	DRY DENSITY	1[illegible]3.[illegible]
	SATURATION,%	1[illegible]+
	VOID RATIO	[illegible]
[illegible]	WATER CONTENT,%	[illegible]
	DRY DENSITY	1[illegible]
	SATURATION,%	1 +
	VOID RATIO	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
INITIAL DIAMETER, IN		1.3[illegible]
INITIAL HEIGHT, IN		[illegible]

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Lean clay, CL**

LL **45** PL **14** PI **31** Gs= 2.74 TYPE SPECIMEN: UNDISTURBED TYPE TEST Q

REMARKS: MACHINE PRINT OUT
FORMAT AFTER ENG FORM 2...
DEVIATOR STRESS CORRECTED
FOR MEMBRANE RESTRAINT

Gray, brittle structure, medium consistency, low strength at PL, no shine. Top 5 inches of sample was peat.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-ED-F

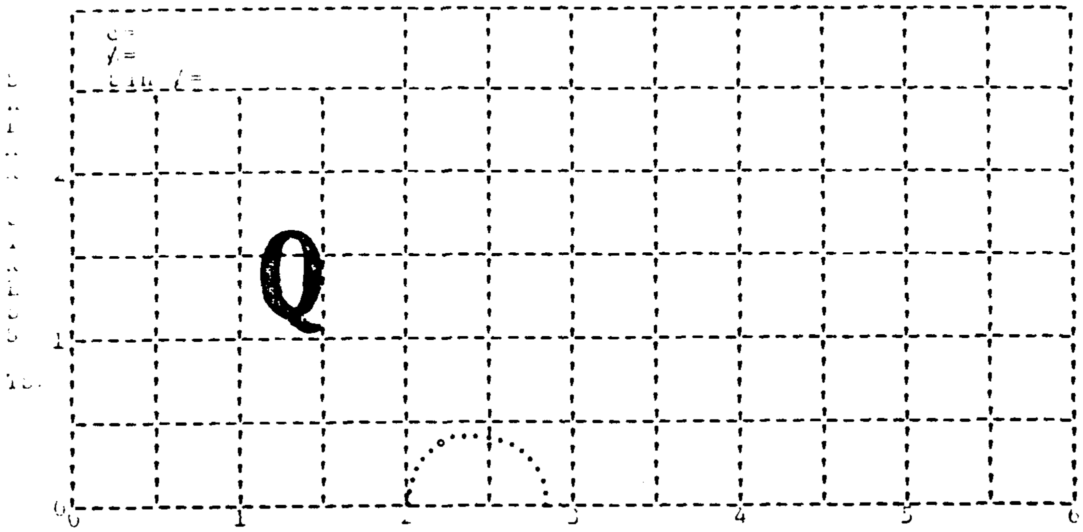
BORING NO. **77-19M** SAMPLE NO: **2**

DEPTH: **4.5 - 6.4**

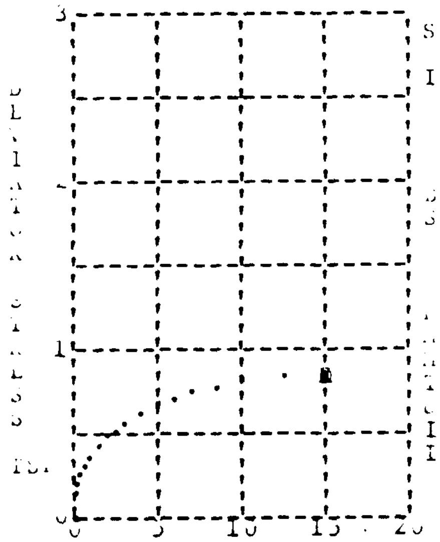
LAB NO: **78/12** DATE 16 MAR 1978

TRIAXIAL COMPRESSION TEST REPORT

Plate E-4(d)



NORMAL STRESS, TSF



SPECIMEN NO.		1
INITIAL	WATER CONTENT, %	14.2
	DRY DENSITY, PCF	123.[illegible]
	SATURATION, %	1[illegible]
	VOID RATIO	.3[illegible]
BEFORE SHEAR	WATER CONTENT, %	14.2
	DRY DENSITY, PCF	123.[illegible]
	SATURATION, %	9[illegible]
	VOID RATIO	.3[illegible]
FINAL BACK PRESSURE, TSF		[illegible]
MINOR PRINCIPAL STRESS, TSF		2.[illegible]
MAX DEVIATOR STRESS, TSF		.[illegible]
TIME TO MAX DEV, MIN		2[illegible]
ULT DEVIATOR STRESS, TSF		[illegible]
INITIAL DIAMETER, IN		1.3[illegible]4
INITIAL HEIGHT, IN		2.[illegible]4

AXIAL STRAIN, %

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Sandy clay, CL**

LL **20** PL **10** PI **10** Gs= 2.7[illegible] TYPE SPECIMEN: UNDISTURBED TYPE TEST Q

REMARKS: MACHINE PRINT OUT
FORMAT AFTER ENG FORM 2089
DEVIATOR STRESS CORRECTED
FOR MEMBRANE RESTRAINT
Gray and tan, brittle structure, soft consistency, medium strength at PL, no shine, fast shake reaction.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-ED-F

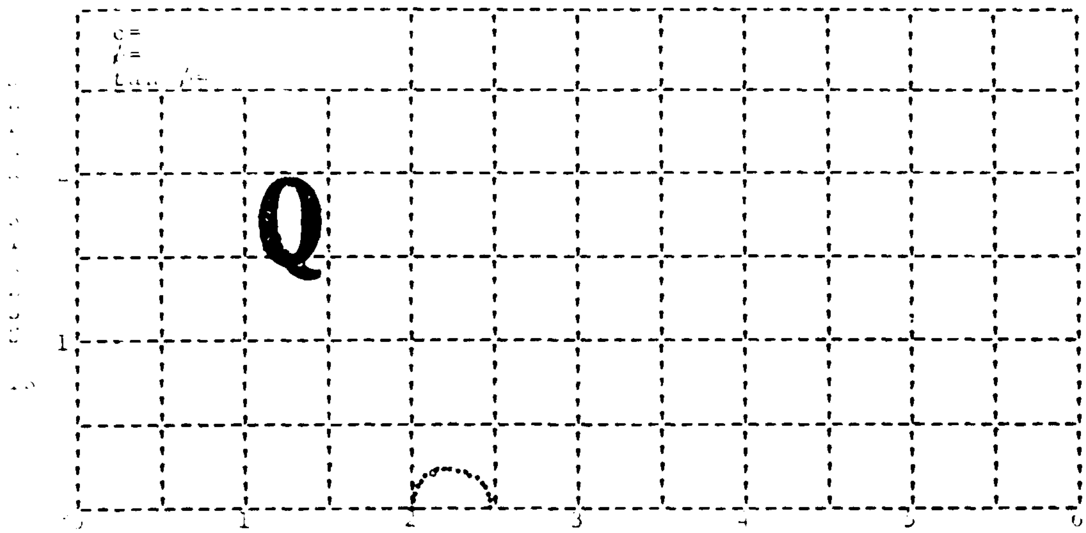
BORING NO: **77-19M** SAMPLE NO: **6**

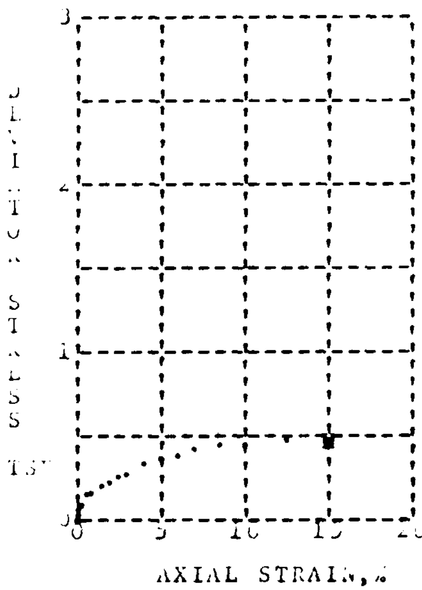
DEPTH: **11.5 - 13.4**

NCD LAB NO: **78/12** DATE **16 MAR 1978**

TRIAXIAL COMPRESSION TEST REPORT

Plate E-4(e)





SPECIMEN NO.		1
INITIAL	WATER CONTENT,%	12.9
	DRY DENSITY,PCF	127.[illegible]
	SATURATION,%	1[illegible]+
	VOID RATIO	.3[illegible]
BEFORE SHEAR	WATER CONTENT,%	12.[illegible]
	DRY DENSITY,PCF	127.[illegible]
	SATURATION,%	1[illegible]+
	VOID RATIO	.34
FINAL BACK PRESSURE,TSF		[illegible]
MINOR PRINCIPAL STRESS,TSF		[illegible]
MAX DEVIATOR STRESS,TSF		.4[illegible]
TIME TO FAILURE,MIN		2[illegible]
ULT DEVIATOR STRESS,TSF		.4[illegible]
INITIAL DIAMETER,IN		1.3[illegible]
INITIAL HEIGHT,IN		[illegible]

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Clayey sand, SC-SM**

LL **17** PL **11** PI **6** Gs= 2.74 TYPE SPECIMEN: [illegible] TYPE TEST [illegible]

REMARKS: MACHINE PRINT OUT FORMAT AFTER ENG FORM 2087 DEVIATOR STRESS CORRECTED FOR MEMBRANE RESTRAINT

Brown, soft consistency, slightly sensitive, very low strength at PL, no shine, fast shake reaction, slight odor. Sample contained material up to 1" diam.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-KD-F

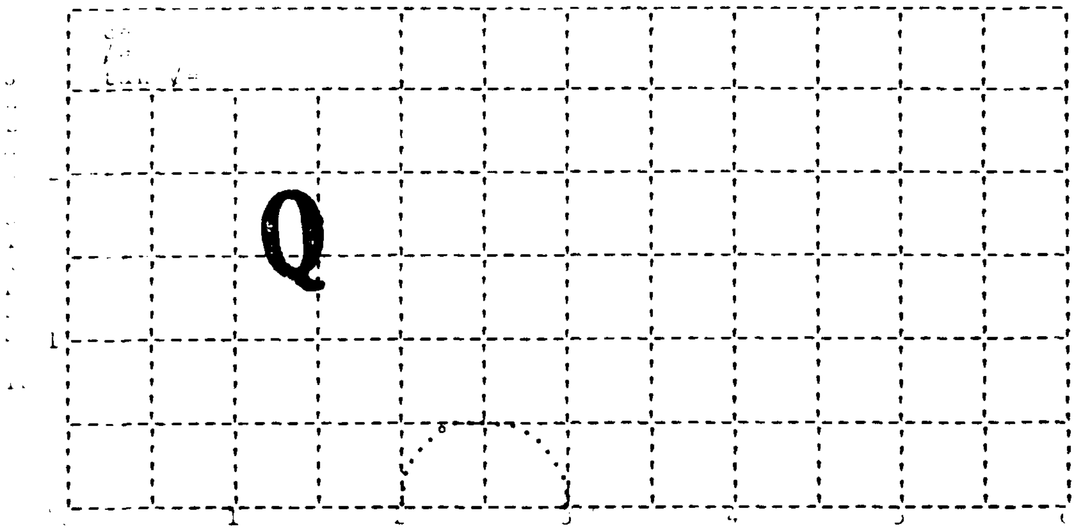
BORING NO: **77-19M** SAMPLE NO: **9**

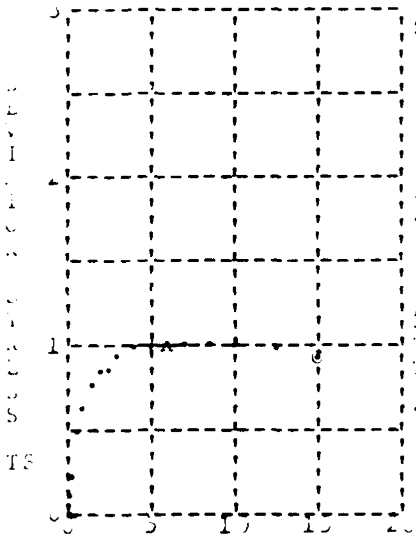
DEPTH: **17.0 - 18.9**

MRD LAB NO: **78/12** DATE **16 MAR 1978**

TRIAXIAL COMPRESSION TEST REPORT

[illegible] **11** Plate E-4(f)





AXIAL STRAIN,%

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS: **Silty sand, SM-SC**

LL **16** PL **11** PI **5** Gs= 2.75 TYPE TEST **Q**

REMARKS: MACHINE PRINT OUT FORMAT AFTER ENG FORM DEVIATOR STRESS CORRECTED FOR MEMBRANE TEST RING

Gray, brittle, medium consistency, low strength at PL, dull shine, fast shake reaction.

PROJECT: **Warroad Harbor**
NCS-IA-78-21-ED-F

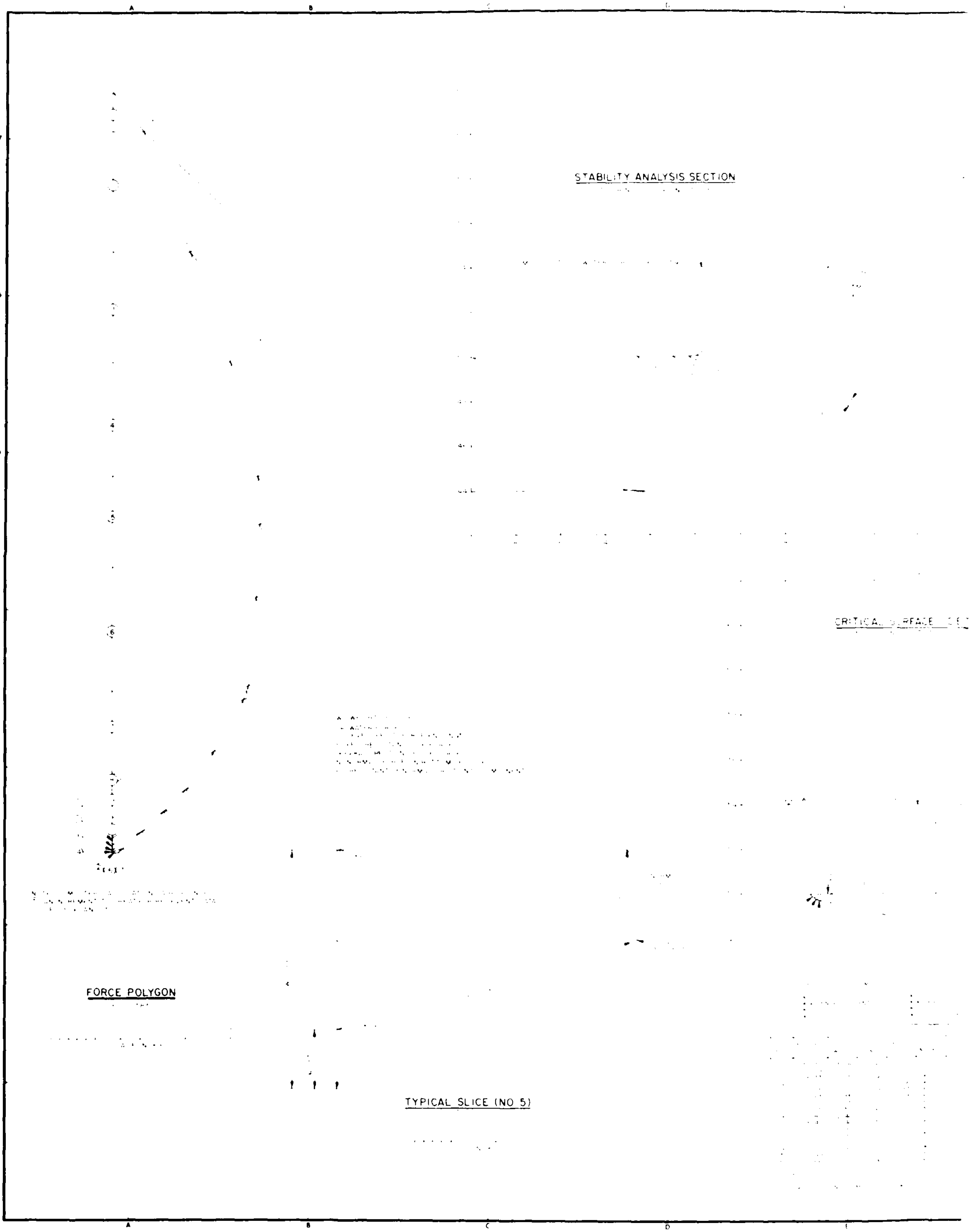
BORING NO: **77-19M** SAMPLE NO: **13**

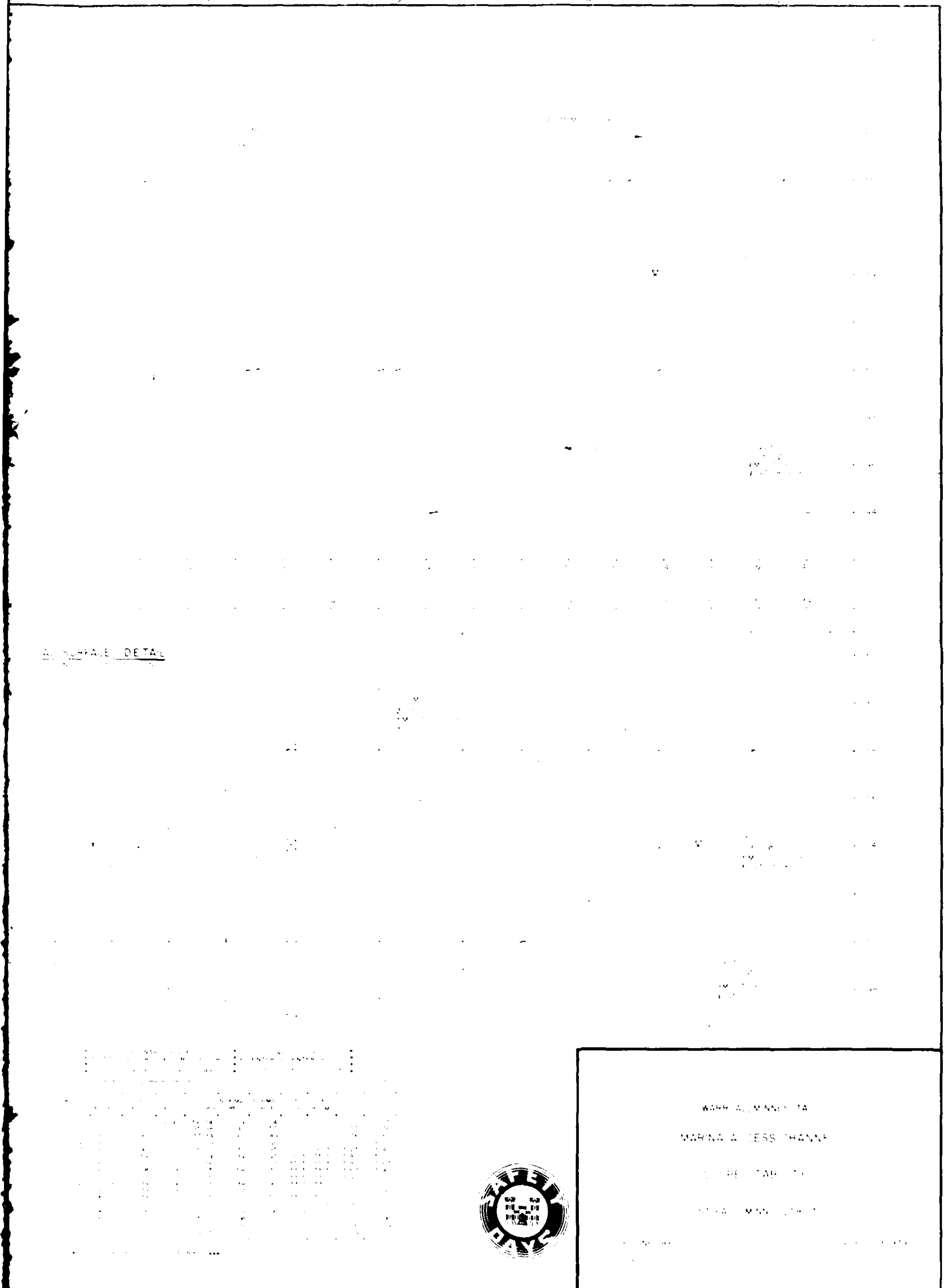
DEPTH: **26.5 - 28.4**

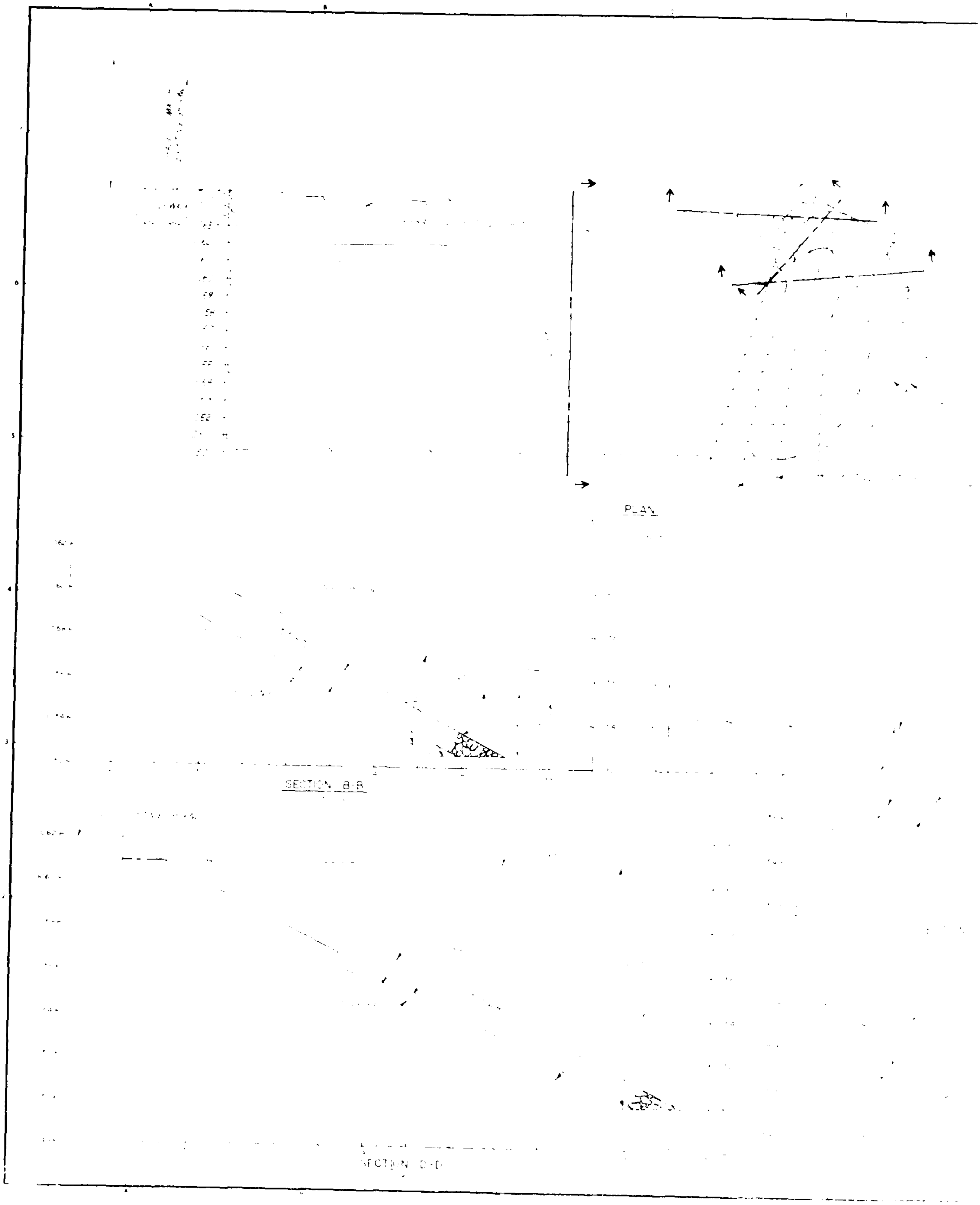
LAB NO: **78/12** DATE **16 MAR 1978**

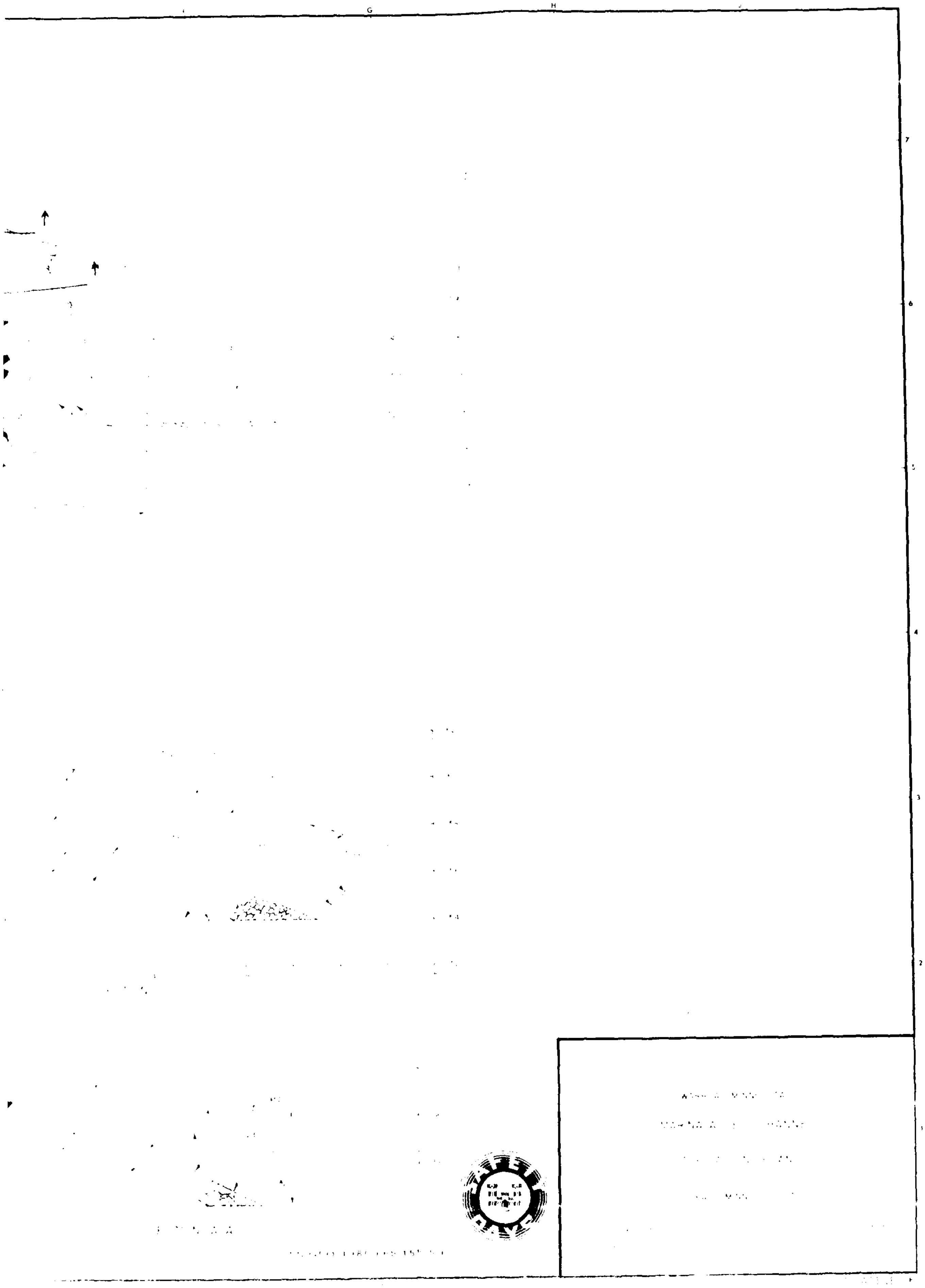
TRIAXIAL COMPRESSION TEST REPORT

FIGURE **13** **Plate E-4(g)**


STABILITY ANALYSIS SECTION
FORCE POLYGON
TYPICAL SLICE (NO 5)


A. SURFACE DETAIL
WARR A, MINNES TA
MARINA A CESS HANNE


PLAN
SECTION B-B
SECTION D-D


G
H

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

COST ESTIMATE

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Marina access channel - overland alignment				
Item	Unit	Quantity	Unit cost	Total estimated amount
General navigation facilities				
Channels				
Excavation	CY	58,000	$1.80	$104,400
Dredging	CY	1,900	12.00	22,800
Concrete removal	CY	30	8.00	240
Sludge removal	CY	1,100	12.00	13,200
Fabric formed pavement	SF	88,000	2.00	176,000
Bedding for riprap	CY	130	14.00	1,820
Riprap	CY	200	30.00	6,000
Backfill on riprap	CY	100	2.00	200
Fill	CY	2,500	2.00	5,000
Stabilized aggregate	CY	330	13.00	4,290
Topsoil	CY	650	4.00	2,600
Seeding	Acre	1.2	850.00	1,020
Relocate trees	Each	15	240.00	3,600
Contingencies				49,830
Total				391,000
Engineering and design				46,000
Supervision and administration				
Supervision and inspection				17,000
Overhead				9,000
Total				26,000
Total cost				463,000

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

NATURAL RESOURCES

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
LWR

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

NOV 8 1976

Dear Colonel Gay:

This responds to your letter of August 25, 1976 which informs us that you have received funding to initiate a detailed project study for a small-boat harbor at Warroad, Minnesota. Enclosed with your letter was the Navigation Reconnaissance Report (Section 107)-Lake of the Woods at Warroad, Roseau County, Minnesota, dated November 27, 1974, which provided us base project information.

Our following comments are submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). They are of a preliminary nature, and are subject to change when project plans are finalized.

The proposed project will include a 5,100-foot access channel for recreational boats from Lake of the Woods to a public inland marina located 2½ miles north of the existing channel (City of Warroad). The channel will be 6 feet deep and have a 100-foot bottom channel width. A 500-foot gabion-type breakwater will be constructed for safety and siltation considerations.

FISH AND WILDLIFE RESOURCES

Riparian vegetation and marsh areas adjacent to Lake of the Woods in the project area contribute significantly to the aesthetics of the area and to the natural resource productivity of the lake. The rooted plants, common to marsh areas, obtain raw materials from beneath the water surface. These rooted aquatics often "recover" nutrients from the anaerobic sediments providing a useful "nutrient pump" for the ecosystem. The emergent plants, together with those on the moist shore, form an important link between the water and land environments. Such areas provide excellent habitat for waterfowl, shorebirds, passerine birds, aquatic mammals, and other species of wildlife important in the total ecosystems of Lake of the Woods.

In respect to fishery resources, the Environmental Assessment for Warroad Harbor of December 1973 states that the "waters of Lake of the Woods support a large and diverse fish population. The area provides habitat for over 30 species of fish including desirable game fish such as walleye, perch, bass, northern pike, sunfish, muskellunge and trout as well as commercially important populations of burbot, tulibees and white sucker." Warroad has one of the most active harbors on Lake of the Woods and offers some of the best walleye fishing in Minnesota.

ANTICIPATED PROJECT IMPACTS ON FISH AND WILDLIFE RESOURCES

Project Site

Dredging the 5,100-foot access channel would destroy several acres of shoreline wetland habitat valuable for waterfowl and as nursery and spawning habitat for fish. Although we recognize that a need exists for a small navigation facility in the immediate Warroad area, we also recognize that adverse environmental impacts would result by locating the facility in the nearby old Warroad Harbor where polluted sediments present a serious dredged material disposal problem. However, a recent report entitled "Chemical, Physical and Biological Properties of the Warroad Small Boat Harbor Project Area, Warroad, Minnesota", prepared by Twin City Testing and Engineering Laboratory, Inc., indicated that the sediments in the proposed project area would not significantly affect the water quality for fish and wildlife. As such, we do not object to the location of the proposed public inland marina and access channel.

Dredged Material Disposal Area

The disposal of dredged material should be considered from both a short and long-term perspective. Our May 5, 1976 letter to the District Engineer concerning an application from the Village of Warroad, Minnesota for a permit (same proposed project), recommends that the disposal of dredged material and associated dike construction "should not extend beyond 60 feet lakeward from the road surface of CSAH 74." This limitation would be necessary to keep the spoil disposal and dike construction above the wetland habitat adjacent to the normal lake level elevation of 1060 m.s.l. The Report indicates that 61,800 cubic yards of dredged material would be disposed in the proposed dike area. However, considering the above recommendation, the size of the disposal area would appear to be inadequate to accommodate initial dredging needs.

In addition, the extent of littoral drift in the project area or what impact the breakwater would have on increasing sedimentation in the proposed access channel should be considered. It is reasonable to assume that future dredging would be required to maintain the design width and depth of the access channel. Basic data found in the Navigation Reconnaissance Report does not indicate if the proposed disposal area would accommodate these future dredging needs.

Because of these apparent limitations, including our concern for resolving both short and long-term disposal needs, it appears that the proposed disposal site is inadequate. We suggest that you establish a permanent dredged material disposal site southwest of CSAH 74 adjacent to the public inland marina. The City of Warroad could either give or sell the material to public agencies or private interests for construction, fill or other uses. In addressing the disposal problem in this manner, one could reduce adverse environmental impacts and provide additional public benefits. Relocating the proposed dredged material disposal site also would maintain the existing scenic and aesthetic character of the Lake of the Woods shoreline. This aspect alone should warrant full consideration of an off-lake site.

Breakwater

We do not object to the use of 11,000 cubic yards of dredged material in the construction of the 500-foot breakwater.

Future Developments

The Navigation Reconnaissance Report indicates that a large boat facility sailboat basin could be developed on the lakeside of CSAH 74 for larger craft unable to clear the bridge leading to the inland harbor. Seaplane operations also could utilize the facility. We strongly urge you to consider other harbors for these craft. For the project area, this could reduce overall maintenance costs and provide for the most critical needs with minimal adverse environmental impacts. Other sites better adapted for larger craft and seaplanes might include Warroad Harbor and other marinas in the Muskeg Bay and Buffalo Bay areas.

Thank you for the opportunity to provide you with these preliminary comments.

Sincerely yours,

Assistant Regional Director
Environment

cc: Minnesota DNR, St. Paul

WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

CULTURAL RESOURCES SURVEY

APPENDIX H

CULTURAL RESOURCES

A cultural resources investigation of the proposed on-land channel was completed by Alan Brew of Bemidji State University, under contract with the Corps of Engineers. The following is a summary of the final report, Cultural Resources Survey of Small Boat Harbor Project at Lake of the Woods, Warroad, Minnesota (1977). The survey included: (1) a review of recorded archaeological and historical information, (2) contacts with local informants, and (3) archaeological shovel-test sampling of the proposed channel D alignment and adjacent park areas.

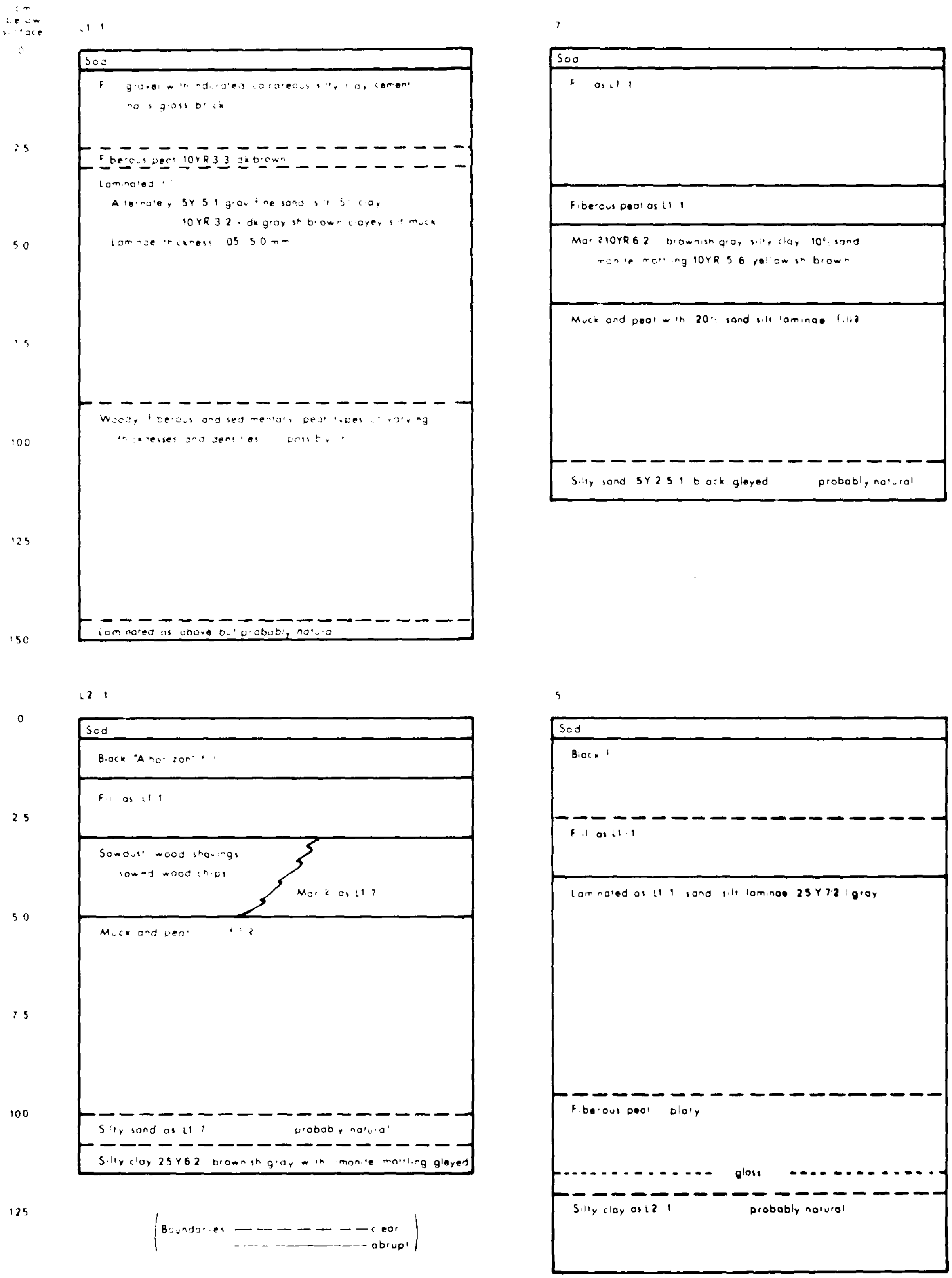
Three archaeological sites have been reported in the vicinity of the project area, including a historic Chippewa Indian village of 24 families, a historic Indian cemetery, and an American Fur Company Post dating from around 1820. To determine the presence or absence of cultural remains in the construction zone, three lines of shovel tests were excavated, ranging in depth from 0.65 to 1.65 meters. Approximately 42 percent of the channel alignment was tested; the remaining extent of the alignment was deemed disturbed or in wetland. Also tested was the area between the trading post and the swimming pool.

A total of 17 shovel tests were excavated, revealing a complex stratigraphy of several different types of laminated artificial fills (see representative vertical sections of shovel tests). A single prehistoric pottery shard was recovered at a depth of 140 centimeters from a natural soil horizon encountered below the artificial deposits. This discovery leaves a possibility that other cultural artifacts may be deeply buried.

Information provided by locals confirmed that the project area had been filled with dredged and waste material, and that it had previously been a low swampy area. The Indian village and cemetery are reportedly outside of the project impact area, while the actual location of the American Fur Company Post is undetermined.

Because of the possibility that in situ archaeological materials may be encountered following removal of the fill overburden, arrangements will be made for an archaeologist to monitor the channel excavation. In the event that cultural remains are encountered, construction will immediately be discontinued in the sensitive area and the State Historic Preservation Officer will be contacted. The significance of the site will be evaluated according to National Register of Historic Places criteria, and any required data recovery will be completed.

REPRESENTATIVE VERTICAL SECTIONS
ARCHAEOLOGICAL TEST AREAS
WARROAD, MINNESOTA



WARROAD CHANNEL PROJECT

SECTION 107

DETAILED PROJECT REPORT

PROJECTED DEMAND

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BENEFIT ANALYSIS

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APPENDIX I

TABLE OF CONTENTS

TABLES

PROSPECTIVE BOATING

GENERAL

An inland public marina facility and interior access channel will provide 90 transient and 100 seasonal slips. The marina will also have boat launching facilities, supporting utilities, and sanitation services. An adjacent municipal camping area and day-use park currently attract local residents and recreation travelers from a large geographical area. A recently added Olympic-size swimming pool augments the available day-use opportunities at these sites.

POTENTIAL DEMAND

Because of the lack of available base line data on recreation use within the project area, estimated demands for project-related facilities are based on assumptions developed from a review of existing literature; area resource data; and discussions with area recreation planners, marina operators, and city officials.

The beauty and productivity of Minnesota's many lakes have attracted anglers from all over the United States. Sport fishing and its associated tourism have been important factors in the economy of northern Minnesota for many years. In 1970, tourists spent an estimated $10 million in the Lake of the Woods area alone.

A State-sponsored creel census of the Lake of the Woods sport fishery was conducted from 1968 to [illegible]. Some of the findings from this survey indicate the magnitude of sport fishing in Lake of the Woods.

> "Total summer fishing effort by Minnesota-based anglers was estimated at [illegible],187 man-hours in 1970. Summer angling takes place from both chartered launches with guides and from small, [illegible] fishing boats. About 20 percent of the total [illegible] is from launches while practically [illegible] is on Minnesota waters and [illegible] of the lake."

[illegible] tourism study completed [illegible] travelled through [illegible] study also predicted that tourist travel will steadily increase [illegible] additional visitors because of the development of Voyageurs National Park. [illegible] study recommended viewing [illegible] as the western entrance to the Voyageur Park area.

[illegible] recreation use was also [illegible] for this area in [illegible] Recreational Planning Study. The [illegible] will increase from an estimated [illegible] percent increase. [illegible] annual increase [illegible] percent. [illegible] percent average annual increase in [illegible] increase for the [illegible]

A similar demand increase was [illegible] Comprehensive Study. The [illegible] resource [illegible] indicated in the following tables reflect an average compounded annual increase in boating demand from [illegible] percent and [illegible] increase in demand for on land boating facilities [illegible] percent.

Demand for outdoor recreation - Rainy River Basin

Activity	1968 Annual	1968 Summer	1980 Annual	1980 Summer	2000 Annual	2000 Summer	2020 Annual	2020 Summer
	Recreation days (in 1,000's)							
Boating	6[illegible]	4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] development required to satisfy demand for outdoor recreation

Activity	1968	1980	2000	2020
	Acres			
Boating (Land)	2[illegible]	42	[illegible]	[illegible]
Boating (Water)	[illegible],416	8,250	[illegible]	1[illegible],708

Information obtained from marina operators in the Warroad area indicates that, on the average, they are selling about 40 boats per year in the 18- to 20-foot class. Boat registrations for both Roseau and Lake of the Woods Counties have been increasing over the last 8 years, with average annual increases of 22 percent and 17 percent, respectively, for 1971-1978. Local marinas are renting all available docking spaces with one exception described in the following section.

A recent draft of a new Minnesota State Comprehensive Outdoor Recreation Plan (SCORP) has identified the need to provide increased public access in Region 2, which includes Lake of the Woods County. The table below summarizes some pertinent figures from this study.

Projections of activity occasions - SCORP Region 2

	Occasions (in 1,000's)				
Activity	1978	1980	1985	1990	1995
Boating	1,026.4	1,035.0	1,064.2	1,113.9	1,173.4
Fishing	1,209.0	1,219.9	1,264.8	1,329.6	1,396.5

These projections forecast increases in boating and fishing activities of about 13 percent and 15 percent, respectively, over the next 15 years. The SCORP also established that 32 percent of the boating and 28 percent of the fishing occasions in the region were by residents of the St. Paul-Minneapolis seven-county metropolitan area. This fact demonstrates the drawing power of the recreation opportunities in the Lake of the Woods area.

Effects of Gasoline Availability and Price

Recent studies indicate that recreational travel will continue to increase more rapidly than other forms of highway travel regardless of gasoline prices or availability. It should be noted, however, that not enough time has gone by to establish reliable trend data. These studies lead us to believe that a 5-percent projected boating demand growth rate is acceptable at this time.

The effects of gasoline availability in the area were quite evident during the 1979 season. The Zippel Bay State Recreation Area, located approximately 20 miles east of Warroad, reported an estimated attendance of 30,000 persons during the 1978 season. In 1979, attendance declined to 23,484. The park manager attributed the decline to spring and early summer gasoline shortages. The U.S. Department of Transportation reported similar decreases in recreation participation and vacation driving during the fuel shortages of 1973-74. As soon as the shortages were over, however, participation once again approached precrisis levels, despite rapid increases in price. It would be safe to say that if and when shortages occur in the future, recreation participation and vacation driving will decline. However, experience suggests that these declines would not be permanent.

A national conference on recreation planning and development held last year in Snowbird, Utah, resulted in numerous reports outlining the future of recreation travel. As previously stated, recreation participation soon returns to preshortage levels despite rapid increases in price. The Department of Transportation reported that recreational travel, as measured by visits to major outdoor recreational resources, will grow about 3 percent per year, a lower rate than during the last 10 to 20 years. The response of the American public has been virtually to ignore the price change. It is expected that consumers will continue a high level of recreation participation regardless of changing energy policies. The Department of Transportation concluded that most citizens will continue to react to foreseen and unforeseen economic changes, resource shortages, and the like with behavior patterns that can be expected to preserve or increase participation in their preferred recreation activities.

A similar situation exists at Bayfield, Wisconsin, adjacent to the Apostle Islands in western Lake Superior. Both of these small-boat harbors exist as a result of an attraction to a unique natural resource. A report on recreational accessibility taken from the previously mentioned conference stated that demand is largely a function of the attractiveness of the area to nonresidents. In western Lake Superior, annual visitations are still projected to increase 25 percent from the current level by 1990. The Lake of the Woods, like the Apostle Islands, is a primary destination area. The Department of Transportation also stated that people will shift, and indeed are shifting, toward more fuel-efficient automobiles so that their driving habits can be maintained. These chances will probably result in high percentage of boats being permanently moored at marinas instead of trailered.

Effects of Recessionary Periods

The Department of Transportation in its report to the Recreation Planning and Management Conference described the following two possibilities related to the real disposable income of consumers:

1. Price substitution - It is possible to maintain normal levels of recreation participation at lower than normal price levels for virtually any recreation activity.

2. Deferral of major purchases - Recreation is considered an integral part of life. Recreation expenditures during periods of economic stress are treated the same as expenditures for necessities.

It is fairly certain that leisure time per individual will continue to increase in the foreseeable future, especially if energy concerns require individuals to switch to a 4-day work week. The effects of price substitution and deferral of major purchases will result in a continue increase in demand for recreation facilities.

Lake of the Woods Boat Facilities

There are currently estimated to be 36 private marinas and 25 water access sites within the counties bordering Lake of the Woods (Roseau and Lake of the Woods). An extensive study would be necessary to determine the amount of recreational boating generated by these facilities since no effective use monitoring efforts exist. The table on page 13 of the main report provides a good overview of the current facility capacity in the area immediately adjacent to the project.

SUPPLY

Warroad Harbor provides dock space for approximately 160 boats. Docks on private property along the river serve an additional 75 craft. An estimated [illegible]0 slips, used to capacity, are provided at a private marina at nearby Springsteel Island. A new residential subdivision, Warroad Estates, located about 2.5 miles north of the existing channel, is under construction. As a reflection of the growing attraction of the area, approximately 170 residential lots have been sold within the last several years without an extensive publicity campaign. The new complex will include 340 to 350 homes. Marina facilities to service these new homeowners are currently under construction; 185 slips were completed by June 1979. Currently, 95 of these slips are being rented.

The following table gives the distribution of boat sizes in the Warroad area.

Existing Warroad area boat size distribution by location (1)

Location	Boat size/percent of total for location		
Warroad River	0-15 feet/21	16-25 feet/64	25 feet/15
Springsteel Marina	16-18 feet/15	20-24 feet/70	26-28 feet/14 32 feet/1
Warroad Estates Marina (includes four 23-foot sailboats)	18-20 feet/45	22-24 feet/15	26-28 feet/30 30-35 feet/10

(1) These are power boats generally used for fishing except as noted. The trend over recent years has been toward larger motorboats and, more recently, larger sailboats.

RECREATIONAL BOATING NEEDS

The information obtained both from project area visits and review of current literature has indicated support for the following assumptions:

a. The current supply of berthing facilities for local and non-area boaters is quickly reaching capacity.

b. Growth indicators for new boating demand within the project area reflect between 5 and 8 percent average compounded annual growth.

Analysis of this information supports the conclusion that the demand for both seasonal and temporary berthing areas as well as other marina-related facilities is sufficient to support the navigational boating benefits described in this report.

PROJECT BENEFITS

The Heritage Conservation and Recreation Service, State of Minnesota, and city of Warroad have invested cooperatively in the development of a recreation complex which includes the subject marina facility, a campground, pool, and day-use park area. Construction of the access channel is essential to maximize public use and related economic returns for these facilities.

Projected benefits would accrue exclusively to recreational boating for both transient and Warroad-based boats. For purposes of this report, transient boating is being defined as trailered boats used at the project area by both local and nonlocal fisherman or boaters. This should not be confused with boats based at other marinas which occasionally use the harbor on a transient basis. Since area use for this type of transient boating is unknown, it is not being addressed in this report. The inland marina will initially provide seasonal berthing space for 100 home-based craft. The city is focusing its concern on the provision of facilities for transient boats to meet extended weekend fishing and camping related demands. The marina development plan calls for 90 transient boat slips. Relocation of transient recreational boating activities, including launchings, from the presently heavily congested river harbor will increase safety for boat operations.

The following benefit analysis is keyed to the projected boat usage of the project. This use rate was determined by identifying growth trends in area boat usage and the estimated boat demand that will be generated by the provision of lake access to the new marina facilities. Benefits are grouped into four use categories:

- Seasonal
- Camper boaters (existing)
- Camper boaters (future)
- Day use

Seasonal boat use of the harbor is expected to come from:

a. Those boaters who currently moor their boats in the Warroad Harbor but would transfer to the new marina when access becomes available.

b. Boaters now trailering their boats who would decide to use the new marina on a seasonal basis.

c. New boaters using boat facilities for the first time (either new residents or previous residents who take up boating).

Because of the lack of specific data on these three sources, the benefits for seasonal demand have been calculated as a whole. Day users are transient boaters who would use the harbor only for the daily launching and retrieving of their boats. The camper boater categories refer to users who would use mooring slips for a few days. Existing camper boater demand comes from campers who would use the new marina slips as soon as they are available. Future camper boater demand is projected to come from increased tourist activity attracted to the area by the recreational opportunities and the convenience of the proposed marina facilities. Once the project was completed, the camper boaters would use the marina slips. Therefore, they would need to launch and retrieve their boats only once during their stay.

The day use category and both classes of camper boaters fall under the heading of transient boaters as previously defined. The benefits for each of the three categories have been calculated separately. All transient boating demand figures have been converted to equivalent seasonal estimates based on the 140-day boating season in the Warroad area.

SEASONAL BOAT USE BENEFITS

Figure 2 of the main report shows three alternative growth curves for boating demand based on different assumptions of the annual growth rate. Boat registrations in area counties have increased substantially in recent years (average annual increases of 22 percent in Roseau County and 17 percent in Lake of the Woods County from 1971-1978). The following table shows benefits for seasonal boat use based on a conservative 5-percent average compounded annual growth rate. The 100-seasonal slip capacity of the marina has not been assumed to be reached until 1987. The benefits were discounted 6 years to reflect this lag.

Projected seasonal-use benefits (boats added because of natural growth)

Size of craft	Number of boats	Depreciated value: Average	Depreciated value: Total	Return on depreciated investment: Ideal rate of return (percent)	Return on depreciated investment: Percent of ideal: Without project	Return on depreciated investment: Percent of ideal: With project	Return on depreciated investment: Gain (percent)	Value
Outboards under 15 feet	27	$3,300	$89,100	12	0	90	10.8	$9,620
Cruisers 16 to 26 feet	65	9,300	604,500	10	0	95	9.5	57,430
Cruisers 27 to 40 feet	8	30,200	241,600	8	0	90	7.2	17,400
Total	100							84,450 (1)

(1) The equivalent average annual benefits adjusted using the average annual equivalent factor for 6 years of compounded growth and no growth for last 44 years (project interest rate of 7 1/8%) = $84,450 x 0.8227 = $69,500.

CAMPER BOATER BENEFITS (EXISTING)

The Warroad municipal campground adjacent to the project marina attracts many campers/fishermen. City campground receipts for 1978 show 3,600 camper days. City records also support the assumption that 70 percent of all campers have boats and use the lake for fishing.

Because of the quality of the new facility and its location next to the campground, this existing camper boater demand would be expected to transfer to the new marina upon completion of the access channel. Using the data just described, an estimate of 2,520 (3,600 x 0.70) existing transient slip days is generated. The 140-day boating season conversion factor results in a seasonal slip equivalent of 18 slips in 1978. At a 5-percent average compounded annual growth rate, there will be an existing demand for 21 seasonal equivalent slips when the access channel opens in 1981, as shown in the following table.

Transfer of existing camper boater craft

Size of craft	Number of boats	Depreciated value		Return on depreciated investment				
				Ideal rate of return (percent)	Percent of ideal		Gain (percent)	Value
		Average	Total		Without project	With project		
Under 15 feet	6	$3,300	$19,800	12	50	90	4.8	$950
16 to 25 feet	14	9,300	130,200	10	40	85	4.5	5,860
Over 25 feet	1	30,200	30,200	8	40	60	1.6	480
Total	21 (1)							7,290

(1) Assumes that 70 percent of existing camping use also engages in boating. This estimate is taken from Warroad's municipal camping receipt records.

This estimate is conservative because persons staying at area motels and private residences also generate a portion of the existing demand for transient slips, as do boaters from other marinas who visit the Warroad Harbor. However, because of the lack of quantifiable data on the amount of this use, only the campground data were used for this calculation.

A second, independent estimate of existing transient slip demand is based on the local estimate that approximately 50 percent of harbor boat launchings are by persons using the campground. The remaining 50 percent are by local day-use boaters and fishermen.

Data collected for a 1973 economic analysis of Warroad Harbor maintenance dredging showed 3,750 boat launchings in 1973. Based on a 5-percent average compounded annual growth rate, 5,540 boats will be launched in 1981. With a 50-percent transient use rate, a latent demand for 2,770 transient slip days will exist in 1981 (5,540 x 0.50). This is equivalent to 20 seasonal slips (2,770 ÷ 140).

The similarity of these two estimates of latent transient slip demand lends confidence to the results.

CAMPER BOATER BENEFITS (FUTURE)

Campground use in the region will probably continue to grow at an average compounded rate of 5 to 8 percent annually. This growth rate is consistent with past recreational studies and is probably conservative in light of recent improvements and expansion of the city's campground/marina complex and the expected growth in tourism that should result. The following estimates are based on a conservative 5-percent average compounded annual growth rate.

Projected recreational use and boating demand			
	Year		
Item	1978	1981	2003
Camper boater use	2,520	2,917	8,533
Equivalent seasonal boat slips (1)	18	21	61

(1) The conversion factor used here is 140. The Minnesota Department of Natural Resources has indicated that Lake of the Woods boaters use their boats an average of 40 times a year. The transient slip/seasonal slip equivalency factor was based on an average length boating season (consistent with EM 1120-2-113), resulting in a more conservative estimate.

As shown above, the camper boater use of transient slips will reach an average annual use of about two-thirds capacity about 22 years after the project is completed. Because this type of use is heaviest on holidays and extended weekends, all 90 transient slips will probably be used only 3 to 4 days a week. The following table shows project benefits for 40 future growth transient slips. Benefits are discounted over a 22-year growth period to account for this use pattern.

Benefits for future growth of camper boater use

Size of craft	Number of boats	Depreciated value: Average	Depreciated value: Total	Return on depreciated investment: Ideal rate of return (percent)	Percent of ideal: Without project	Percent of ideal: With project	Gain (percent)	Value
Under 15 feet	12	$3,300	$39,600	12	0	90	[illegible]	[illegible]
16-25 feet	27	9,300	251,100	10	0	[illegible]	[illegible]	[illegible]
Over 25 feet	1	30,200	30,200	8	0	90	[illegible]	[illegible]
Total	40							[illegible](1)

(1) Equivalent average annual benefits are adjusted using average annual equivalent factor for 22 years of compounded growth and no growth for last 28 years ($30,300 x 0.4724 = [illegible]).

DAY-USE [illegible]

Field observations and discussions with area recreation planners established that the municipal boat ramp handles about 90 percent of the day use launching activity in the Warroad area. Annual boat launchings are anticipated to increase from 3,750 in 1973 to 5,540 in 1981, again assuming a 5-percent average compounded annual growth rate.

Consistent with earlier findings, an estimate can be developed to determine the number of launchings which will be transferred from the present municipal ramp which will be relocated to the marina. The new ramp will be of much better quality than the two local competing ramps which are now used primarily during peak periods. The new ramp will also provide increased wave protection, parking and sanitary facilities which are lacking at the other locations.

Assuming that 50 percent of all launching is attributable to day users and that 90 percent of these launchings use the municipal ramp, day-use launching rates can be projected as indicated below.

Projected day-use launchings

Use	1981	1991
Total Warroad Harbor launchings	5,540	-
Day-use launchings (50 percent of total)	2,770	-
Marina launchings (90 percent of day use)	2,495	4,065
Equivalent seasonal berths at proposed marina (marina launchings ÷ 140-day boating season)	18	29

The benefits shown in the following table have been held constant beyond 10 years because the impact of competing facilities is difficult to forecast beyond this period of time. This consideration insures a more conservative estimate.

Projected day-use benefits (1)

Size of craft	Number of boats	Depreciated value: Average	Depreciated value: Total	Return on depreciated investment: Ideal rate of return (percent)	Percent of ideal: Without project	Percent of ideal: With project	Gain (percent)	Value
Under 15 feet	8	$3,300	$26,400	12	60	80	2.4	$630
16-25 feet	20	9,300	186,000	10	55	75	2.[illegible]	3,720
Over 25 feet	1	30,200	30,200	8	50	70	1.[illegible]	480
Total	29							4,830 (2)

(1) Estimate assumes an 18 craft-equivalent seasonal use transferred from Warroad River Harbor upon project completion (1981) with straight growth for 10 years to reach acceptable capacity of 29 craft.

(2) Benefits must be adjusted to reflect 10-year growth period for day launching activity at the project using average annual equivalent factor for 10 years of compounded growth and no growth for last 40 years ($4,830 x 0.7100 = $3,430).

BOAT VALUE

Boat value was determined through a telephone survey of boat dealers in the Twin Cities metropolitan area in May 1979. An outside consultant analyzed a similar, earlier survey to determine if the values were applicable to northern Minnesota. The analysis concluded that they accurately reflected area retail prices. These values have been updated to May 1980 levels.

DEPRECIATED AVERAGE VALUE

The standard approach generally used to determine the depreciated average value of each class of boats is to estimate the boats' market values at the midpoint of their service lives. Based on straight-line depreciation, this value is one-half the boats' new market values. This is the conventional approach used by most Corps small-boat harbor studies and has been applied in this analysis. The following table shows average values for each class of boats.

Summary of survey data to determine average boat value by size[1]

Type of craft	Boat length (feet)	Average value[2]	Average value by type
Outboard	14	$3,100	
	15	5,900	$6,600
	16	8,500	
	19	9,000	
Cruiser	17	11,800	
	20	14,400	
	22	17,100	
	23	18,300	18,900
	24	21,000	
	25	21,200	
	26	25,400	
Cruiser	27	32,000	
	28	33,700	
	30	43,700	
	32	49,400	
	33	53,300	60,400
	35	59,800	
	36	80,100	
	37	91,700	
	40	99,900	
Cruiser	44	173,200	
	45	227,600	
	47	255,300	267,500
	50	267,500	
	54	284,200	
	58	397,400	
Sailboat[3]	17	6,700	
	19	6,900	11,500
	23	13,700	
	26	18,600	
Sailboat	27	25,500	
	29	36,600	
	32	44,400	
	34	50,000	69,300
	35	52,200	
	37	81,000	
	39	103,200	
	42	161,000	

(1) May 1980 prices.
(2) Includes median accessory costs.
(3) Outboard power models.

IDEAL RATE OF RETURN

Benefits for recreational boating harbors are based on the net return on the depreciated investment in a for-hire fleet of similar small boats. The method assumes that the owner of a recreational boat places a similar value on the availability of his boat and water area as the net return a for-hire owner of the same boat would receive. The method for calculating recreational benefits is given in Corps EM 1120-2-113.

The ideal rate of return is the percentage of net annual return for hire (recreational value) that could be assumed to accrue to each class of boats if ideal harbor conditions were available. Studies of boating operations in several parts of the country have established a range of percentages for various classes of boats. Ideal rate of return percentages used in the benefit calculations were selected from percentage ranges given in EM 1120-2-113. The percentages were selected from approximately the middle of each range.

PERCENT OF IDEAL RATE OF RETURN

The ideal rate of return is based on the availability of ideal harbor conditions. Inadequate harbor facilities may restrict full realization of recreational benefits. Navigation obstacles, shortage of boat slips and boat servicing facilities, natural harbor restrictions, and local weather conditions are some of the things which could restrict realization of the ideal rate of return. The difference between the percent of ideal rate of return without the project and with the project is a measurement of the increase in recreational benefits which will result from project construction. The following table summarizes the factors affecting the percent of ideal rate of return for each category of use, both without and with the project.

Percent of ideal rate of return

Use category	Percent	
	Without project	With project
Seasonal slips (future)	0; presently at capacity.	90-95; nearly ideal conditions, restricted by the need to obtain fuel in Warroad River.
Camper boater (existing)	40-50; restricted by congestion and safety hazards in Warroad River, need to launch boats daily during average 4-day stay, auto/trailer maneuvering and parking congestion, and ramp capacity. Launching ramp lacks wave protection.	60-90; restricted only by the need to obtain fuel in Warroad River. Other marina-related facilities will be readily available.
Camper boater (future)	0; transient boater launching and camping facilities presently at capacity.	90-95; restricted only by the need to obtain fuel in Warroad River. Other marina-related facilities will be readily available.
Day use (existing and future)	50-60; restricted by congestion and safety hazards in Warroad River, auto/trailer maneuvering and parking congestion, and ramp capacity. Ramp lacks wave protection.	70-80; restricted only by the need to obtain fuel in Warroad River.

The following table summarizes annual project benefits.

Total estimated annual project benefits

Use category	Benefit
Seasonal	$69,500
Camper boater (existing)	7,290
Camper boater (future)	14,330
Day use	3,430
Total	94,550

REFERENCES

Souris-Red-Rainy River Basins Comprehensive Study - Volume 5 - Appendix 1, Recreation & Preservation, 1972.

"Upper Great Lakes Regional Recreation Planning Study Part 2: Recreation Demand - Survey & Forecasts," Recreation Resources Center, University of Wisconsin - Extension - 1974.

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"Tourism in the Lake of the Woods - Rainy Lake Area" - Uel Blank, University of Minnesota - November 1971.

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Draft State Comprehensive Outdoor Recreation Plan, Minnesota Department of Natural Resources, 1979.

ENVIRONMENTAL ASSESSMENT
WARROAD, MINNESOTA
SMALL BOAT HARBOR
CHANNEL CONSTRUCTION

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ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE AND CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

ENVIRONMENTAL ASSESSMENT

WARROAD, MINNESOTA
SMALL BOAT HARBOR
CHANNEL CONSTRUCTION

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ENVIRONMENTAL ASSESSMENT

WARROAD, MINNESOTA
SMALL BOAT HARBOR
CHANNEL CONSTRUCTION

INTRODUCTION

The purpose of this statement is to assess the environmental impact of the proposed St. Paul District, Corps of Engineers channel construction at Warroad, Minnesota. This assessment has been drawn in part from a 1974 environmental assessment study of Warroad Harbor dredging and from a Section 107 Navigation Reconnaissance Report (1974) prepared by the St. Paul District, Corps of Engineers.

1.00 PROJECT DESCRIPTION

Project Location

1.01 The city of Warroad is located in Roseau County, in northwestern Minnesota (Figure J-1). The city is situated on both banks of the Warroad River, which flows into Muskeg Bay at the southwestern extremity of Lake of the Woods 6 miles south of the United States-Canadian border, at 48°54' north latitude and 95°16' west longitude. A boat harbor basin is located within Lakeview Park, a city-owned park on the shore of Lake of the Woods and the north bank of the Warroad River. No marina facilities are presently located in the boat harbor which was constructed by the city in 1972. An excavated channel connects the boat harbor basin to the lake, but does not extend to deep water and does not provide access to the boat basin from the lake.

Project Authorization

1.02 This project has been designated for funding under the Corps of Engineers Continuing Authorities program, Section 107, River and Harbor Act of 1960. In 1973 the Corps of Engineers initiated a Section 107 reconnaissance study to determine the feasibility of constructing a deepwater channel to connect with the boat harbor. This was done in response to a resolution of the Warroad City Council requesting such a study.

Project Purpose

1.03 The purpose of this project is to provide an access channel to deep water in Lake of the Woods from the Warroad municipal boat harbor and marina. No navigable access exists at the present time although the harbor has been completed.

Description of the Project

1.04 Five structural alternatives were proposed. These were described as Alternatives A, B, C, D, and E. Of these, alternative D was selected for the proposed project. The others are examined in Section 6.00, Alternatives to the Proposed Action.

1.05 Deepwater access to Lake of the Woods would be obtained by the excavation of a channel from the existing marina basin to the Warroad River (Figure J-2). The channel would be 1700 feet long with a 55-foot bottom width, an average water depth of 10 feet, and would be constructed overland, linking with the southeast edge of the existing canal connecting the two mooring basins. It would then intersect County State Aid Highway (CSAH) 74, turn southerly, and proceed parallel to the shoreline to connect with the Warroad River channel approximately 100 feet upstream of the protective jetty at the river mouth. A protective berm about 2.5 feet high and 10 feet wide at the top would be constructed along the lakeward side of the channel. The marina channel would require the excavation of 58,000 cubic yards of material. Currently, a 6-foot deep channel, excavated by the Corps of Engineers, extends from the Canadian National Railroad bridge in Warroad to the 6-foot depth contour in Lake of the Woods. Protected by a short jetty extending lakeward from the north bank of the Warroad River, this channel is 8,900 feet in length and 5,100 feet from the river mouth to deep water. The proposed channel would connect with the existing Warroad River channel near the river mouth.

Existing Projects

1.06 The U.S. Government is responsible for the maintenance of the existing channel connecting the Warroad River and deep water. This channel is 6 feet deep, 100 feet wide, and 9,100 feet long, and connects with a 900-foot turning basin.

1.07 The Corps of Engineers is involved in channel and harbor activities at Baudette and Pine Creek (Northwest Angle) Harbors on Lake of the Woods.

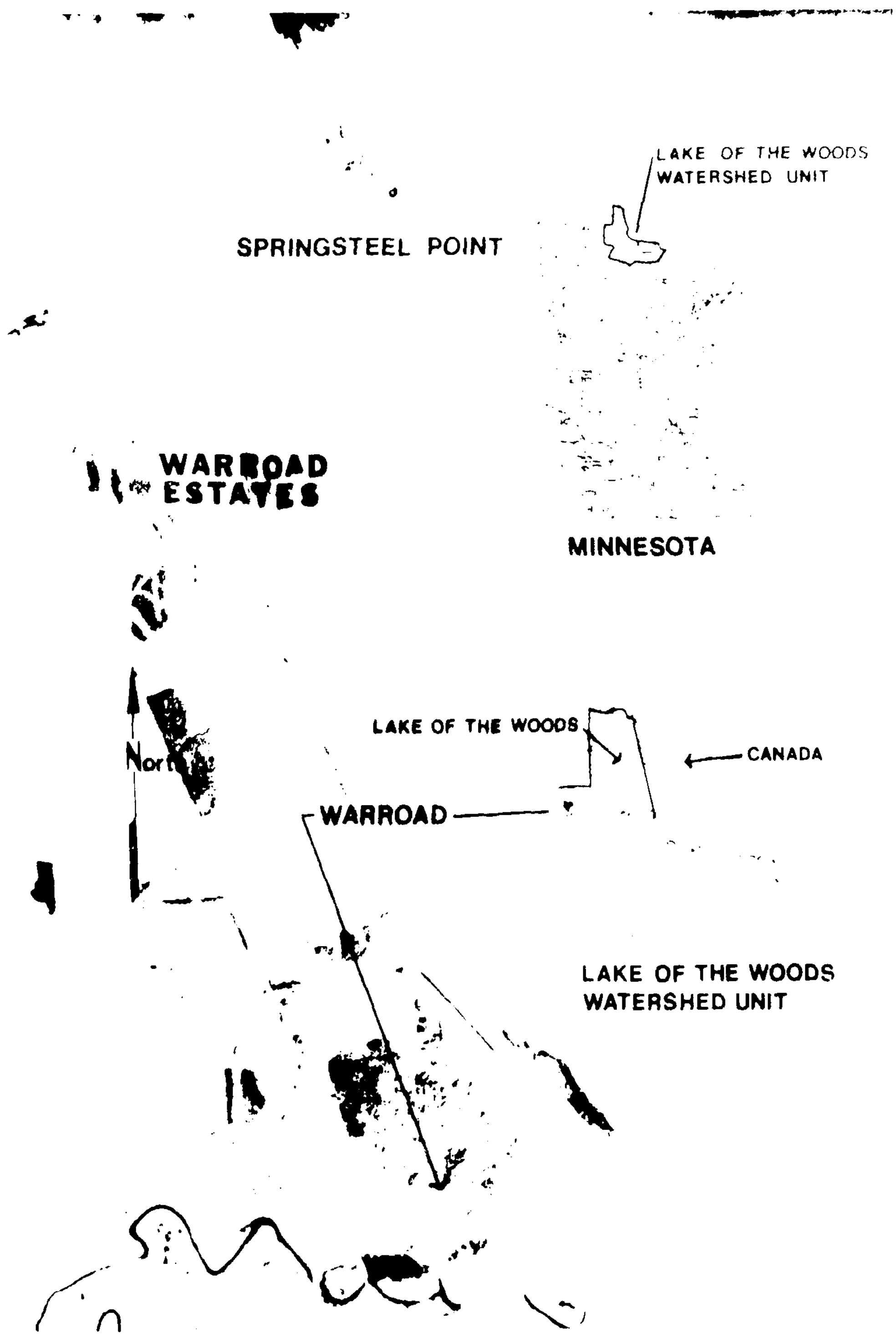
1.08 The city of Warroad is developing the park within which the proposed project would be built. The campground encircling the marina basins is in use although not complete. A municipal swimming pool has been constructed in the park. Removal of the sewage plant to a location outside of the city park is scheduled for 1980-1983.

Economics

1.09 The proposed project has a benefit-cost ratio of 1.97 to 1. Total project cost, including construction of the channel and removal of the sewage plant settling basins, is $539,300. Average annual costs over the 50-year project life are $48,100.

1.10 Benefits would accrue to boat owners utilizing the new marina. Average annual benefits would be $7,290 for transient boats transferring to the new harbor, $69,500 for Warroad-based boats added because of natural growth, $14,330 for new transient boats added due to natural growth or attracted by improvements, and $3,430 for boats launched for day use. Net annual benefits would be $94,550.

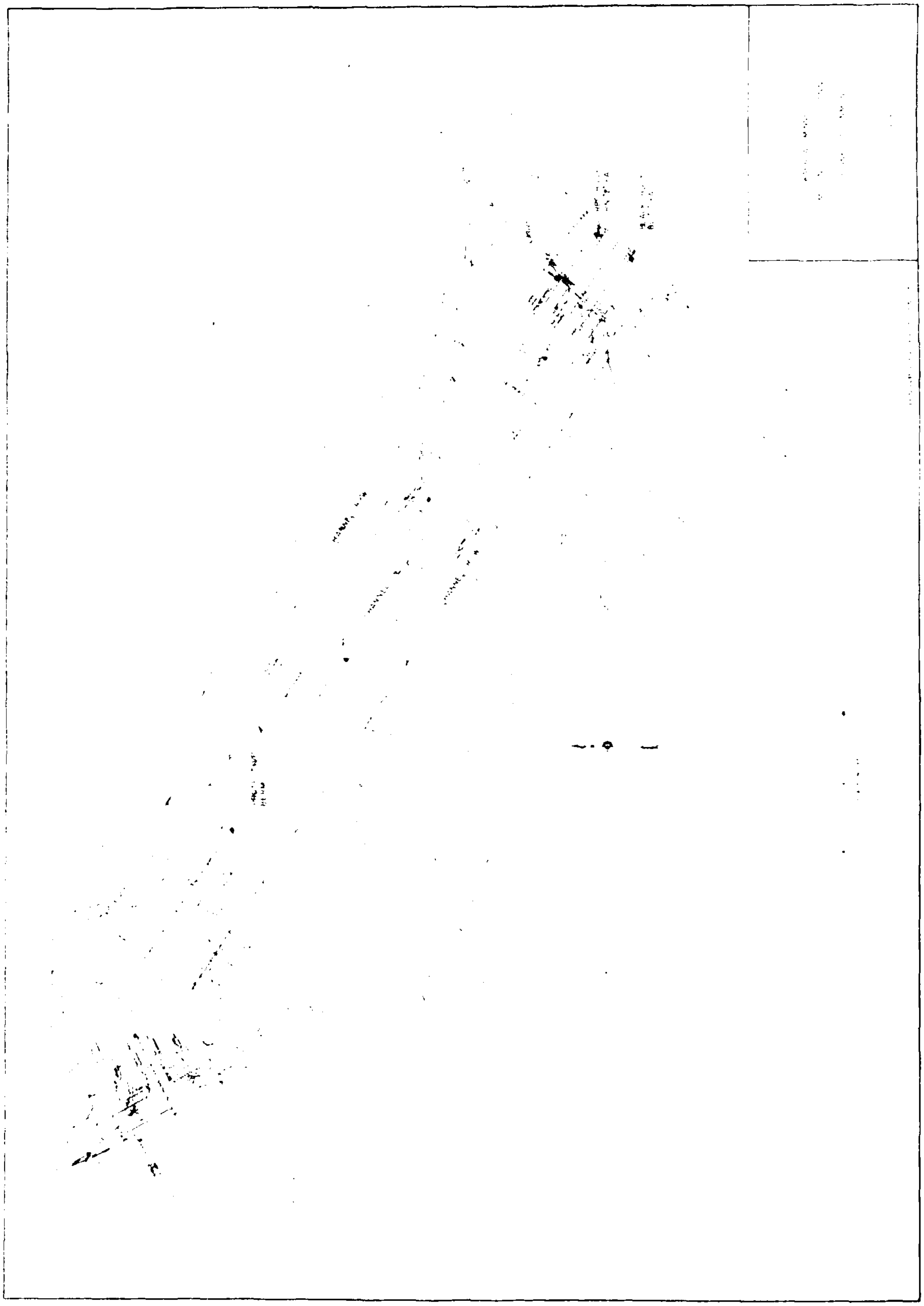
1.11 Section 107 of the River and Harbor Act of 1960, as amended, requires that local interests provide without cost to the United States all lands, easements, and rights-of-way required for the project. Also, the local sponsors (i.e., the city of Warroad) must pay 50 percent of the general navigation facilities cost.



LOCATION MAP

E. A. HICKOK & ASSOCIATES
Engineers – Hydrologists
Minneapolis Minnesota

FIGURE J-1



2.00 ENVIRONMENTAL SETTING

Natural Environment

Lake of the Woods

2.01 Lake of the Woods lies on the international boundary between Minnesota and the Canadian provinces of Ontario and Manitoba. It is 1,485 square miles in area, with approximately 470 square miles within Minnesota. The northern two-thirds of the lake contains about 14,000 islands, but the lower third is mostly open water with only 25 islands.

2.02 The Minnesota portion of the lake has a maximum depth of 36 feet and an average depth of 24 feet. Approximately 23 percent of the Minnesota portion of Lake of the Woods is less than 15 feet deep. At Warroad, the 6-foot depth contour occurs about a mile offshore in Muskeg Bay.

Soil and Geology

2.03 Roseau County is generally flat with occasional low ridges of sand and gravel, thought to be remnants of beach ridges of glacial Lake Agassiz which once covered the area.

2.04 A depth of 75 to 115 feet of water-deposited clay, silt, and sands overlays the crystalline bedrock of the Warroad area. Little bedrock is exposed.

2.05 In the Warroad area, mineral soils have been formed from lacustrine (lake-formed) clays and modified glacial till. Approximately one-third of the soils are organic (peat). The shore of Lake of the Woods along Muskeg Bay is a peat bog extending as much as one-half mile inland.

Surface Drainage

2.06 Drainage is generally poor in Roseau County. Average land slope of 7 feet per mile, fine-grained topsoils with compacted subsoils, and a high water table are the causes of this condition. Extensive networks of drainage ditches have been constructed to alleviate this problem.

2.07 The eastern portion of Roseau County is drained by the Warroad River, which empties into Lake of the Woods. The river's headwaters are in a swampy area 13 miles south of Warroad. The river has a well-defined channel and a relatively narrow floodplain. Approximately 2 miles west of Warroad, the river turns eastward and broadens. Prior to dredging and disposal, the river was about one-quarter mile wide at the mouth.

2.08 There are no permanent lakes, other than Lake of the Woods, in the area. Numerous shallow depressions from burned-out peat bogs provide temporary storage for runoff water.

Climate

2.09 The mean annual temperature at Warroad is 37.3° F. The average January temperature is 1.1°, with a recorded minimum of -50°. The average July temperature is 67.3°, with a recorded maximum of 103°.

2.10 The average annual precipitation is 20.7 inches. Snow accounts for approximately 4.7 inches.

2.11 Prevailing winds are usually from the northwest in winter and the south in summer.

Flora

2.12 Present forest vegetation in eastern Roseau County consists of balsam fir (Abies balsaemea), white pine (Pinus strobus), spruce (Picea sp.), poplar (Populus sp.), elm (Ulmus sp.), ash (Fraxinus sp.), birch (Betula sp.), and tamarack (Larix laracina). Poorly drained areas contain willow (Salix sp.), tag alder (Alnus rugosa), birch, and small poplar. Ground cover in the bogs is dominated by sphagnum moss (Sphagnum sp.), leatherleaf (Chamaedaphne calyculata), and Labrador tea (Ledum groenlandicum). A few of the marshy areas support stands of wild rice (Zizania aquatica).

Fauna

2.13 Approximately 50 species of mammals occupy the forests of the area, including white-tail deer (Odocoileus virginianus), black bears (Ursus americanus), foxes (Vulpes fulva, Urocyon cinereoargenteus), skunks (Mephitis sp.), porcupines (Erethizon dorsatum), squirrels (Sciurus sp.), mice (Peromyscus sp.), weasels (Mustela sp.), beaver (Castor canadensis), and snowshoe hares (Lepus americanus). The moose (Alces alces), and the timber wolf (Canis lupus), inhabit the area. Rare or uncommon animals such as pine marten (Martes americana), fisher (Martes pennanti), and otter (Lutra canadensis) may be living in isolated parts of the forest.

2.14 Amphibians and reptiles are not abundant in the region. There may be a dozen species.

2.15 Lake of the Woods supports a population of over 38 species of fish. An important commercial fishery has existed there since 1885. Over 99 percent of test gillnet catches between 1968 and 1970 were composed of six species of fish (Schupp, 1974): walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), tullibee (*Coregonus artedii*), and white sucker (*Catostomus commersoni*). Only the last two are not important to the sport fishery. Other species taken by gillnets include lake sturgeon (*Acipenser fulvenscens*), silver redhorse (*Moxostoma anisurum*), mooneye (*Hiodon tergisus*), smallmouth bass (*Micropterus dolomieui*), and burbot (*Lota lota*).

2.16 Sport fishing is an important aspect of the recreational use of Lake of the Woods. A 3-year study (1968-1970) by the Minnesota Department of Natural Resources (MDNR) (Schupp, 1974) showed that an average of 537,105 man-hours for open water fishing and 42,950 man-hours for winter fishing were expended per year, about 86 percent on Minnesota waters. Catches of walleyes, accounted for 81 percent of the total catch by number and 83 percent by weight. Only three other species were caught by sport fishermen. In order of abundance, these were sauger, northern pike, and yellow perch.

2.17 The 3-year (1968-1970) average catch per unit effort was 0.52 walleyes per man-hour. This may be considered an excellent fishing success rate since catch rates of 0.20-0.50 walleyes per man-hour provide satisfactory fishing at other Minnesota lakes.

Water Quality

2.18 The excellent walleye fishery and diverse fish community reflects the water quality of Lake of the Woods. According to the Minnesota Pollution Control Agency, the lake is moderately high in nutrients and is productive, but has been stable over a long period. Although algae blooms are typical, dissolved oxygen levels are high and no degradation has been noted. Sediments in and near the mouth of the Warroad River have elevated levels of several potential pollutants; however, no specific guidelines have been established for evaluating sediment quality in Lake of the Woods. The marina basin for which the proposed project would provide a navigable access channel does currently have a physical connection to Lake of the Woods. As a result, water level fluctuations in Lake of the Woods, as well as runoff and groundwater seepage, appear to cause water exchange and prevent stagnation. The water in the basin is clear and supports aquatic plant growth (macrophytes) but not algae blooms.

Endangered and Threatened Species

2.19 The Eastern timber wolf was listed as endangered on the Federal List of Endangered and Threatened Species published 14 July 1977. The Fish and Wildlife Service changed the classification on 9 March 1978 to threatened in Minnesota and designated five zones of varying levels of protection and control. Warroad is in Zone 4, peripheral wolf range, where depredation control may be practiced.

2.20 The project area is within the range of the bald eagle (*Haliaeetus leucocephalus*) which is listed as threatened in the State of Minnesota. The endangered Arctic peregrine falcon (*Falco peregrinus tundrius*) may migrate through Roseau County in the spring and fall but would not find suitable nesting habitat in the flat terrain.

2.21 Lake of the Woods was once known as one of the world's best sources of lake sturgeon because of its commercial yield of that fish (Scott and Crossman, 1973). The intense, indiscriminate 19th century fishery, the effects of pollution and dams on reproduction, and the advanced spawning age (12-23 years) have contributed to the decline of the lake sturgeon. No reproducing population of lake sturgeon presently exists in Lake of the Woods, although a few migrants from the Rainy River are caught occasionally. The species is presently listed for special consideration and management by the State of Minnesota as one with a changing or uncertain status. A major habitat change could cause the lake sturgeon to become threatened. It is presently protected from commercial fishing, and a minimum size limit and season are imposed on sports fishing.

Social Setting

Population

2.22 At the U.S. Census of 1970, the median age of the municipal population was 35.6 years, markedly higher than the statewide median of 26.8 years. According to this census, Warroad had a population of 1,086, indicating a decline of 17 percent during the decade 1960-1970.

2.23 Following the trend of declining population in Roseau County in the previous decade, Warroad appears to have had a population increase between 1970 and 1975, with a 13.7 percent advance compared to a gain of 5.5 percent in the county (Table J-1).

TABLE J-1 POPULATION IN WARROAD AND ROSEAU COUNTY (1950-2000)

	WARROAD		ROSEAU COUNTY	
	No.	Percent Change	No.	Percent Change
1950	1,276	-	14,505	-
1960	1,309	+2.6	12,154	-16.2
1970	1,086	-17.0	11,569	-4.8
1975	1,235	+13.7	12,200	+5.5
1980 (1)	-	-	12,100	-0.8
1990 (1)	-	-	12,700	+5.0
2000 (1)	-	-	12,800	+0.8

Source: U.S. Bureau of the Census, Characteristics of the Population.
(1) Projections derived from OBERS Series E data.

[illegible]

[illegible]

[illegible], JUNE 1967

[illegible]	Number	Percent
[illegible], and Fisheries	36	1.1
[illegible]	96	[illegible]
Transportation, Communication, and [illegible]	77	[illegible]
[illegible]	709	22.5
[illegible]	[illegible],779	56.[illegible]
[illegible]	460	14.6
[illegible]	3,148	79.[illegible]
[illegible]	811	20.5
[illegible]	3,959	100.0

[illegible] Department of Employment Services, and [illegible] "[illegible]" unemployment compensation.

[illegible] unemployment [illegible] for the full labor force [illegible] Minnesota [illegible] coverage) [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	Unemployment	
			No.	Rate
[illegible]	[illegible]	4,924	566	10.3
[illegible]	[illegible]	4,609	656	12.5

[illegible] Department of Employment Services

[illegible] information on employment and industry is not [illegible] the municipality of Warroad. In the following [illegible] and its distribution in the local economy will be [illegible] through narrative description.

2.27 The largest single employer in Warroad is Marvin Lumber and Cedar Company. This firm manufactures wooden window units and other millwork, and operates grain elevators, a marine store, and marina. Gross sales exceed $10,000,000 annually and the firm has approximately 800 employees.

2.28 Other major employers are Christian Brothers, Inc., a hockey stick manufacturer with 27 employees; Cal's Motel, a resort complex with 50 employees (seasonally); and Thermo-Lite, Inc., a manufacturer of insulated windows with 10 employees. The public school system employs a total of 81 persons. Other sources of employment are Canadian National Railroad, Burlington Northern Railway, commercial fishing operations, and retail stores.

2.29 Forestry and agriculture were once important industries but are on the decline. Most of the raw timber has been harvested and existing timber consists mostly of smaller, second-growth trees, suitable only for use as pulpwood. Some pulpwood is harvested and shipped to International Falls, Minnesota, for processing, but this is not a large industry. The number of farms declined from 1,077 in 1940 to 389 in 1964, a decrease of 63.7 percent. Many farms are part-time operations, with farmers coming into Warroad for employment.

Harbor-Related Employment

2.30 An estimated 65 persons work at harbor-related jobs, including seasonal employees. Cal's Motel has about 35 motel and restaurant employees, 8 fishing guides and 7 attendant personnel. Two independent fishing guides also operate out of Warroad. Six persons are employed by the seaplane flying service, and the U.S. Bureau of Customs has a pilot for its seaplane. Four are employed at Marvin Marine, which operates a marina, and sells and repairs boats. There are 13 commercial fishermen and about 7 others employed in processing, transporting, and marketing the catch.

Commercial Fishing

2.31 Lake of the Woods has been fished commercially since the 1880's Most of this is rough fish, and an estimated 85 percent of the commercial fish catch for the period 1955-1969 was used as mink feed on nearby ranches. Most of the fishermen use gill nets, although some have pound or fyke nets.

2.32 The 1972 commercial fish catch from U.S. waters on Lake of the Woods totaled 1,444,500 pounds, worth approximately $188,100. Over half the catch consisted of tullibee, a variety of rough fish, particularly valued by mink farmers. Of the 18 fishermen licensed to fish commercially on Lake of the Woods, 13 operate out of Warroad. If one assumes that the catch was divided equally among all fishermen, the catch at Warroad in 1972 would have been valued at approximately $135,800.

2.33 The one fish packing house in Warroad (owned and operated by a Motley, Minnesota, resident in conjunction with a fish wholesale operation held there) employs an estimated seven persons in processing, transporting, and marketing the catch. The 19 mink ranches in the Lake of the Woods-Rainy Lake region depend heavily upon the commercial fishery as a source of feed.

2.34 Figure J-3 represents commercial activity at Warroad Harbor from 1955 to 1971 showing the principal component of this commerce - local fresh fish. Data have been obtained from records of the U.S. Corps of Engineers, St. Paul District, and from Waterborne Commerce of the United States, an annual publication of the Corps of Engineers. Total commerce gradually increased from 1955 onward to a peak of almost 2,200 tons in 1961, then declined gradually, reaching barely above 500 tons in 1971. The reason for the decline is two-fold. It results partly from the decline in the volume of the commercial fishing catch, and partly from the reduction in freight volume moved by water since the completion of the road to Angle Inlet in 1968. Prior to that time, all supplies needed at Angle Inlet had to move by water.

Transportation

2.35 Minnesota Trunk Highway (TH) 313 originates in Warroad and runs north to Winnipeg, Canada. TH 11 runs east and west to International Falls and North Dakota, respectively.

2.36 Warroad is served by several trucking firms, both local cartage and common carriers. Railroad freight service is provided by Canadian National Railway (CCN) and Burlington Northern. There is a municipal airstrip located 3 miles north of Warroad which is lighted and has a 3,?00-foot paved runway. Water-based aircraft also serve the Warroad area and with the airport, are used quite heavily during the summer season. Warroad serves as a distribution center for the immediate area.

Utilities

2.37 The electric power distribution system is owned by the village of Warroad. Power is purchased from Roseau Electrical Cooperative. The natural gas distribution is also owned by the village. Water is obtained from local wells. The village has its own sewage treatment plant, with construction of a new one scheduled for 1980-1983. Phone service is provided by Northwestern Bell.

Community Services

2.38 The village owns a 22-bed hospital and a 30-bed nursing home, so a wide range of medical services are available in town. There is a small retail and service sector, consisting of one bank, a liquor store, grocery stores, service stations, an auto dealer, hardware stores, appliance stores, drug stores, and the like. The nearest major regional shopping and services centers are Winnipeg, Canada, and Grand Forks, North Dakota, both approximately 120 miles away. Warroad has an elementary and a high school. Enrollment in 1972 totalled 746 children in grades K through 12. The professional staff numbered 45 in 1972, with a supporting staff of 36 persons. No post-secondary educational facilities exist in the city.

Warroad Harbor - Commercial and Recreational Significance

2.39 The harbor in the Warroad River is heavily used for a variety of purposes. It serves as a base for seaplanes, commercial fishing boats, and limited commercial shipping. It provides slips and service to approximately 235 recreational craft. Swimmers and water skiers use the harbor and swimming beach. It also provides a harbor-of-refuge from storms on Lake of the Woods.

2.40 Inhabited islands in Lake of the Woods are supplied by commercial vessels and by seaplanes which also carry passengers.

2.41 Recreational boaters use a private marina with 50 slips, a village marina at Hospital Bay with 75 slips, and numerous private slips. A resort complex at the river mouth rents boats, provides charter trips, and sells bait and supplies. Both the resort and the private marina sell gasoline and have launching ramps.

Lakeview Park - Recreation

2.42 A municipal park, swimming pool, and campground are located on the north bank of the river extending along the lake shore. A boat ramp located on the river bank contributes to congestion and safety hazards near the harbor mouth.

2.43 The city park on the shore of Lake of the Woods consists of open land with scattered stands of trees along the lake shore. A picnic area is located in a stand of trees along the western edge of the park. The majority of the park land is composed of campsites along the periphery of two boat mooring basins connected by a canal.

2.44 The city's master plan for the park calls for an access channel from the marina to navigable water, relocation of the boat ramp within the park, construction of a swimming pool, and abandonment of the city

WARROAD HARBOR, MINNESOTA

Tons of Commerce and Major Component, 1955-1971

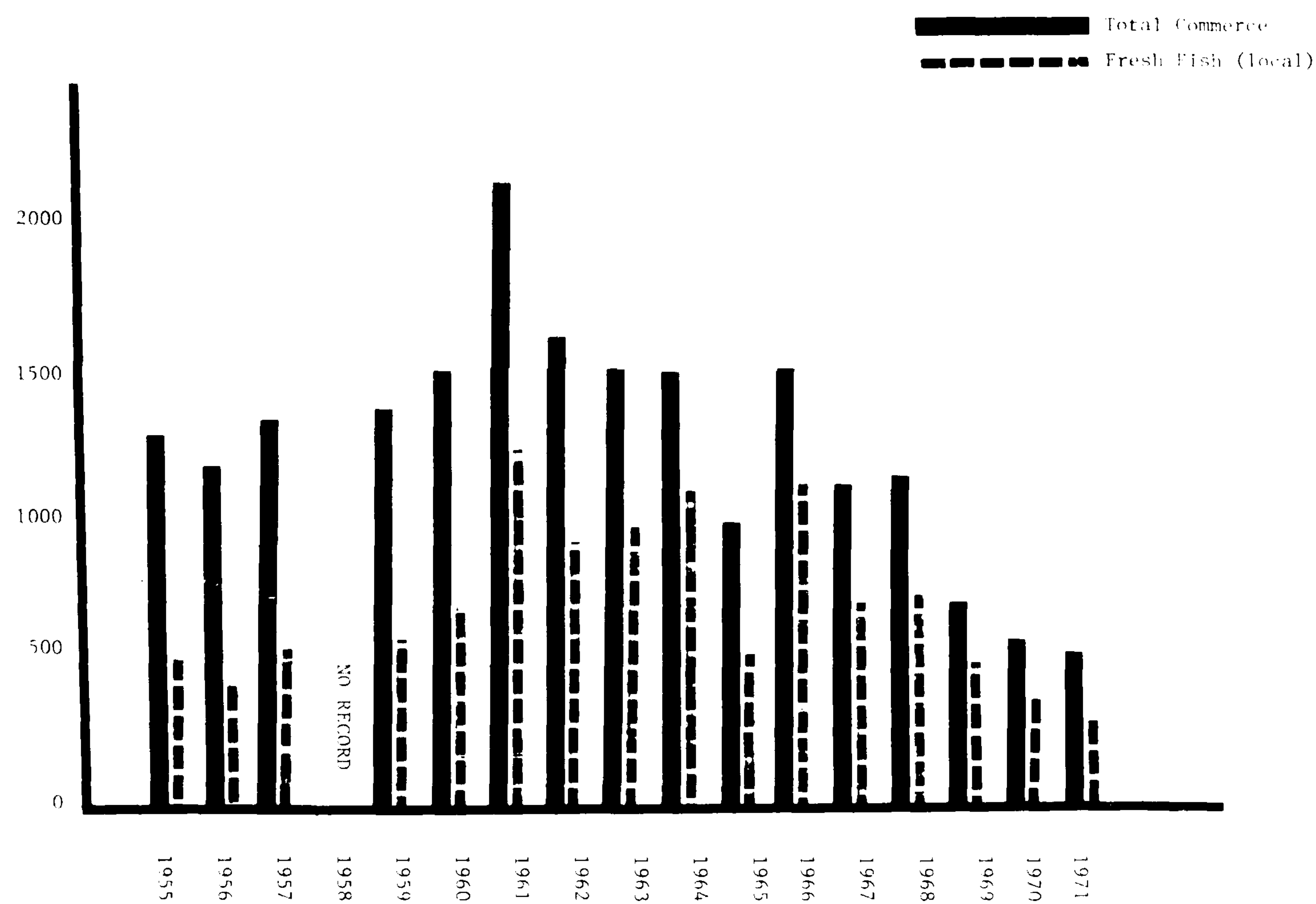


FIGURE J-3

beach. In addition, the city sewage plant will be removed from the park, and landscaping and parking facilities will be developed. The proposed project is an integral part of this plan.

2.45 To complete the development of the marina, the city would add 100 slips for area home-based craft. An additional 90 slips may be provided for transient boats to meet weekend fishing and camping-related demands. Sanitary facilities will be provided for boaters, and a pumping station to service boats with sanitary holding tanks will be installed.

Other Recreation

2.46 Lake of the Woods has long been a popular resort area and Warroad is the primary access point to the resorts. A municipal park and campground are just west of the mouth of the Warroad River on the lakeshore. Camping spaces, picnic facilities, a swimming beach, and a boat launching ramp with parking spaces are provided.

2.47 Springsteel Island is a small resort about 4 miles north of Warroad. A marina with 300 boat slips, camping space, and many second homes are at this site.

2.48 Lake of the Woods has some of the best fishing waters in the State. A creel census conducted by the Minnesota Department of Natural Resources indicated that Lake of the Woods was nearly twice as productive as inland State lakes. Warroad Harbor is one of the most active harbors on the lake and offers some of the best walleye fishing in Minnesota. Ten fishing guides are employed in Warroad.

2.49 Snowmobiling and cross-country skiing are popular in the area.

Cultural Resources

Artifacts

2.50 A record and literature review and field survey was conducted in order to identify and locate any known and previously unknown cultural resources in the area of the proposed access channel, recreational facilities, and potential disposal sites. Although it was anticipated that the remains of a large Chippewa village and cemetery, and an American Fur Company Trading Post would be located in the Lakeview Park area, no significant remains were recovered during the field testing of project areas. Because the park area has been deeply filled with dredged deposits, there is a possibility of encountering deeply buried remains during excavation of the access channel. An archaeologist would be present during channel excavation, in the event that any previously undetected remains are uncovered. The following paragraphs briefly describe the history of the Warroad vicinity.

Early History

2.51 The historic period in this area began in 1732 with the arrival of the French explorer La Verendrye, who established Fort St. Charles on the Northwest Angle. According to his records, the Assiniboine and the Cree Indians were living in the area at the time of the initial historic contact. By 1800, these tribes had been displaced by the Chippewa who had been living along Lake Superior. The Chippewa and numerous other Indian groups living in the Great Lakes region had been forced to move westward by the Iroquois, who were waging war in the east for control of the fur trade.

2.52 One of the largest Chippewa villages along Lake of the Woods was located at the present site of Warroad. Dating from before the 1800's, this historic settlement and cemetery were continuously occupied for over a century.

2.53 The American Fur Company maintained a post from about 1820 to 1833 on the north side of the mouth of the Warroad River near Lakeview Park, although its exact location is unknown. Little information is available regarding this post. An earlier Hudson Bay Post from the British fur trade period was also located in the Warroad area.

2.54 In 1899, the settlement at Warroad consisted of a few homes scattered along the river, an independent trading post on the north side of the river, Indian tepees, Indian burials, an old log cabin, and a store. In 1901, the town of Warroad was incorporated.

2.55 Several major travel routes passing through the area were used for a number of years. The name Warroad is derived from the river emptying into Lake of the Woods which was used by the Sioux as a "war road" for gaining access to the lake's rice fields, which were controlled by the Chippewa. Between Warroad and Roseau, State Highway 11 follows the old Sandridge Trail, which was used by the Indians, fur traders, and early settlers. Another major regional travel route, the old Dawson Trail, was maintained by the Canadian government from 1867 to 1876. It connected Port Arthur (now Thunder Bay) on Lake Superior and Fort Garry (now Winnipeg) on the Red River. This waterway and over-land route utilized the Red River and Lake of the Woods, passing through Angle Inlet of the Northwest Angle.

3.00 RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

3.01 The proposed channel construction will allow the completion and use of the Warroad park, campground, and marina. It will provide increased dockage for resident recreational craft and allow a combination of camping and dockage for transient craft.

3.02 The boat harbor and marina are part of a recreation complex which includes a campground, swimming pool, boat launching ramp, picnic areas, tot lot, and trading post.

3.03 Various businesses have been established to serve needs generated by commercial and recreational use of Lake of the Woods. These businesses will probably continue and may expand in response to increased recreational use of the area. Since no services are to be provided initially by the harbor-marina, any expansion in the number of boats will likely lead to increased use of the present boat service and repair facilities on the Warroad River.

3.04 A private development is underway 5 miles north of the project on Springsteel Island which includes a marina and sites for second homes. A similar development which includes a golf course and marina is in place on the lake shore 2½ miles north of Warroad.

3.05 The new Voyageurs National Park and the Rainy River are located east of Lake of the Woods and may attract recreationists who travel through the Warroad area and who make occasional use of its facilities.

3.06 Resorts on Flag, Oak, and other islands, and the harbor of the Northwest Angle Inlet will probably receive boat traffic originating from the new Warroad Marina.

3.07 New facilities may be developed in the new harbor. Boat and camper supplies and services may be provided by future development.

3.08 All land in the proposed project area is under public ownership.

4.00 ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

Social Impact

Home/Business Relocations

4.01 The Warroad project would involve no relocations of residences or businesses. Because all proposed project lands are currently publicly owned and earmarked for channel construction, the project would not result in any tax value losses to the area. The city views completion of the channel not only as necessary to operation of the marina but also as an important component to development of the new city park through which it would pass.

Economic Impact

4.02 Completion of the proposed channel would allow full use and operation of the inland marina, thereby providing 190 additional boating slips in Warroad. One-hundred of the slips would be reserved for use by seasonally-based craft, with the other 90 available for transient docking. The increase in recreational craft capacity of the harbor area is expected to economically benefit the area. Beyond income generated directly from craft usage (i.e., slippage fees, fueling and maintenance costs, bait and equipment purchases, etc.), marina operation would lead to secondary economic benefits: hotel or camping fees, restaurant or grocery purchases, entertainment income, automobile (vehicle) fueling and servicing for transient boaters, and other services and sales. Whether this secondary increase in economic activity would increase employment or merely increase revenues to existing facilities is not certain. Some small temporary seasonal increases in employment probably would result for the direct economic beneficiaries (e.g., fueling stations, bait shops). A small temporary increase in employment would also result from construction of the channel.

Regional Growth

4.03 This increase in economic activity should contribute to regional growth. Transient recreationists (who come to the Warroad area from Minnesota, Wisconsin, Canada, North and South Dakota, and to a limited extent from other areas, to enjoy the fine fishing resources of Lake of the Woods) would provide some additional economic benefit to the surrounding region.

Community Cohesion

4.04 The proposed action is also expected to have a beneficial effect upon community cohesion. Local support for the project is vigorous, and the proposed action is viewed as a positive one by the community. Because the area relies heavily upon recreation for economic activity (winter vs. spring, recreation employment vs. manufacturing), additional recreational capacities would improve the local economy. The project would also benefit local recreation. By providing 100 slips for local use, the project would not only increase economic activity through attracting more transient recreationists but also add to the recreational opportunities for area citizens.

Aesthetic Impact

4.05 The village of Warroad plans to incorporate the marina and boat channel into the recreational complex of the park. Material excavated from the channel would be used to build berms in the park to provide a more visually-pleasing topography. The project sponsor feels that the channel would also aesthetically benefit the park by providing recreationists the opportunity to view boat passage through the channel. However, this benefit must be weighed against the negative effect of noise and visual intrusion from the passing boats on other recreationists. Apart from the long-term aesthetic effects of the boat channel, it would result in short-term negative impacts during construction activities.

Transportation

4.06 The proposed marina access channel crosses CSAH 74 in Lakeview Park. To avoid this conflict, a short section of CSAH 74 between Lake Street and the Taylor Road Bridge would be abandoned. Access to the Taylor Road Bridge from Lake Street would be provided by a street extension presently included in the city's street construction program. However, if the city has not completed the street extension when the segment of CSAH 74 is abandoned, a detour would be required. A short-term disruption of transportation could result.

4.07 The proposed street extension would provide a more direct route for traffic on CSAH 74. The amount of traffic passing private dwellings would be reduced and access to the downtown business area improved. Rerouting CSAH 74 would also benefit the park since the current alignment separates the marina from other park facilities and is not compatible with the developing land use of the park area.

4.08 Connecting the new harbor to the Warroad River channel would increase the density of traffic in the river channel. Presently, this channel is congested by multiple uses which include the passage of recreational, fishing, and commercial boats and floatplanes, as well as water skiers and swimmers. The principal safety hazard, the conflict of boat traffic with recreation in the river channel, may be alleviated by the provision of separated swimming facilities. An Olympic-sized swimming pool has been constructed within the park. Also, the provision of boat-launching facilities within the proposed marina may reduce the use of boat ramps along the river and decrease the risk of collision between boats in the launching area and those transitting the Warroad River channel.

Public Services

4.09 Effects of channel construction and full operation of the marina may have a minor adverse effect on fire and police services. Completion of the recreational facilities in the park would require some additional police patrolling, due to potential increases in vandalism and minor civil disturbances. The frequency of this type of disturbance would depend largely on how the village of Warroad operates the park complex (e.g., hours of operation of the park, separation of camping from other facilities during late night hours, rules concerning use of liquor in the park, hours of marina operation).

4.10 The municipal sewage treatment plant is scheduled for relocation in 1983-1984, after the city builds a more efficient plant at another location. If channel construction begins before then, it would be necessary to remove the sludge dewatering tanks since they would be within the proposed channel alignment. If this occurs, the city must provide an alternative method of handling the sludge. A proposed method is discussed in paragraphs 4.23-4.28. Alternative handling should be necessary for no more than 3 years.

Floodplain Development

4.11 The probability that floodplain development would occur as a result of the proposed project is low. The project would have no effect on flood levels or frequency. Since the proposed channel would be constructed through municipal land, no development, other than for recreation, would be expected adjacent to the project. Much of the floodplain area adjacent to the park boundaries was previously developed as residential area and any future development would be limited by city floodplain ordinances.

General Social Acceptability of the Project

4.12 This proposed plan has the greatest public support of all the plans to provide access to Lake of the Woods from the new marina. Local support centers around the lower cost of this alternative and environmental support rests on the avoidance of significant wetland destruction. No visible public opposition to this alternative has arisen, and the plan involves no identifiable "taking" from one group to benefit another. Therefore, this plan should moderately benefit the social well-being of the area, if implemented with regard for any potential problems which might arise in design or construction phases of project development.

Archaeological and Cultural Impact

4.13 The on-land access channel, recreational improvements, and potential disposal areas have been surveyed by a professional archaeologist. Although a large Chippewa village and cemetery plus several fur trading posts were located near the mouth of the Warroad River, no significant prehistoric or historic remains have been located during the testing of the project areas. Because of the possibility of encountering deeply buried remains during construction of the access channel, an archaeologist would be present while it is being excavated. Should previously undetected cultural materials be encountered during construction, the work would be immediately discontinued and the significance of the remains evaluated according to National Register criteria. (See Exhibits I-5, I-6, and I-7 for the coordination letters with the Minnesota State Historic Preservation Officer and the Minnesota State Archaeologist.)

Natural Resources Impact

Suspended Sediment

4.14 The selected channel alignment would be excavated through Lakeview Park. The overland route would allow dry excavation of most of the channel. Banks would be stabilized and protected, where necessary, with fabric-form pavement before water would be let into the channel. Channel ends would be excavated last in a manner that would minimize turbidity as the channel fills. These measures would ensure that the amount of suspended sediment entering the Warroad River and marina basin would be minimal and of short duration.

Aquatic Habitat

4.15 Approximately 100 feet of riverbank habitat would be lost at the mouth of the proposed channel. However, the corners of the channel mouth would be armored with riprap to prevent erosion. The extensive surface area and interstitial spaces provided by riprap would increase the diversity of habitat and provide partial replacement of the lost bank habitat. In addition, the fabric-form pavement should provide benthic habitat and substrate for algal growth.

Wetland Impact

4.16 The proposed channel alignment was chosen to ensure that the project would have minimal impacts on wetlands. Much of it would be excavated from land with an elevation of 1062 msl (mean sea level) or higher. The alignment would, however, intersect a wetland area of less than one-half acre (Figure 2). The area between elevations 1061 and 1062 msl appears to be a remnant from past filling of the shoreline wetlands. It has no standing water but does support vegetation, predominantly the giant reed (*Phragmites communis*) which is indicative of a high water table. The area may be used by waterfowl for nesting but not for fish spawning, as it is rarely inundated.

4.17 Changing the alignment to avoid the wetland was not considered practical since it would require relocation of the entire sewage treatment plant and the newly constructed municipal swimming pool. This impact has also been evaluated in the attached 404(b) evaluation.

Terrestrial Impact

4.18 Impacts of the channel construction on terrestrial habitat and wildlife would be minimal. The channel alignment crosses open city parkland. The majority of the area to be excavated would be mowed grass which would support few resident animals. A small grove of ornamental coniferous trees is located near the Warroad River. Some of these trees would be affected by the proposed alignment; they would be relocated when possible and those that could not be moved would be replaced.

Excavated Material (Fill)

4.19 Since much of the material to be excavated along the proposed channel alignment had originally been placed as fill, samples were analyzed for nutrients, heavy metals, and chlorinated hydrocarbons. Samples were taken at random elevations at four selected boring locations: one near the riverbank, one close to the sludge dewatering tanks at the sewage treatment plant, and two intermediate locations along the proposed channel alignment (Exhibit J-1). A total of ten samples were taken.

4.20 Values for chemical parameters (Exhibit J-2) were compared to Environmental Protection Agency (EPA) Standards for Great Lakes Sediments. The sample taken from the surface to the 2-foot depth adjacent to the sewage treatment plant (1063-1061 msl) showed evidence that sewage sludge had been spilled around the dewatering tanks. The sample exceeded EPA Standards for the following: Barium, Chemical Oxygen Demand, Copper, Cyanide, Lead, Mercury, Total Kjeldahl Nitrogen, Ammonium Nitrogen, Total Volatile Solids, and Zinc.

4.21 At all locations, EPA Standards were exceeded for the following: Barium, Chemical Oxygen Demand, Cyanide, Total Kjeldahl Nitrogen, Ammonium Nitrogen, and Total Volatile Solids. However, it should be noted that the EPA guidelines are intended for lake bottom sediment and are not directly applicable to soil borings. They were only used for comparative purposes. The Permits and Facilities Sections of the Minnesota Pollution Control Agency (MPCA) were consulted about the disposition of material excavated during channel construction. As a result, it was determined that, with the exception of the areas around the sewage treatment plant and near the riverbank, material excavated from the channel may be disposed of in any location above the high water mark, provided that proper site preparation is accomplished. Clean material would be used for a berm to protect the channel from wave induced sedimentation, for road and parking lot fill, and for landscaped park berms. Some small trees in the camping area would be removed prior to placement of fill. Excavation would be scheduled so that successful revegetation of the material can begin soon after placement has been completed. The locations of sites for fill placement are shown in Exhibit I-6.

4.22 The chemical analysis revealed that cyanide levels at sampling station 1 (located on the riverbank) were nearly 5 times the mean level of cyanide at all stations. Therefore, the MPCA specified that material excavated along the first 100 feet inland of the riverbank would be placed above the ground surface and capped with an impermeable material such as clay or asphalt. Soil around the sludge dewatering tanks that is contaminated by sludge spillage would be placed at the location selected for the disposal of digested sludge from the tanks. Since the exact extent of contamination is unknown, a band of soil 4 feet wide and deep around the tanks and in areas with visible contamination would be removed for disposal. A sample from the same boring which included soil from 8 to 10 feet below the surface at the sewage treatment plant did not show evidence of contamination. The concrete from the tanks would be disposed of in compliance with a solid waste disposal plan, including a disposal site, to be developed with and approved by the MPCA.

4.23 Planning is in progress for a new sewage treatment plant for the city of Warroad. However, the location and time of construction have not been finalized.

4.24 Construction of the new plant is not related to the marina channel project. The channel would probably be constructed prior to completion of the new treatment plant, requiring removal of the sand beds presently used to dewater digested sludge. While it would in no way interfere with sewage treatment, this action would require an alternate means of handling or treating the product of the digester (i.e., digested sludge solids in water). The city of Warroad has developed a plan to store the sludge in a holding pond until the new plant is constructed. The pond, which would be constructed adjacent to the existing treatment plant, would be lined with a 1-foot layer of clay, would cover 2,500 square feet at the bottom, and would be 4 feet deep. Sludge solids would be contained in half the pond by a wooden dike, but seepage of water through the dike would make the entire surface of the pond available for evaporation. The pond would have sufficient capacity to operate for 3 years.

4.25 If needed after that, the dried sludge would have to be removed and placed in a landfill site. The placement of digested sludge in a holding pond would be similar to the present treatment. The major difference would be that the sludge would be dewatered by evaporation rather than a combination of evaporation and drainage to Lake of the Woods. The sludge would remain wet longer and might be more unpleasant aesthetically than before. The pond could be screened to reduce that impact.

4.26 It would also be necessary at the time of channel construction to re-route the treatment plant outfall pipe. It has been proposed that the existing outfall at the mouth of the Warroad River be abandoned and that a new outfall be routed under the proposed marina channel. (This would be an interim measure since the proposed new sewage treatment plant would probably not discharge to the lake.) The pipe would terminate in a ditch outletting at the shore of Lake of the Woods. Because the hydraulic characteristics of the present outfall are not adequate, manholes at the plant and a [illegible] in the city park sometimes discharge effluent over the ground. The proposed outfall pipe relocation would eliminate this problem. The location of the new outfall would be 60 feet inland from the shoreline and 1 foot above the bottom of a 7-foot deep trench. The trench would slope upward to the lakeshore and would be 2 to 3 feet deep at the shoreline.

4.27 Effluent from the sewage treatment plant is presently discharged into the mouth of the Warroad River. The effluent may remain concentrated for some distance because a 4- to 6-foot navigation channel connects the river mouth with the 6-foot depth contour approximately 1 mile offshore. If effluent would be discharged directly into the lake, it may be well mixed and aerated by wave action. However, it could be trapped between the shoreline and the sandbar approximately 3,000 feet offshore. In winter, the effluent may be extremely localized since winter ice thicknesses of the lake often exceed water depths in the area offshore from the proposed outfall location. The bottom of the outfall ditch at the shoreline is proposed to be at 1058.0 msl. Ice surface elevations range between 1059.1 to 1057.9 during an average winter. During the early months of 1977, the ice surface never rose above 1057.0. In these situations, effluent may flow over the ice surface. However, in most years, the average flow of 150,000 gallons per day should be sufficient to keep the outfall open and to form a channel under the ice for the dispersal of the effluent. Limited dilution of the effluent may occur when the lake is frozen. There may not be free circulation because of the offshore sandbar, but this is not expected to be a significant problem.

4.28 No bacteriological problems should occur because the effluent is chlorinated. Nitrogen and phosphorus would be readily incorporated by the extensive aquatic vegetation between the lakeshore and sandbar. Any increase in the deposition of suspended sediment would be insignificant compared to the amount of decaying organic matter present on the lake bottom in the beds of aquatic vegetation. An increase in oxygen demand may not be significant compared to existing conditions. Wave action in the spring would quickly mix and aerate any stagnant water.

Maintenance Dredging

4.29 Due to the nature and location of the proposed channel, maintenance dredging should be minimal and would be a Federal responsibility.

Channel Protection

4.30 The setback from the shoreline and the elevated berm would provide the channel with protection from storms and high lake levels. The presence of banks would eliminate the need for navigational channel marking.

Fuel Spills

4.31 Since no service facilities are presently planned for the new marina, boats berthed there would have to enter the Warroad River for gasoline and service. Increasing the use of these service facilities would increase the risk of fuel and oil spills in the river. Education of marina employees and the general public would help to minimize the occurrence of fuel spills. Likewise, the installation of floating booms at boat-fueling facilities would help to ensure containment of spills and to facilitate clean-up operations. Because oil and grease levels in the river and lake channels are above acceptable levels, further spills should be minimized to prevent further degradation of water quality in the river and lake channels. The installation of fueling facilities in the new marina would decrease congestion at existing facilities. Fuel spills would likely be confined to the marina basin, facilitating clean-up and preserving water quality in the lake.

Sanitary Wastes

4.32 A dump station for sewage holding tanks is planned for the marina. Convenient access to this dump station along with minimal fees, qualified attendants, and information signs should decrease the overboard emptying of boat tanks both in the harbor and the lake.

Water Quality

4.33 The proposed project would not be expected to have significant impacts on water quality. The absence of fueling facilities would minimize the likelihood of fuel spills and oil and grease contamination. Use of the planned sewage dump station by boaters would greatly reduce the likelihood of fecal contamination, high coliform bacteria levels, and high biochemical oxygen demand. Since the marina is within a park surrounded by flat terrain and a residential area, it is highly unlikely that industrial discharges or agricultural runoff would enter the marina. Therefore, excessive levels of nutrients, pesticides, sediment, or heavy metals should not occur, and no decrease in the ambient water quality of the Warroad River and Lake of the Woods would result from water circulation through the marina.

4.34 The present shallow water connection to Lake of the Woods in combination with the new channel is expected to provide adequate water circulation through the harbor to the river. Water would circulate as a result of fluctuating surface water levels, due to precipitation or control of lake levels, and from groundwater inflow. If stagnation would become a problem, it could be solved by deepening the channel to Lake of the Woods, or by providing mechanical circulation. According to Hickock and Associates (1977), a constant pump discharge of 350 gallons per minute would equal a complete total volume change of the 46.5 acre-feet every 30 days. The installation of a water circulation system would be a local responsibility.

Endangered and Threatened Species

4.35 No known endangered species inhabit the project area or its vicinity. However, the endangered Arctic peregrine falcon (Falco peregrinus tundrius) may migrate through the area in the spring and fall but the area does not provide suitable nesting sites. Construction of the channel would not be expected to interfere with the type of resting or feeding areas utilized by the peregrine falcon.

4.36 The project area would be within the range of two threatened species. The bald eagle (Haliaeetus leucocephalus) may nest in the more densely forested areas of Roseau County near the Canadian border. The project area would not provide suitable nesting habitat, and the bald eagle would likely avoid the project area due to the availability of less densely populated lands. There are no known active bald eagle territories in the project area.

4.37 The proposed project would fall within an area designated by the U.S. Fish and Wildlife Service as Habitat Zone 4 of the Eastern timber wolf. Depredation control may be practiced in Zone 4, which was not designated as critical habitat. The proposed project is unlikely to affect the wolf since habitat and prey species are not and would not be available in the project area.

4.38 The U.S. Fish and Wildlife Service issued a biological opinion (Exhibit J-4) for this project on 17 August 1979 indicating that this project would not endanger the continued existence of any federally listed species. There is no critical habitat in the project area.

4.39 The State of Minnesota lists plant and animal species which require special consideration and management. The lake sturgeon (Acipenser fulvescens) has been listed as a species of uncertain or changing status. That is, a major habitat change could cause the species to become threatened. A review of the life history of the sturgeon indicated that, since it requires swift water or rapids for spawning, the proposed project would neither contribute nor eliminate habitat.

5.00 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Terrestrial Habitat, Land, Vegetation

5.01 There would be a loss of 3.8 acres of land area and its associated vegetation including one-half acre of wetlands. Although the path of the channel was chosen to avoid trees, a few would be lost. Loss of vegetation and land would result in a loss of habitat for birds, invertebrates, and mammals. Except for erosion protection areas, channel banks would be seeded with grass and possibly shrubs and most trees would be replaced or relocated. Many of the animals would migrate away from the area temporarily when disturbed by construction, but some subterranean dwellers may be destroyed by excavation.

Benthic Habitat

5.02 The opening of the proposed channel into the Warroad River would destroy approximately 100 feet of riverbank. This involves the loss of benthic organisms and habitat, but this amount is small and would probably be offset by new habitat made available in the constructed channel, particularly where riprap would be placed.

Noise

5.03 A temporary increase in noise would result from construction activities. Use of the park may be limited by the presence of machinery, and air quality may be degraded by emissions. These adverse effects would cease when construction is complete.

Boat Traffic

5.04 An increase in the number of boats using the Warroad River would increase congestion and the risk of accidents. However, relocation of swimming and boat-launching areas should reduce the safety hazard by facilitating traffic movement in the river channel.

6.00 ALTERNATIVES TO THE PROPOSED ACTION

No Action

6.01 If no action is taken, there would be no reduction of park land, wetlands, benthic habitat, or terrestrial vegetation. The likelihood of water quality reductions would be low because there is some natural circulation, but it is not likely that the lake will completely flush out the harbor. Since the harbor is shallow, any fish that might emigrate from the lake or be planted may not survive the winter when dissolved oxygen levels are low. Lowered lake levels could trap fish in the harbor. With no access, the harbor would have little or no recreational value, could be aesthetically displeasing (heavy plant growth), and may breed mosquitoes.

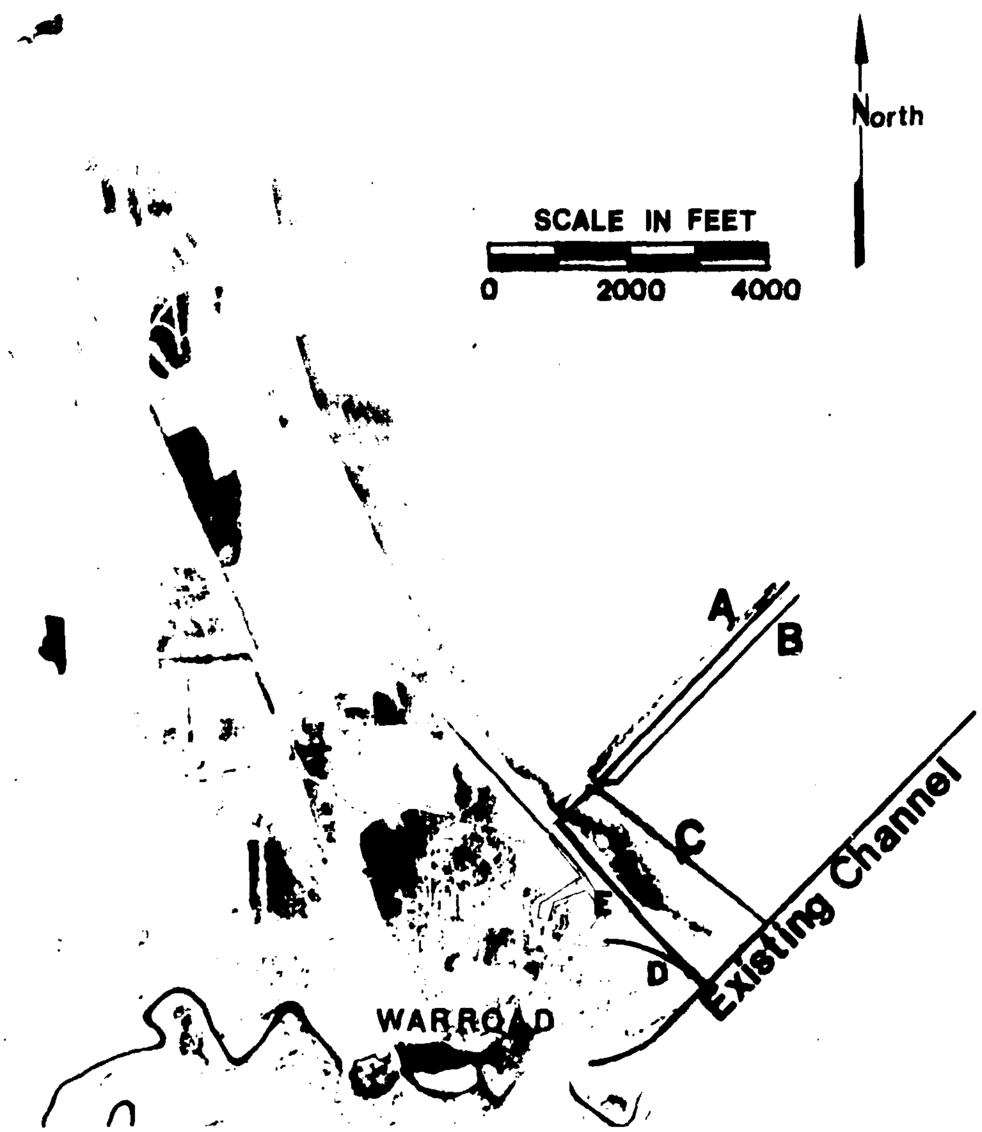
6.02 The marina basins have been completed for several years. If no connecting channel is constructed, local sentiment, which is strongly in favor of the project, would probably demand some action. The property might be transferred to a private developer for completion. Several private developments with marinas have recently been constructed in the area and have been highly successful.

Alternative Channel Alignments

6.03 Four alternatives to the proposed channel have been analyzed (Figure J-4). Alternatives A, B, and C, utilize the existing, shallow connection between the harbor and the lake. These consist of a dredged channel to provide access to deep water and some sort of protective structure, differing mainly in alignment. The fourth (Alternative E) is a variation of the proposed on-land alignment. (See Section 1.00 for a description of Alternative D, the proposed plan.)

6.04 Alternatives A, B, and C would require deepening of the existing access channel which would cause the destruction of shoreline wetland. Dredging impacts would also result from any of the three. These impacts would include destruction of benthic habitat and organisms and short-term increases in turbidity levels above State standards.

6.05 The sediments in the proposed dredging area are considered polluted. Since State policy is to oppose open water disposal of dredged material, an on-land site would need to be located for disposal of wet dredged material. Dikes would need to be constructed to contain the dredged material.



ALTERNATE CHANNEL ALIGNMENTS

FIGURE J-4

E A HICKOK & ASSOCIATES
Engineers – Hydrologists
Minneapolis. Minnesota

6.06 Alternatives A, B, and C could require the construction of protective jetties to prevent sedimentation of the channel. However, jetties might interfere with and modify the littoral drift of sediment and could change the character or structure of the lakeshore or the offshore sandbar.

6.07 These alternatives would use the existing CSAH 74 (Taylor Road) and would be suitable for future expansion of the boat harbor. Future basins would be developed to the north of the present ones. The channel would then be centered between these old and new basins.

6.08 The existing bridge on CSAH 74 would place constraints on the size of watercraft entering the harbor. The lowest part of the bridge is at 1070 msl. Minimum height clearance during high water (1064 msl) would be 6 feet. At average water levels, 10 to 11 feet of clearance would be available. Channel width is only 20 feet at maximum depth.

6.09 All alternative plans which include a new channel to deep water in Lake of the Woods would relieve, or at least not increase, the present congestion of the channel leading into Lake of the Woods from the Warroad River by providing a separate access to the lake. However, this possible reduction of congestion would be offset by the need for boats from the new marina to enter the Warroad River harbor for service and fuel, increasing the density of two-way traffic (as opposed to lake-bound in the morning and harbor-bound in the evening) and the risk of accidents. Also, it would require a trip of over 2 miles from the new harbor to the lake and into the Warroad River. Fuel consumption would increase and recreation time would be diminished.

Alternative A

6.10 Alternative A would be the construction of a straight channel parallel to the existing Warroad River channel from the CSAH 74 bridge to the 6-foot depth contour in Lake of the Woods. This channel would be 4,800 feet long from the bridge and would require the dredging and on-land disposal of approximately 115,000 cubic yards of material. A larger radius would be required for the 90-degree turn immediately landward of the bridge to ensure the safe maneuvering of boats.

6.11 A protective jetty would be required for the entire length of Channel A, or high maintenance dredging expenditures would be incurred. Littoral drift of sediment would be interupted, and increased deposition would occur along the north edge of this jetty, eventually passing the end and blocking the channel. The construction of a channel through the sandbar would eliminate part of the natural wave barrier.

6.12 The benefit-cost ratio for Alternative A is 0.50, with a total project cost of $2,262,000.

Alternative B

6.13 Alternative B would involve the construction of a channel similar in alignment to Alternative A. It would incorporate a "dogleg" to the southeast, approximately 800 feet lakeward of the CSAH 74 bridge. A second turn to the northeast would align the channel parallel to its original heading. The purpose of this design feature would be to suppress waves traveling landward through the channel into the harbor and to compensate for the loss of sandbar protection. This channel would be 4,800 feet long and would require the dredging and on-land disposal of approximately 120,000 cubic yards of material.

6.14 Alternative B would require a jetty. A jetty with a "dogleg" would require additional fill for the turns. If a straight jetty were constructed, it would not fully parallel the channel and would not be useful as a navigation aid. Safety and navigation would be a concern for this alignment. Extensive marking of the channel would be required, involving annual fall marker removal, spring replacement, and maintenance. The turns would increase the likelihood of boat collisions.

6.15 Potential benefits for Alternative B do not appear to justify the additional problems and risks created by this alignment and no benefit-cost ratio has been calculated.

Alternative C

6.16 Alternative C also utilizes the existing access channel and continues northeast for 800 feet. It then turns southeast and proceeds parallel to the shoreline until it intersects the existing Warroad River channel in a broad curve. This channel would be 3,800 feet long and would require the dredging and disposal of approximately 115,000 cubic yards of material.

6.17 This alignment would be between and parallel to the sandbar and the shoreline. The sandbar would provide some protection to the channel, but a single breakwater may be necessary. Although wave deposition of sediment may be minimal, littoral drift would be down the channel and could cause serious sedimentation problems.

6.18 The two 90-degree turns in this design constitute a safety and navigation hazard and, as such, would require extensive marking and maintenance as in Channel B.

6.19 This alternative would cause increased congestion in the Warroad River. It is also the most suitable alignment for the future development of a proposed harbor for sailboats and commercial fishing boats on the shore of the lake. This harbor would require extensive wetland excavation. There are no plans to develop this at present.

6.20 The benefit-cost ratio for Alternative C is 0.5, with a total project cost of $2,271,000.

Alternative E

6.21 Suggested by local citizens to utilize the existing bridge on CSAH 74, Alternative E is a variation of the proposed on-land channel construction (Alternative D). The channel would be excavated through the park parallel to the shoreline from the lakeward side of the existing bridge to the Warroad River. Unlike Alternative D, this channel would not be above the high water mark and would destroy wetland along the lake shore. It would not, however, require the construction of a new bridge or rerouting of CSAH 74. This channel would present a significant safety hazard because boats would make a 90-degree blind turn, from either direction, to pass under the bridge. Boaters exiting these turns would meet under the bridge, which has minimal horizontal clearance. The Coast Guard is not expected to favor this alignment, and no benefit-cost ratio has been calculated for it.

National Economic Development (NED) Plan and Environmental Quality (EQ) Plan

6.22 The National Economic Development (NED) Plan is the alternative that maximizes net economic benefits in relation to cost. The proposed plan is the NED Plan. The Environmental Quality (EQ) Plan is that which makes net positive contributions to the EQ account. None of the alternatives could be designated as an EQ plan because no opportunities for adding contributions to environmental quality were available. There were no areas in reasonable proximity to the project area in which a significant loss or degradation of environmental quality could be predicted. The project area is located within a city park; as such it has more value for social well-being than it would have as a natural resource, particularly in light of the vast acreage of lakes, State forest, wildlife management areas, and national wildlife refuge within 50 miles of the project.

6.23 The proposed plan provides the method of accomplishing the project purpose with the least damage to the environment. No significant environmental impacts have been identified for the proposed plan; therefore, it is the most satisfactory alternative from an environmental standpoint. Implementation of the proposed plan would provide a positive measure of control in achieving the project purpose which independent completion of the project (one of the alternatives) would not provide.

7.00 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Short-Term Adverse Impacts

7.01 Construction activities would create noise and short-term decreases in air quality. Congestion in the Lakeview Park would increase temporarily while construction crews and machinery are present.

Long-Term Adverse Impacts

7.02 No irretrievable commitments of park land or lakeshore would be made, and wetland losses would be minimal. Future land-use options would not be significantly restricted.

Long-Term Benefits

7.03 The long-term benefits of this project would be economic, social, aesthetic, and recreational. Increased revenue to businesses may be expected. Completion of the project would permit the use of a major feature of the park and would encourage further construction activity leading to completion of the planned park. Quality of life would be increased by aesthetic features and recreational opportunities.

8.00 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Petroleum Products and Construction Materials

8.01 The construction of a channel will entail the consumption of petroleum products to operate construction machinery as well as the use of rock and concrete, most of which would be irretrievable.

9.00 COORDINATION

Cultural Resources

9.01 In compliance with Section 106 of the National Historic Preservation Act of 1966 and Executive Order 11593, the National Register of Historic Places has been consulted and as of 13 May 1980 there are no listed sites in the project area. It has also been determined that no areas listed on the National Register of Natural Landmarks will be affected by the project. Coordination has been initiated with the State Historic Preservation Officer and the State Archaeologist. See Exhibits J-5, J-6, and J-7 for their responses concerning the proposed project.

Detailed Project Report

9.02 The following agencies were consulted during the planning process. Most were asked to indicate their choice of the preferred alternative for construction.

U.S. Environmental Protection Agency
U.S. Department of Agriculture - Soil Conservation Service
U.S. Department of Commerce - National Oceanic and Atmospheric Administration - National Weather Service
U.S. Department of the Interior - Bureau of Outdoor Recreation (Heritage Conservation and Recreation Service)
U.S. Department of the Interior - Fish and Wildlife Service
U.S. Department of Health, Education, and Welfare
U.S. Department of Housing and Urban Development
U.S. Department of Transportation - Coast Guard
U.S. Department of Transportation - Federal Highway Administration
Minnesota Department of Health
Minnesota Department of Highways
Minnesota Department of Natural Resources
Minnesota Historical Society
Minnesota Pollution Control Agency
Minne ota State Archaeologist
Minnesota State Board of Health
Minnesota State Department of Administration
Minnesota State Planning Agency
Roseau County Highway Department
City of Warroad

Environmental Assessment

9.03 This assessment has been sent to concerned Federal, State, and local agencies; interest groups; individuals; libraries; and the news media.

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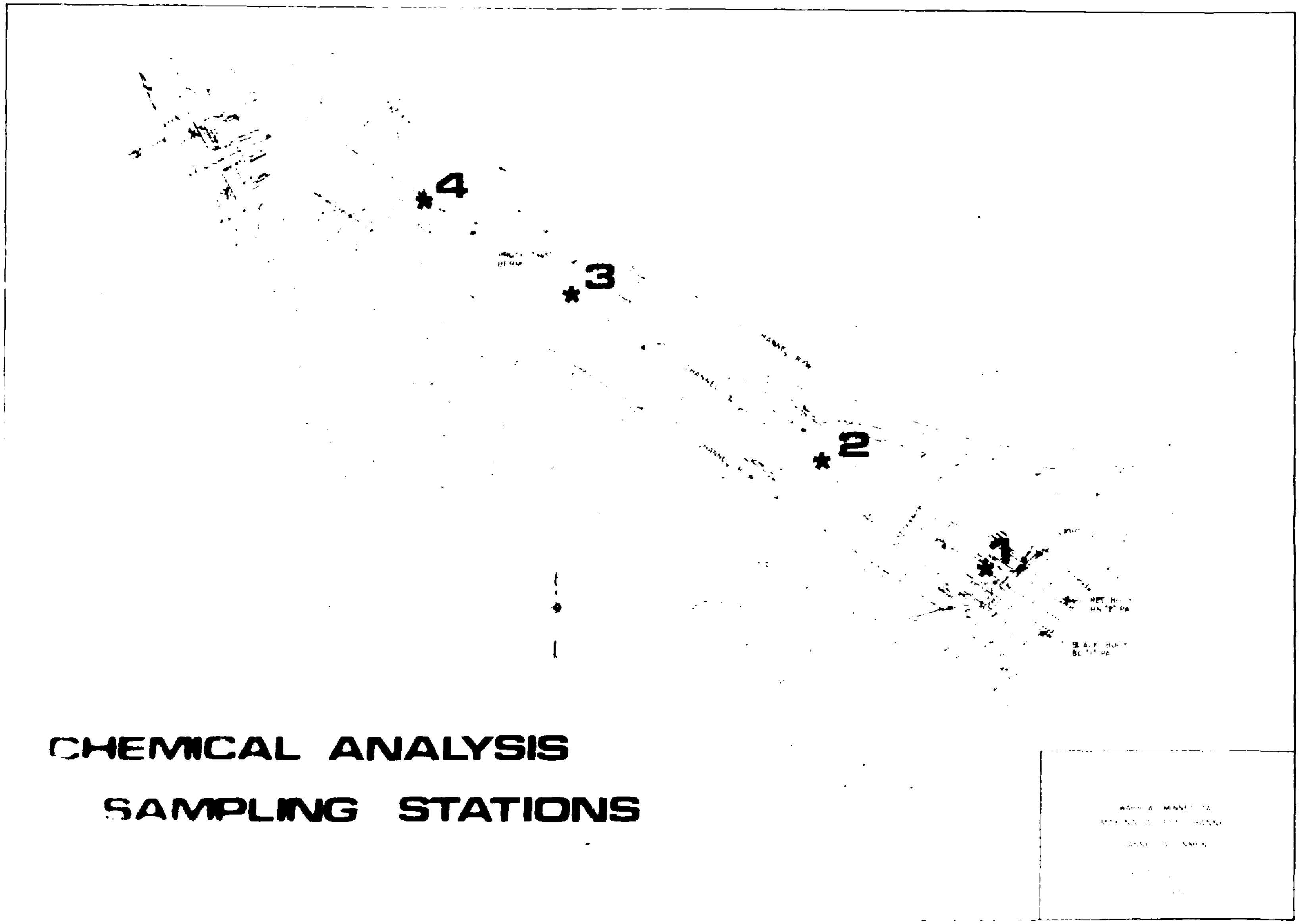

CHEMICAL ANALYSIS
SAMPLING STATIONS

AD-A184 683 WARROAD CHANNEL PROJECT SECTION 107 DETAILED PROJECT REPORT WARROAD MINNESOTA(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JUL 80 4/4

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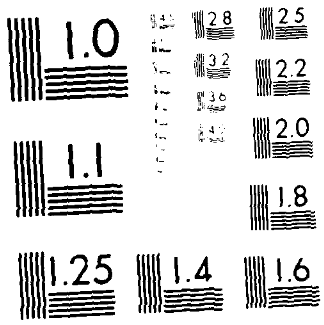
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WARROAD CHANNEL EXCAVATION
CHEMICAL PARAMETERS

Parameter (ppm) / Feet Below Surface	Station 1			Station 2			Station 3		Station 4	
	2-4	5-10	10-15	0-2	2-6	6-10	[illegible]	[illegible]	0-2	5-10
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VEGETATIVE DISTRIBUTION
AND FILL PLACEMENT MAP

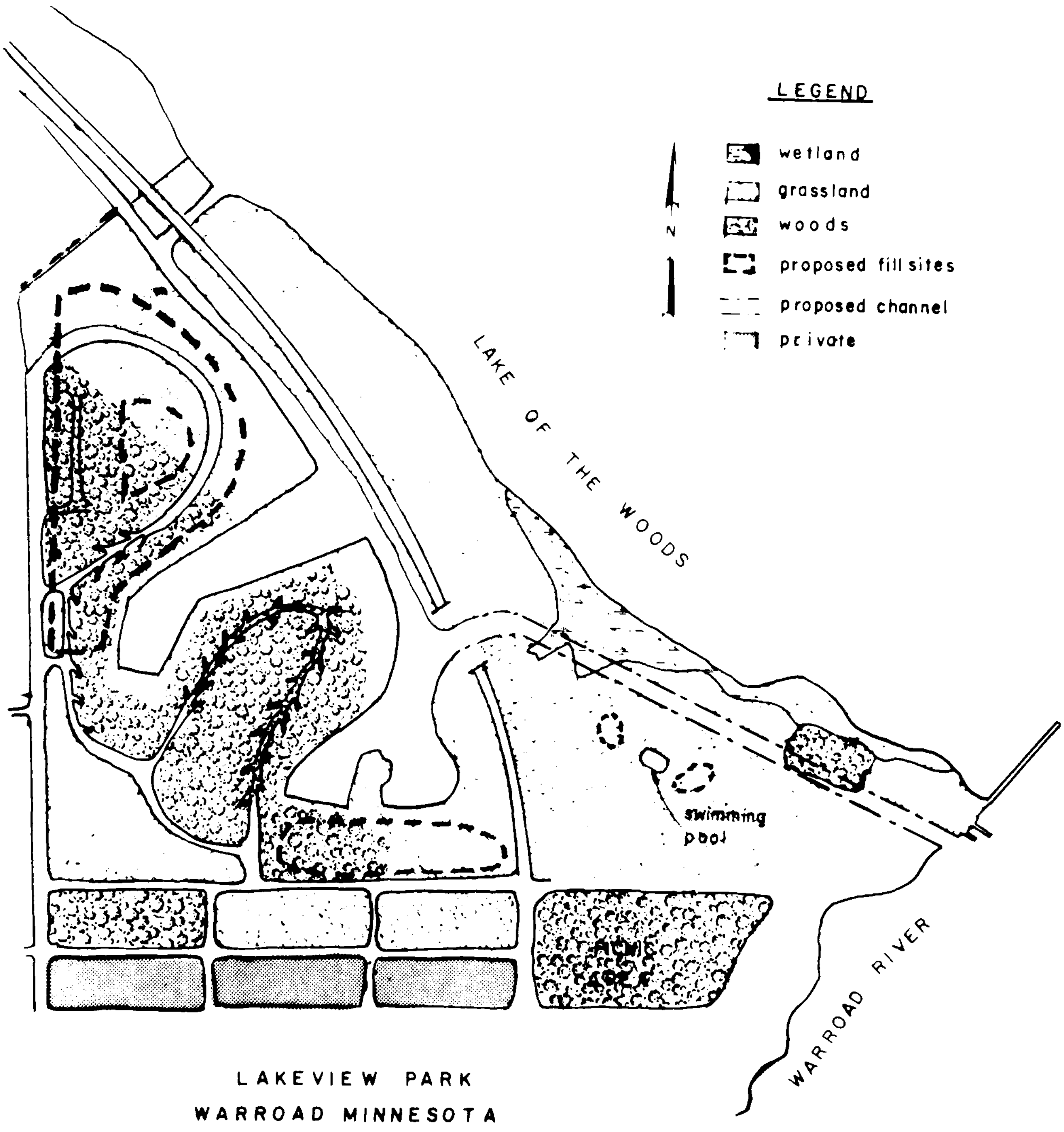


EXHIBIT J-3

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:

AFA-SE

AUG 17 1979

Colonel William W. Badger
District Engineer
U.S. Army Engineer District
St. Paul
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

We are in receipt of the environmental assessment for the Warroad, Minnesota Small Boat Harbor and Channel Construction project. We concur with the conclusions in the assessment that no suitable habitat exists in the project area for the Gray Wolf, Bald Eagle or Arctic Peregrine Falcon. Therefore, it is my biological opinion that the project as currently planned, will not jeopardize the continued existence of any federal listed species. There is no Critical Habitat currently designated in the project area.

This letter provides comment only on the endangered species aspect of the project. Comments on other aspects of the project under the authority of and accordance with provisions of the Fish and Wildlife Coordination Act (48 Sta. 401, as amended; 16 U.S.C. 661 et. seq.) may be sent under separate cover.

Sincerely yours,

Harvey K. Nelson

Harvey K. Nelson
Regional Director

EXHIBIT J-4

MINNESOTA HISTORICAL SOCIETY
690 Cedar Street St. Paul Minnesota 55101

1 December 1976

Colonel Forrest T. Gay
Department of the Army
St. Paul District,
Corps of Engineers
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

NCSED-PB
RE: Small Boat Harbor
Warroad, Minnesota
Roseau County

Both the historic and the archaeology sections of the Minnesota Historical Society have reviewed the permit described above. It is the opinion of the former section, with whom I concur, that no historic resources will be affected by the issuance of the permit. On the other hand, staff archaeologists are concerned, and I agree, that the proposed project may affect as yet unknown archaeological materials. Prehistoric habitation sites in Minnesota are frequently located near the outlets of streams and rivers into lakes -- such as in the case at hand. Therefore, I would recommend that a shoreline reconnaisance survey be conducted,before construction begins, of the area where the channel is to be cut and where the dredge spoil is to be deposited.

Such a survey may be conducted by any of the persons whose names appear on the appended sheet. Should you have any questions you may contact Mr. Edward Lofstrom, Survey Archaeologist, Minnesota Historical Society, Building 27, Fort Snelling, St. Paul, Minnesota 55111, Phone 726-1630.

Sincerely,

Russell W. Fridley
State Historic Preservation Officer

RWF/fr
Encl.

EXHIBIT J-5

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Anthropology
215 Ford Hall
Minneapolis, Minnesota 55455

October 19, 1976

Col. Forrest T. Gay, District Engineer
Corps of Engineers, St. Paul District
Regulatory Branch
U. S. Post Office and Custom House
St. Paul, Minnesota 55101

Re: Flood Control, Sauk Rapids, Mn.
Small Boat Harbor, Warroad, Mn.

Dear Col. Gay:

I have reviewed the reconnaissance report for the proposed flood control project at County Ditch No. 3 in Sauk Rapids, Minnesota, and the small boat harbor at Warroad. A literature and field survey will be necessary before I can recommend one of the alternatives suggested.

Sincerely yours,

Elden Johnson
State Archaeologist

EJ:bw
CC:Russell Fridley

MINNESOTA HISTORICAL SOCIETY

690 Cedar Street St. Paul Minnesota 55101

August 9, 1978

Colonel Forrest T. Gay
Department of the Army
St. Paul District
Corps of Engineers
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

RE: NCSED-ER
Review of two cultural resources surveys.
Lake of the Woods, Minnesota

MHS Referral File Number 858

We have received and reviewed the reports "Cultural Resources Survey of Small Boat Harbor Project at Lake of the Woods, Warroad, Minnesota" by Alan Brew and William Yourd and "Cultural Resources Investigation of the Proposed Pine Creek Channel Dredging Disposal Sites, Lake of the Woods, Angle Inlet, Minnesota" by Alan Brew. These reports clearly establish that the proposed undertakings will have no effect on properties eligible to the National Register of Historic Places.

Thank you for your continuing support for preserving Minnesota's cultural resources.

Sincerely,

Russell W. Fridley
State Historic Preservation Officer

RWF:cjb

404(b)(1) EVALUATION OF THE
SMALL-BOAT HARBOR CHANNEL CONSTRUCTION,
WARROAD, ROSEAU COUNTY, MINNESOTA

The following is an evaluation of the proposed construction and fill activities in accordance with the requirements of Section 404 of the Clean Water Act of 1977 (Public Law 95-217).

1. PROJECT DESCRIPTION

The proposed project would consist of a 1,700-foot channel excavated through the existing city park in Warroad, Minnesota. The channel would connect an existing marina basin with the Warroad River near its mouth, to provide access to Lake of the Woods. The marina basin is currently connected to Lake of the Woods by a non-navigable ditch.

a. Description of the proposed discharge of dredged or fill materials

(1) General characteristics of material - Three types of fill material would be placed: (a) the banks where the channel enters the river and the marina would be protected with clean riprap; (b) channel banks would be protected by fabric-form pavement which consists of grout injected into a fabric matrix or form (when the grout has dried, the fabric-form pavement resembles half-buried smooth rubble); and (c) some material excavated to construct the channel would be placed alongside the channel alignment (this would include that part of the channel which passes through a small wetland area near the existing marina).

(2) Quantity of material proposed for discharge - Bank protection would be accomplished with the minimum amount of material required to provide the desired protection. Approximately 200 cubic yards of riprap would be utilized. Approximately 83,000 square feet of fabric-form pavement would be used. Approximately 1,025 cubic yards of grout would be used to fill the fabric. The channel protection embankment would require 800 cubic yards of fill in the wetland area.

(3) Source of material - Fabric-form pavement and grout would be purchased from commercial suppliers. Riprap rock would be acquired from agricultural field piles. Wetland fill material would be obtained from excavation of the channel.

b. Description of the proposed disposal sites for dredged or fill material

(1) Location - The fill activities would take place in Lakeview Park in the city of Warroad, Roseau County, Minnesota (Figure J-5). Fill would be placed in the excavated channel where it intersects the Warroad River, and in a small wetland area below elevation 1062 m.s.l. (mean sea level) contiguous with the shore of Lake of the Woods (Figure J-6).

(2) Type of disposal sites - Fabric-form pavement would be placed on excavated banks of the proposed channel. Riprap would be placed to protect the transitions from channel to river and channel to marina.

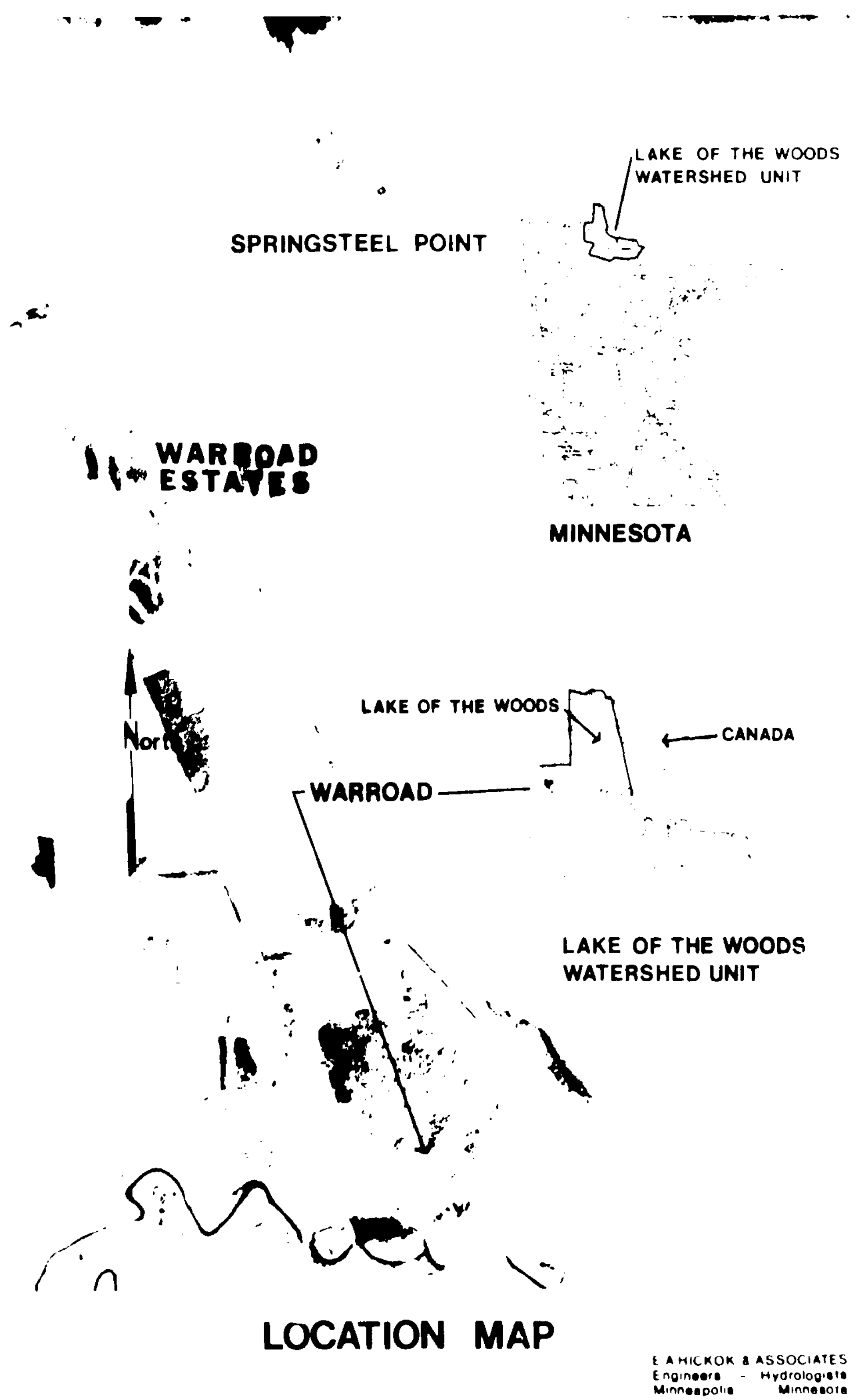
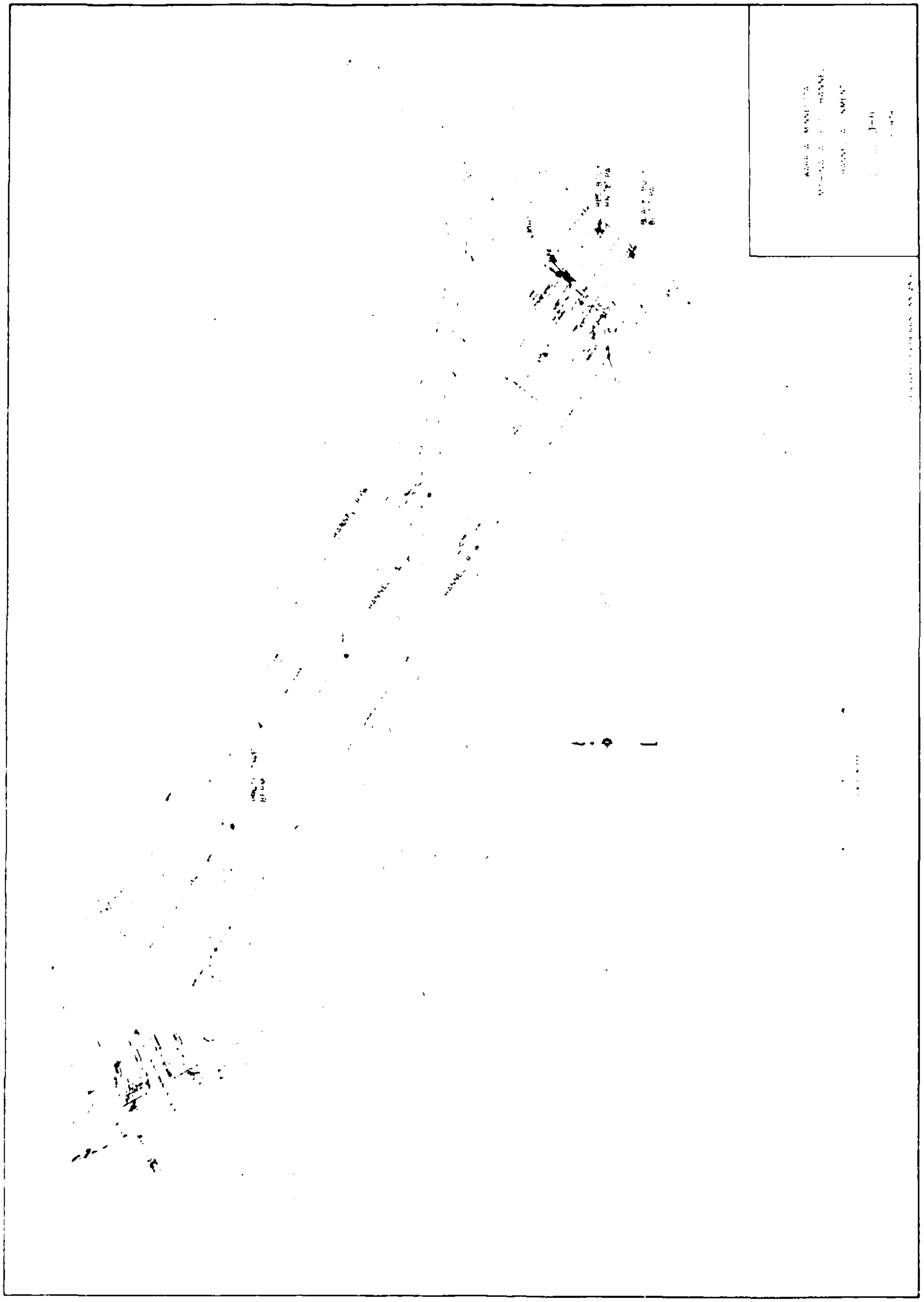

LAKE OF THE WOODS
WATERSHED UNIT
SPRINGSTEEL POINT
WARROAD
ESTATES
MINNESOTA
LAKE OF THE WOODS
CANADA
WARROAD
LAKE OF THE WOODS
WATERSHED UNIT
LOCATION MAP
E A HICKOK & ASSOCIATES
Engineers - Hydrologists
Minneapolis Minnesota

FIGURE J-5



Some material excavated from the channel would be placed in a wetland area but only to the extent necessary to provide the required protection of the channel from the high lake levels and waves (Figures J-7 and J-8).

(3) Method of discharge - Riprap and excavated material would be placed with construction machinery such as front-end loaders or cranes with buckets. The fabric-form pavement would be placed on the banks and fastened down. Grout would then be pumped into the channels in the fabric.

(4) When will disposal occur? - Disposal would occur during excavation of the proposed channel. This is projected for the 1981 construction season.

(5) Projected life of the project - The projected life of the project is 50 years.

(6) Bathymetry - No open water disposal would be included in the project.

2. PHYSICAL EFFECTS (40 CFR 230.4-1(a))

a. Potential Destruction of Wetlands - Effects on (40 CFR 230.4-1(a)(1) (i-vi))

(1) Foodchain production - The wetland area receiving excavated material for the protective berm would be removed from foodchain production.

(2) General habitat - A small amount of waterfowl nesting and feeding habitat could be eliminated by the placement of excavated material.

(3) Nesting, spawning, rearing, and resting sites for aquatic or land species - It is not likely that the impacted area would provide aquatic spawning or rearing habitat since it is above the normal lake level. A small amount of waterfowl habitat could be eliminated.

(4) Those areas set aside for aquatic environment study, sanctuaries, or refuges - No areas of this type are within the project area.

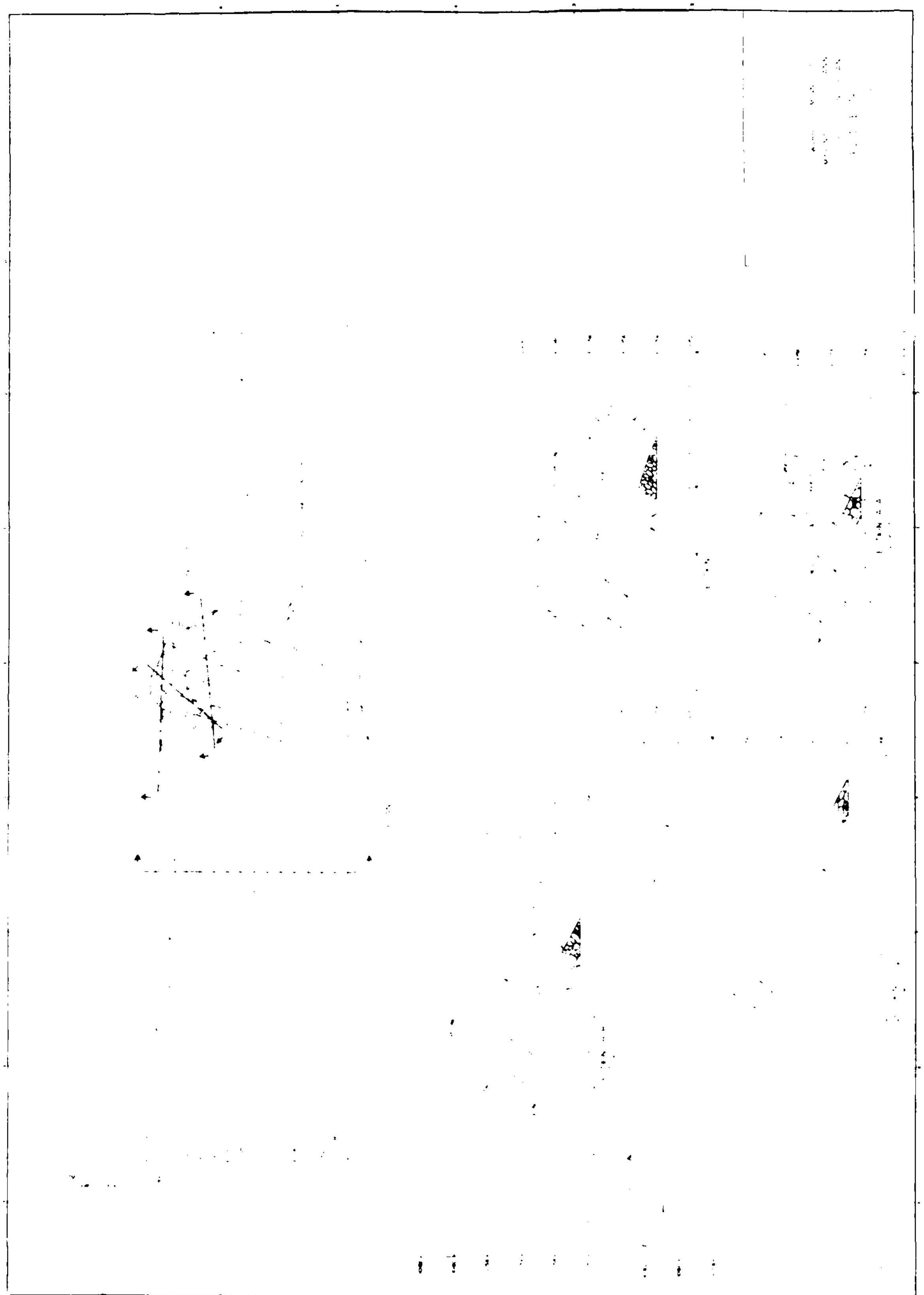
(5) Natural drainage characteristics - The placement of excavated material to form a protective berm would not interfere with natural drainage characteristics other than in the small area directly covered by the material.

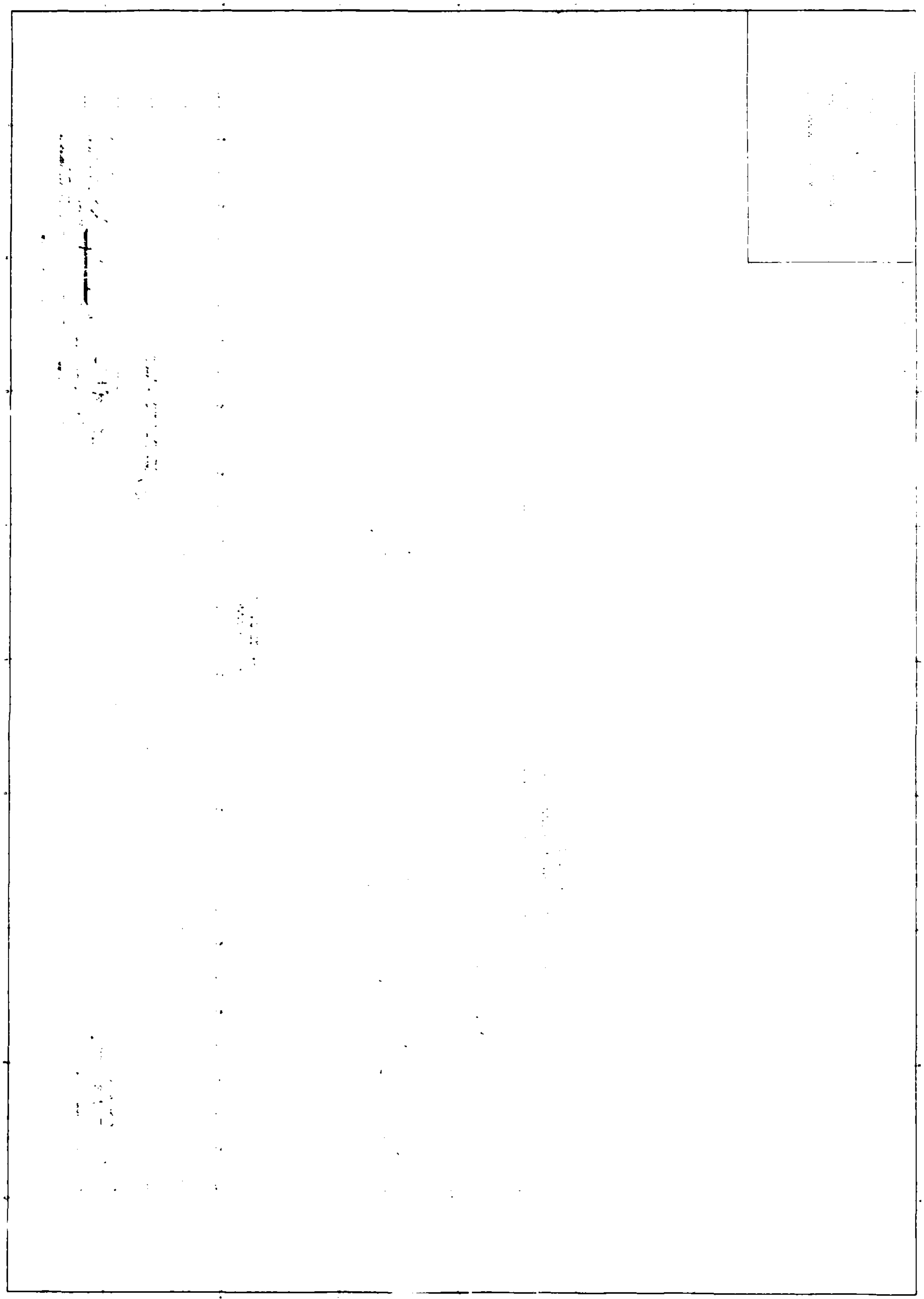
(6) Sedimentation patterns - The project area would be landward of the lakeshore and would not interfere with sedimentation patterns (littoral drift) in the lake.

(7) Salinity distribution - Not applicable

(8) Flushing characteristics - The berm placed in the wetland would essentially prevent flushing by high lake levels of the area behind it.

(9) Current patterns - No construction would occur within the





lake which would interfere with current patterns.

(10) Wave action, erosion or storm damage protection - The berm would protect the proposed channel from storm damage caused by wave action.

(11) Storage areas for storm waters and floodwaters - The wetland area to be filled would not provide substantial storage for storm waters or floodwaters.

(12) Prime natural recharge areas - No prime natural recharge areas are within the project area.

b. Impact on water column (40 CFR 230.4-1(a) (2))

(1) Reduction in light transmission - Excavated material would be stabilized soon after construction to prevent runoff. The banks of the excavated channel would be stabilized during construction before filling. Some short-term increases in turbidity would be expected when the openings to the marina and river channel were made.

(2) Aesthetic values - Aesthetic values may be slightly reduced by the unnatural appearance of riprap or fabric-form pavement where it would be visible under water.

(3) Direct destructive effects on nektonic and planktonic populations - No impacts of the project on nektonic or planktonic populations would be expected since all excavation except the openings to the marina and river would be done on dry land.

c. Covering of benthic communities (40 CFR 230.4-1(a) (3))

(1) Actual covering of benthic communities - Only a small portion of the benthic communities in the Warroad River would actually be covered by riprap. The rock would provide improved habitat for some species of benthic invertebrates.

(2) Changes in community structure or function - The stable substrates and interstitial spaces provided by riprap may permit the localized development of higher diversity invertebrate communities. Environmental quality would improve slightly if this occurred.

d. Other effects (40 CFR 230.4-1(a))

(1) Changes in bottom geometry and substrate composition - There would be a slight change in substrate composition where riprap was placed. Wetland would be changed to upland where berms were placed and changed to deepwater channel where excavated.

(2) Water circulation - Water circulation would not be impeded by any of the measures proposed for this project. Circulation may be improved or induced in the marina since the channel would provide a second connection of the marina with Lake of the Woods.

(3) Salinity gradients - Not applicable.

(4) Exchange of constituents between sediments and overlying water with alterations of biological communities - No significant alteration of biological communities would be expected.

3. CHEMICAL-BIOLOGICAL INTERACTIVE EFFECTS (40 CFR 230.4-1(b))

a. Does the material meet the exclusion criteria?

Riprap would meet the exclusion criteria since it would be primarily composed of naturally-occurring material with a particle size larger than silt. Fabric-form pavement would also meet the exclusion criteria because the concrete would be formed and set before exposed to water, thus minimizing the potential for contamination. The clean material that would be placed in the wetland area would be excavated immediately adjacent to the area to be filled and would be similar to the substrate at the fill site. Additionally, the material would be stabilized immediately after placement to ensure that it would not damage the environment outside the disposal area.

4. DESCRIPTION OF SITE COMPARISON (40 CFR 230.4-1(c))

a. Total sediment analysis (40 CFR 230.4-1(c)(1))

An analysis of the chemical constituents (including pesticides and heavy metals) of the fill material was done for several locations and depths. Material contaminated by overflow of the sludge dewatering tanks at the city sewage treatment plant would not be used for wetland fill but would be disposed of in a designated upland site along with the sludge. Material to be used for fill would be classified as non-polluted according to the interim guidelines for sediment classification developed for the Great Lakes by Region V of the Environmental Protection Agency.

5. REVIEW APPLICABLE WATER QUALITY STANDARDS

a. Compare constituent concentrations

Fill material to be placed in the wetland would be expected to have constituent concentrations similar to those at the adjacent receiving site.

b. Mixing zone

No discharge of liquid material would result from this project.

c. Based on a. and b. above, will disposal operation be in conformance with applicable standards?

Fill activities would be in conformance with Minnesota State Standards. Turbidity standards may be exceeded temporarily during placement of wetland fill, but only if water levels in Lake of the Woods were high.

6. SELECTION OF DISPOSAL SITES (40 CFR 230.5) FOR DREDGED OR FILL MATERIAL

a. Need for the proposed activity

Riprap and fabric-form pavement would be necessary for erosion protection of banks and entrances of the channel. The wetland fill would provide a berm to protect the channel from wave damage when lake levels are high, and to allow maintenance vehicle access to the government jetty.

b. Alternatives considered

Channel bank erosion could be prevented with steel or aluminum sheet pile, riprap, gabions, or conventional concrete pavement. All of these would be more costly than the proposed fabric-form pavement. Additionally, rock for riprap or the filling of gabions is not readily available in quantity. Sheet pile placement would result in vertical channel banks which would present a significant safety hazard, particularly in a park where small children would be frequently present. The only feasible alternative to the placement of a protective berm would be the elimination of that feature. The resultant overtopping would not damage the channel bank protection but could result in siltation of the channel. Additionally, no vehicular access to the jetty would be possible. Realignment of the channel to avoid the wetland would require relocation of the sewage treatment plant and of a new municipal swimming pool.

c. Objectives to be considered in discharge determination (40 CFR 230.5(a))

(1) Impacts on chemical, physical, and biological integrity of aquatic ecosystem (40 CFR 230.5 (a) (1))- Clean fill would not cause any significant impact on the integrity of the aquatic system. Wetland fill would alter the physical integrity of the wetlands by changing these areas to upland with a resultant change in habitat and vegetation types.

(2) Impact on the foodchain - Increased productivity of invertebrates would likely result from the increase in substrate made available by the placement of riprap. The extensive area of fabric-form pavement placed in the new channel would eliminate a small area from the wetland foodchain and replace it with components of the aquatic foodchain.

(3) Impact on diversity of plant and animal species - A slight increase in invertebrate diversity might result where riprap is placed due to the increased diversity of habitat (substrate) available.

(4) Impact on movement into and out of feeding, spawning, breeding, and nursery areas - None of the proposed fill activities would be expected to interfere with movement into any reproductive or rearing areas.

(5) Impact on wetland areas having significant functions of water quality maintenance - There would be no effect on wetlands with significant functions in water quality maintenance.

(6) Impact on areas that serve to retain natural high waters or floodwaters - The project would not significantly affect water storage.

(7) Methods to minimize turbidity - Berms created by wetland fill would be stabilized as soon as possible to prevent erosion. Riprap and fabric-form pavement would be placed with intent to minimize turbidity resulting from channel bank erosion.

(8) Methods to minimize degredation of aesthetic, recreational, and economic values - The proposed activities would protect the newly constructed channel from storm damage and erosion, preserving economic and recreational values.

(9) Threatened and endangered species - The proposed activities would have no effect on threatened or endangered species.

(10) Investigate other measures that avoid degredation of aesthetic, recreational, and economic values of navigable water - No other measures have been identified.

d. Impacts on water uses at proposed disposal site (40 CFR 230.5 (b) (1-10))

(1) Municipal water supply intakes - No water supply intakes are located within the proposed project area.

(2) Shellfish - Substantial mollusk populations in the lake would not be disturbed by any of the proposed activities. Approximately 100 feet of riverbank would be removed, but the 1700 feet of new channel may replace any lost habitat.

(3) Fisheries - Existing fisheries uses would not be disturbed by the placement of fill or riprap.

(4) Wildlife - The small size of the fill area and its location in the city park would not seriously disturb water use by wildlife in the project area.

(5) Recreation activities - Recreation would not be reduced by the fill activities. This project is intended to provide increased recreational opportunities.

(6) Threatened and endangered species - The proposed activities would have no impact on water uses of threatened or endangered species.

(7) Benthic life - Benthic habitat lost due to project construction would be partially compensated for by the placement of riprap which would provide increased habitat diversity.

(8) Wetlands - A small area of wetlands would be changed to upland habitat by the placement of fill; however, only those areas filled or excavated for the channel would be affected.

(9) Submersed vegetation - A minimal amount of submersed vegetation may be covered by riprap placement on the riverbank. Other activities would have no effect on submersed vegetation.

(10) Size of disposal site - The disposal sites are no larger than necessary to accomplish their protective function.

(11) Coastal zone management programs (40 CFR 230.3 (c)) - Not applicable.

e. Considerations to minimize harmful effects (40 CFR 230.5 (c) (1-7))

(1) Water quality criteria - Clean rock and set concrete would be the only materials exposed to open water. The placement of wetland fill may cause a temporary rise in turbidity if lake levels are high enough to innundate the fill area.

(2) Investigate alternatives to open water disposal - No open water disposal would be conducted.

(3) Investigate physical characteristics of alternative disposal sites - There would be no alternative disposal sites that would provide the desired protection.

(4) Ocean Dumping - Not applicable.

(5) Where possible, investigate covering contaminated dredged material with cleaner material - No contaminated material would be placed in the water.

(6) Investigate methods to minimize effect of runoff from confined areas on the aquatic environment - Not applicable.

(7) Coordinate potential monitoring activities at disposal sites with EPA - It is not expected that monitoring activities would be required at disposal sites due to the clean nature of the materials.

7. STATEMENT AS TO CONTAMINATION OF FILL MATERIAL IF FROM A LAND SOURCE (40 CFR 230.5 (d))

Fill material would include weathered rock from agricultural field piles, plus set and cured concrete which would not be contaminated. Material excavated from the city park has been tested and no contaminated material would be used for fill.

8. DETERMINE MIXING ZONE

Not applicable. Fill would be non-liquid.

9. COORDINATION

This evaluation was mailed to Federal, State, and local government agencies and mailed or otherwise made available to the general public through a public notice dated 26 November 1979. No comments were received.

10. DETERMINATIONS

a. An ecological evaluation has been made following the evaluation guidance in 40 CFR 230.4. An environmental assessment has been prepared which evaluates the proposed project, impacts, and alternatives to the selected plan. Evaluation considerations of 40 CFR 230.5 were also examined in conjunction with the project evaluation to select suitable sites and methods of disposal.

b. Appropriate measures have been identified and incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the discharge (40 CFR 230.3(d)(1)). All of the proposed fill activities are covered by these measures to minimize adverse effects by controlling erosion on channel banks (riprap, fabric-form pavement) or protecting the newly constructed channel from storm damage and sedimentation (protective berm). The impact of these protective measures on the aquatic community would be minimal. The project was aligned to intersect the smallest possible wetland area.

c. In the environmental assessment and this 404(b)(1) evaluation, consideration has been given to the need for the proposed activity, which is to provide protection from erosion and sedimentation. Eliminating the activity would not accomplish that purpose, nor would there be suitable alternatives for this action. The methods of placement are the least damaging methods available. Clean rock would be used for riprap, fabric-form pavement would be installed and cured before being exposed to water, and the berm would be seeded immediately to prevent erosion. Water quality, aside from a possible short-term increase in turbidity, would not be diminished by the fill activities (40 CFR 230.5).

d. Wetlands (40 CFR 230.5(b)(8))

The activity associated with the fill must have direct access to the water resource in order to fulfill its basic purpose, and no other sites or construction alternatives are practicable. The proposed fill and the activity associated with it will not cause permanent, unacceptable disruption to the beneficial water quality uses of the affected aquatic ecosystem.

11. FINDINGS

I find, based upon the above determinations, that the discharge sites for the Warroad Small Boat Harbor Channel Construction Project have been specified through the application of the Section 404(b)(1) Guidelines.

24 JUN 80
DATE

William W. Badger
WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

DATE
ILMED
8