FINAL REPORT FOR 831.4

CITY OF TWO RIVERS
COASTAL MANAGEMENT PROGRAM
DREDGE SPOIL TRANSFER SITE STUDY

FINANCIAL ASSISTANCE FOR THE PREPARATION OF THIS REPORT HAS BEEN PROVIDED THROUGH THE WISCONSIN COASTAL MANAGEMENT PROGRAM BY THE COASTAL ZONE MANAGEMENT ACT OF 1972, ADMINISTERED BY THE FEDERAL OFFICE OF COASTAL ZONE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION.

PREPARED BY GARY L. PETERSON AND ASSOCIATES

NOVEMBER 1983

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

The City of Two Rivers is located at the mouth of the East and West Twin Rivers on the west shore of Lake Michigan six miles northeast of Manitowoc. The harbor and harbor entrance have been dredged a number of times in the past, and can be expected to require regular dredging in the future. Until recently, vacant land at the harbor entrance has been available as an on-land transfer site for dredge spoils. That land will probably not be available much longer as it is being seriously considered for development.

A. Study Purpose

This report is intended to furnish information on which the City can base its selection of a future dredge spoil transfer site.

To prepare for future private or government dredging efforts, the City needs to find a site, and soon. The Army Corps of Engineers is considering dredging in 1985, and private development might require some dredging before that. Sediment accumulation rates vary, but approximately 60,000 cubic yards of unpolluted sandy sediments accumulate annually if dredging is done annually.

B. Study Methods

A comprehensive survey of sites was made, starting with a walking tour of the harbor and rivers by an outsider with a fresh eye for land use opportunities. A fresh look at possible sites, with a specific project in mind often uncovers otherwise overlooked opportunities. All vacant land on or near the lower reaches of the rivers and harbor was investigated and no sites were summarily rejected no matter how remote the possibility of their use seemed at the time. One reason for this is that dredging equipment specifications cover such a wide range that marginal sites could perhaps be modified and made useful at a low cost.

Information was then collected from federal, state, and regional agencies in order to better assess government programs and policies that affect dredging in Two Rivers. The final sites examined in depth in this report were picked in consultation with City staff, and with careful consideration of the many physical and regulatory factors important here.

Lastly, development cost estimates are provided for the most promising sites. However, no one site has been recommended because circumstances may change before dredging is done. The most promising site might suddenly become less desirable than it is at the moment and vice versa. For example, beach nourishment may become feasible if the Department of Natural Resources' (DNR) policy toward disposal of dredge spoil in the states' waters changes.

II. REVIEW OF EXISTING DATA

To understand Two Rivers dredging needs, a review of the physical characteristics of the rivers and harbor is necessary. This section starts with a description of the harbor and a discussion of sedimentation processes. This is followed by a review of harbor users, and state and federal policies that affect harbor dredging.

A. Physical Characteristics

1. Description of the Harbor

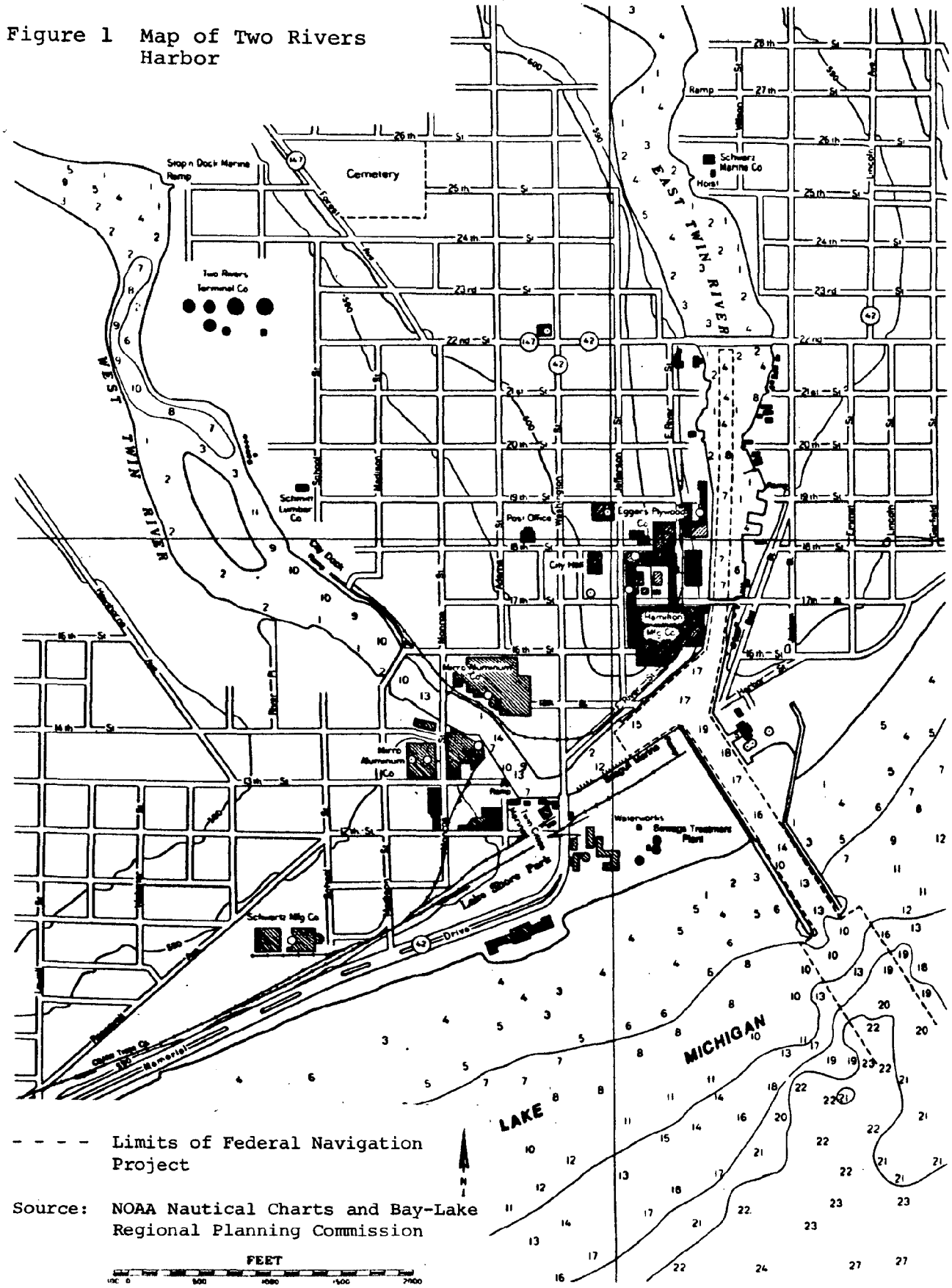
The harbor consists of an outer harbor formed by two parallel piers, an inner harbor basin at the confluence of the East and West Twin Rivers, and a channel one half mile in length extending from the basin upstream in the East Twin River to the Twenty-Second Street Bridge. (See Figure 1 on page 4).

The Federal navigation project at the Two Rivers harbor was authorized by the Rivers and Harbors Acts of 1871 through 1958. The project defines how deep each part of the harbor should be for use by commercial boats. The project calls for an entrance channel and inner basin 18 feet deep; a small stilling (turning) basin beyond the shoreline on the east side of the channel; and a channel 10 feet deep in the East Twin River.

2. Shoaling (Why Sediment Accumulates)

Sediment of concern to Two Rivers comes from two sources - in the inner harbor from river transport, and in the outer harbor from lake transport. The East and West Twin Rivers carry sediment from the surrounding farms and villages of Kewaunee and Manitowoc counties. The amount and quality of sediment is heavily dependent on the number of rain storms and on farming practices, specifically on whether soil erosion control techniques are used. Some of the material from farmland is fine-grained material of special concern. These fine-grained sediments tend to carry with them a higher concentration of heavy metals and organics, which are deposited in the harbor, and also at bends in the river where the current slackens. Organics from soil erosion, and from farm animals allowed direct access to the streams and rivers, are a major polluter of the inner harbor sediments.

Figure 1 Map of Two Rivers Harbor



- - - - Limits of Federal Navigation Project

Source: NOAA Nautical Charts and Bay-Lake Regional Planning Commission

The patterns of sedimentation in Lake Michigan are well known. The nearshore zones are very energetic, resulting in considerable erosion in many areas and sorting of sediments according to particle size. The Wisconsin shoreline of Lake Michigan is characterized by almost continual erosion of the underlying glacial till and the clay cliffs. The circulation patterns driven mainly by the southwesterly prevailing wind transfer much of the fine grained materials to the deep waters of the lake and deposit the coarser material as dunes on the eastern shore. (Kewaunee Beach Nourishment Project Proposal).

Along the Two Rivers shoreline, the offshore current is moving from southwest to northeast, eroding the shoreline on both sides of the harbor and depositing sediment near and in the harbor entrance piers. Much of the beach erosion occurs during storms, and thus the magnitude of erosion and deposition varies widely from year to year. The volume of sediment being deposited will automatically increase as natural fluctuation causes the presently high Great Lakes water levels to fall. It is also found that dredging does not create a static bottom configuration, and extensive dredging causes quicker deposition of sediments. (Bob Mundelius).

B. Harbor Use

The City's central business district is adjacent to the harbor area. Other adjacent land uses include a commercial fishing village, heavy industry, recreational boating facilities, and a City park.

The City's economic base is industrial, with large manufacturing properties located on the harbor or on the first reaches of the East and West Twin Rivers. Generally, operations do not take advantage of their harbor location; the harbor is not used for shipping by these companies.

One minor exception to this rule is a City-owned dock that has been used for the unloading of petroleum products and caustic soda. A pipeline from the dock connects with a 212,000 barrel petroleum storage facility located upstream on the East Twin River. But, these facilities have not been used for several years.

Major use of the harbor is made, however, by commercial and recreational fishing boats. Eleven commercial fishing operations have licenses to operate out of Two Rivers and in 1981, they caught $719,826 worth of fish. In 1982, the total value was $754,356. (Michael Tonys, DNR).

Recreational fishermen can operate out of any of the private marinas in Two Rivers, or they can use the City boat ramps at Eighteenth Street (Municipal Marina) and Twenty-Seventh Street.

Figure 2 Table of Harbor Use by Recreational Craft in 1983

Marina	# of Boats Moored	# of Ramps	Average Daily Launchings
Private [a]			
Two Rivers Sports and Marine	25	1	d = 10-12 e = 20
M & M Marina	12	0	n/a
Twin Cities Marina	64	1	d = 10-15 e = 50-75
Stop 'n Dock	72	6	d = 24-40 e = 75
Public [b]			
18th Street	n/a	5	d = 12.8 e = 65.25
27th Street	n/a	2	d = 3.1 e = 15

Note: d = weekday, e = weekend
Source: a = Telephone Survey by Gary L. Peterson and Associates, September, 1983
b = Howard Perry, Recreation Department, City of Two Rivers

At the larger four private marinas, listed in Figure 2, there are now 173 boats moored. Rough estimates from the managers of each marina put daily launchings between 45 and 65 boats on weekdays, and 150 to 160 boats on weekends. Other facilities, both public and private, are available as support services for recreational fishing boats.

A more accurate survey was done by the City of Two Rivers this summer of the public boat ramp usage. From August 23, 1983 through September 5, 1983, the two marinas saw 479 boats launched from the seven ramps. Weekday launchings averaged 15.8, and weekend days saw 80.25 boats launched. After September 9th, the usage decreased dramatically.

Both commercial and recreational fishermen are making use of the Two Rivers harbor. It is expected that recreational fishing use will increase; commercial fishing trends are more difficult to predict because DNR regulations change and because fish populations fluctuate so much.

C. Physical Limitations to Dredge Spoil Transfer

Certain physical limitations to navigation exist in the East and West Twin Rivers that reduce the number of feasible dredge transfer sites. It was found that the existing bridges would not constrain barge traffic; only the Twenty-Second Street bridge would constrain tug traffic because it is so low. When the bridge is open, however, there would be no problem with tugs getting through. Figure 3, details the five bridge crossings of the East and West Twin Rivers. The smallest clear height is nine feet on the Twenty-Second Street Bridge; the narrowest span openings are fifty feet on the Chicago and Northwestern Railway Bridge.

Water depths, however, would be a constraint. Figure 1, on page 4 is a map of the Two Rivers Harbor with some water depth information included. While this map is not up-to-date, it does provide some idea of water depths in the two rivers and along the shores of Lake Michigan.

Further discussion of limitations as they affect specific sites can be found in Section V of this report.

Figure 3 Table of Bridge Specifications

Bridge Location and Name	Miles Above Mouth of River	Draw or Span Openings-Clear Width in Feet Proceeding Upstream			Clear Height Above Low-Water Datum
		Right	Left	Center	
East Twin River					
17th Street	0.3			70	14.5
22nd Street	0.65			70	9.0
West Twin River					
Washington Street	0.34			54	14.2
Chicago & Northwestern Railway	0.45	50	50		
16th Street & Madison Street	0.63			70	14.0

All bridges open to allow river traffic through except the Washington Street Bridge.

Source: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, United States Pilot, Great Lake, 1981

D. Government Policies Affecting Dredging

1. Federal Policies

Federal agencies that regulate dredging and harbors are the Army Corps of Engineers, the U. S. Coast Guard, and the Environmental Protection Agency.

a. Army Corps of Engineers

The U. S. Army Corps of Engineers is a division of the Department of the Army and is in charge of flood-control improvements and the administration of laws for the protection and preservation of navigation and navigable waters of the United States. The Corps has the responsibility of issuing permits, conducting research and special studies of water related issues, and actual construction of water related improvements.

Authority for the Corps is derived from several laws among which are the following:

1. The River and Harbor Acts of 1899, 1902, and 1968.

2. The Outer Continental Shelf Lands Act of 1953.

3. The Federal Water Pollution Control Act of 1972 (Section 404).

4. The Marine Protection Research and Sanctuaries Act of 1972.

Corps permits will be required when dredging at Two Rivers takes place. Permits are generally required for work on structures in all areas channelward of the mean waterline on the Great Lakes. The mean high waterline is defined as being four feet above the low water datum for Lake Michigan, at an elevation of 576.8 feet. Permits are also required for projects where fill or dredged material is deposited into any "water of the United States" or its adjacent wetlands. Although not to be considered a legal definition, "waters in the United States" can generally be considered as all rivers and streams in the United States and their tributaries, to the headwaters; and all lakes over ten acres in size, such areas to include the adjacent wetlands. Some of the projects for which permits are required are as follows:

1. Constructing piers, wharfs, docks, dolphins and mooring cells.

2. Excavating and commercial sand or gravel dredging.

3. Filling and disposal of dredged material.

4. Placement of riprap, groins, revetments, retaining walls, breakwaters, levees, or fishing reefs.

5. Constructing wires or cables over the water.

6. Clearing channels and upland canal connections.

7. Placing intake or outfall pipes and structures.

8. Providing navigational aids (except those established by the U. S. Coast Guard), platforms, ramps, signs and fences.

9. Transporting dredged material for ocean dumping.

10. Pipeline crossing (natural gas, eletrical conduits, etc.)

11. Cable crossing (electrical cables, telephone cables, etc.)

As part of its responsibility for the protection and preservation of navigation, the Army dredges harbors that it deems important for commercial purposes. However, commercial and recreational fishing are not included in their commercial use calculation. For Two Rivers, this is unfortunate, because it is a harbor that is heavily used by fishing vessels. The fishing activity adds diversity to the local economy and brings tourists to the area who patronize other businesses.

Now being considered in Congress is a bill that would require a user fee for recreational and commercial fishing vessels in order to pay for their share of harbor dredging.

b. U. S. Coast Guard

The U. S. Coast Guard is responsible for numerous duties such as approving marine events (e.g. regattas), permitting private aids to navigation, and permitting the construction of bridges and causeways.

Of special relevance here is their responsibility to approve the establishment of Special Anchorage Areas for the mooring of small craft. These areas are designated by local government, and may also be regulated under a local ordinance. The turning basin next to the Coast Guard station might be a prime candidate for designation as a Special Anchorage Area. (Harbor Study, Bay-Lake Regional Planning Commission, November, 1982)

c. Environmental Protection Agency

Environmental Protection Agency (EPA) regulations come into play when dredged material is polluted. The Two Rivers inner harbor and river dredge spoil is usually found to be polluted when tested, because of organic sediment transported down the rivers. However, it probably will not be grossly polluted (containing toxic or hazardous contaminants) and therefore can be put in a Confined Disposal Facility (CDF) such as the diked area offshore at Manitowoc. Grossly polluted materials would have to be placed in a licensed hazardous waste disposal facility, but, again, this probably does not apply to Two Rivers.

Further disposal restrictions are based on the source of the dredged materials. Only those materials dredged for commercial navigation purposes from federal project areas and classified by the EPA as polluted may be placed in a CDF constructed totally with federal money. Polluted material from outside the federal project area cannot be placed in the Manitowoc CDF, and must be otherwise managed.

2. State Policies

The DNR'S specific role in dredging and dredged material disposal is outlined by several major laws and administrative codes. The preservation of public rights or interests including unobstructed waterways and good water quality was the Legislature's main concern in passing the laws which regulate dredging.

a. General Dredging Regulations

Removal of material from beds of navigable waters is covered under Section 30.20, Wisconsin Statutes. Removal of any material from the bed of any navigable lake requires a contract with, or permit from, the DNR. Dredging contracts/permits specify methods of disposal which help minimize or eliminate adverse effects of dredging on water quality, habitat and recreation.

Dredging projects on the beds of waterways is regulated by NR 347, Wisconsin Administrative Code. This rule provides legal definitions of dredging-related terms, lists required project and environmental information, and specifies standards and procedures to assist dredging project applicants and DNR staff. NR 347 outlines the implementation - as it applies to dredging - of the wastewater treatment facility plan approval program, the solid and hazardous waste management programs, and the Wisconsin Pollution Discharge Elimination System.

b. Water Quality-Related Laws

Wastewater treatment facility plans require approval under Section 144.04, Wisconsin Statutes. Under this program, all wastewater treatment facilities and sewer extensions constructed for the handling of dredged material disposal must have approved plans prior to beginning construction. Changes to such facilities must also be approved. All treatment facility plans must conform with existing approved areawide waste treatment management plans under the Federal Clean Water Act. A dredge material disposal facility may require plan approval since it can involve treatment of water-borne pollutants.

Solid and hazardous waste management programs, (Section 144.43 through 144.784 Wisconsin Statutes), can also affect dredging operations. This group of laws directed the DNR to develop standards for permitting and licensing the construction and operation of solid and hazardous waste disposal facilities. From a preliminary discussion of a proposed dredging project, the DNR determines what technical information is required for permitting based on the amount of dredged material and the potential for contamination of the sediments with PCB's or other hazardous substances. The laws provide for county-level solid waste management planning, to be coordinated with recycling and other regional plans. Depending on the nature of the dredged material and the disposal site, a solid or hazardous waste license may be required.

The Wisconsin Pollution Discharge Elimination System, (Chapter 147, Wisconsin Statutes), directly bears on dredging operations. To eliminate the harmful effects of pollutants on waters and the organisms that depend on them, the legislature directed the DNR to establish limits on effluent discharges. No one may discharge a pollutant to a waterway without a permit. DNR review of the dredging discharge permit application may determine that the project can be authorized by a "general permit," which establishes basic effluent limitations that must be met. For dredging projects not receiving the general permit, a permit is processed and individual effluent limitations are established.

The water quality certification program, (NR 229, Wisconsin Administrative Code), is an attempt to coordinate state and federal programs. The Federal Clean Water Act of 1977 requires projects requiring federal approval in state waters to meet state water quality laws. The administrative rule establishes the standards and procedures for determining whether federally-issued permits meet the requirements of state laws.

c. Obstruction-Related Laws

Establishment of bulkhead lines is regulated by Section 30.11, Wisconsin Statutes. This statute enables a municipality to pass an ordinance subject to DNR approval establishing an artificial line (bulkhead line) delineating the shore of any navigable water within its boundaries. Waterfront property owners may place solid structures or fill up to such lines if they meet standards for the protection of fish, wildlife and water quality. A bulkhead line must meet two legal requirements: its purpose must be in the public interest and it must follow the existing shorelines as nearly as practicable. In the Great Lakes and other waterways where the Corps of Engineers maintains commercial navigation projects, a submerged lands lease may be combined with a bulkhead line to allow structures or fill to be placed farther from the shoreline than by bulkhead line alone.

The rule governing structures and deposits in navigable water, (Section 30.12, Wisconsin Statutes), is being reviewed, and might be changed in the next couple years. This statute prohibits the deposit of any material or the placement of any structure on the bed of any navigable water or beyond a lawfully established bulkhead line without a permit. Structures such as groins and jetties, sand blankets, fish cribs or riprap may be placed in navigable waters by permit. Deposits of materials that have no intended use or form are generally prohibited.

A submerged land lease, (Section 24.39(4), Wisconsin Statutes), was obtained at Manitowoc for their Containment area. Under this section, the Board of Commissioners of Public Lands may lease rights to use the beds of Lakes Michigan and Superior to a municipality for a maximum of 50 years. Rights to the bed, including the right to fill the lakebed, can be leased for improving recreational facilities related to navigation for public use. The state holds the beds of lakes in trust for the public. The state legislature has entrusted the DNR with ensuring that uses of leased lakebed areas are in the public's interest.

(Great Lakes Dredging, DNR, September, 1982)

III. DREDGING HISTORY

A. Frequency and Volume

As already mentioned, the Army Corps authorized a Federal Navigation Project at Two Rivers, as outlined on the map on page 4. The project outlines the area to be dredged, and the depths to which each section should be dredged. Controversy over financial responsibility for the disposal of unpolluted dredged materials halted dredging in the Two Rivers Federal Project Area after 1973. By 1977, fuel oil barges could no longer enter the harbor. Annual accumulation in the East and West Twin Rivers part of the Federal Project Area is moderate (65,000 to 95,000 cubic yards), however, these sediments are classified as heavily polluted. The greatest need for dredging is in the entrance channel; these sediments are classified as unpolluted. The Two Rivers entrance channel has the largest annual deposition (approximately 20,000 cubic yards) of unpolluted sediments of any harbor in the region.

According to existing Corps policy, the expense of the state-required on-land disposal of these unpolluted sediments was not justified by the commodity movements in Two Rivers. Two Rivers did not become eligible for Corps dredging until July, 1979, when the Corps adjusted their economic justification policy to allow for state environmental standards which were more restrictive than federal standards. The State of Wisconsin then appropriated $325,000 to assist the City in the development of on-land disposal sites.

Dredging of the Two Rivers Federal Project Area resumed in 1980 and 1981. The area to be dredged was also expanded to include the entire authorized project to the Twenty-Second Street Bridge.

Figure 4 on page 16, "Dredging History 1956-1981", presents the material volumes removed each year from 1956 through 1981. The accompanying Figure 5 on page 17 indicates where the dredging was done in each of these areas. It is important when looking at these figures to remember that each dredging cycle did not return the harbor to the Corps Navigation Project specifications. The Project was almost complete in 1961; all parts of the Project were dredged to their authorized depths, except for the 10 foot width along either side of the lakeward portion of the entrance channel between the piers. The 1980 and 1981 dredging was the first time that the East River portion of the project was dredged to the authorized depth.

Figure 4 Bar Graph of Dredging History 1956-1981

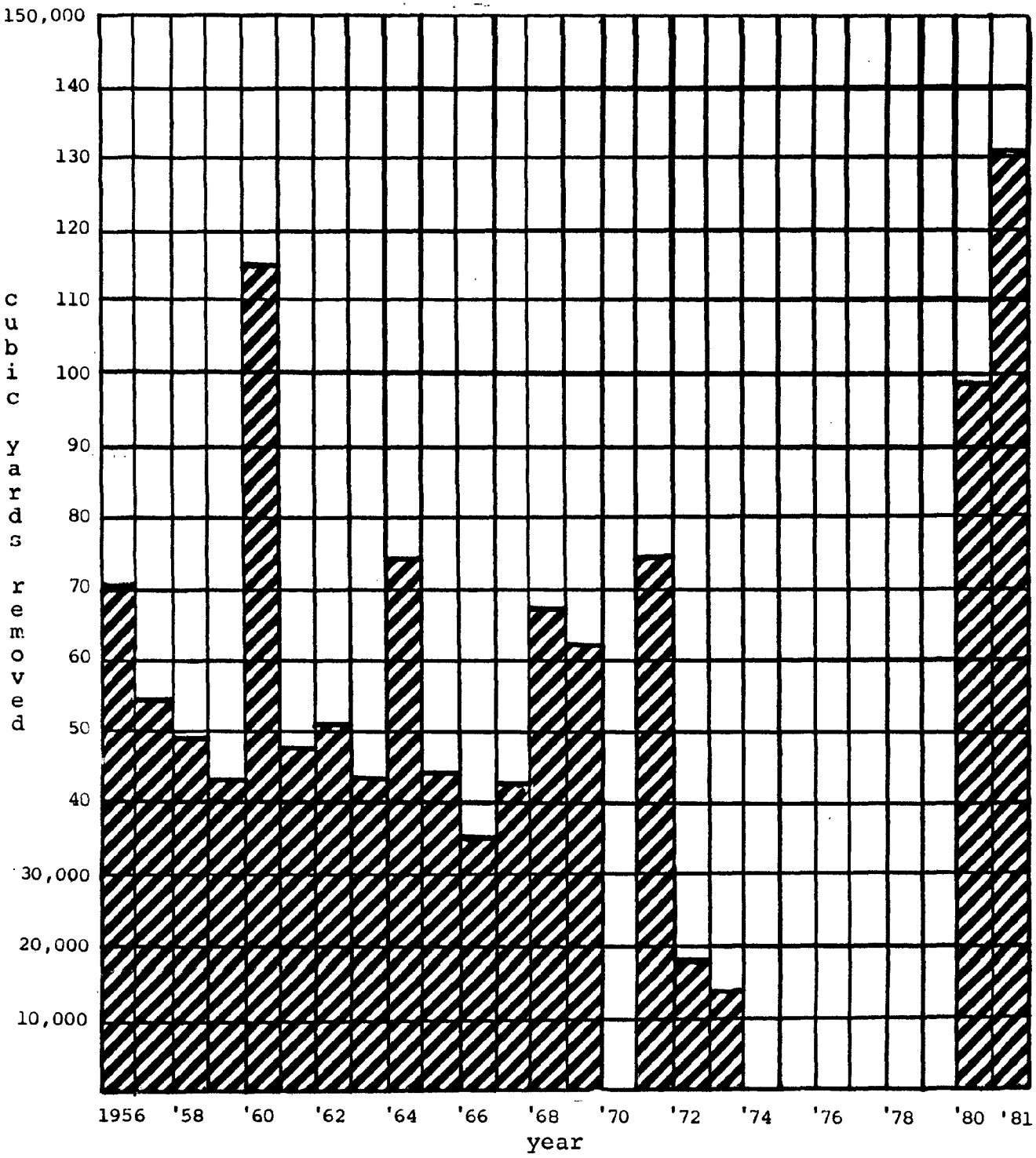


Figure 5 Table of Two Rivers Dredging History 1956-1981

Year	Location	Cubic Yards of Dredge Spoil
1981	Harbor and River	130,717
1980	Outer and Entrance Channel	99,571
1973	Outer Harbor	14,400
1972	Outer Harbor	18,350
1971	Outer Harbor	74,100
1969	Outer Harbor	62,225
1968	River and Outer Harbor	67,575
1967	River and Outer Harbor	43,150
1966	Outer Harbor	24,012
1966	Outer Harbor and River	11,550
1965	Outer Harbor and River	43,700
1964	Outer Harbor	17,427
1964	Outer Harbor	50,573
1964	Outer Harbor	6,620
1963	Outer Harbor and River	43,560
1962	Outer Harbor and River	51,258
1961	Outer harbor and River	47,462
1960	River	69,986
1960	Outer Harbor and River	45,075
1959	Outer Harbor and River	43,750
1958	Outer Harbor and River	49,250
1957	Outer Harbor and River	54,885
1956	Outer Harbor and River	71,570

Source: Bob Mundelius, Army Corps of Engineers

B. Methods

The Army Corps has generally used their suction dredge, the Hains, for the work they have done in Two Rivers. It has recently been decided by the Corps that the Hains will be mothballed, and any dredging will be done by local contractors. A discussion of the capabilities of local contractors can be found in Section IV of this report.

Permits filed since 1978 indicate private dredging was done in the West Twin River by the Stop and Dock Marina. Schwarz Marine, a boat builder on the East Twin River, also has a permit to dredge 5,000 cubic yards of sediments, and has done some work under this permit. A private developer has applied for a permit to dredge 36,000 cubic yards of material for a marina/condominium project on the south side of the harbor entrance, and would use the dredged material as fill on the property. However, this project is behind schedule and is now on hold. These private dredging operations are not included in Figures 4 and 5 because they are insignificant compared to the Army Corps of Engineers dredging volumes.

IV. POTENTIAL DREDGING METHODS

Because different dredging methods produce spoil with different handling requirements, these methods need to be discussed. Another reason to discuss dredging methods before discussing specific sites is because some of the potential dredge spoil transfer sites could only be available for certain types of dredging operations. Also discussed here are the capabilities of private contractors who might be doing the work.

A. Mechanical Dredging

Mechanical dredging makes use of a clamshell or bucket-like crane mounted on a barge to lift the underwater material from the river, dump it into a barge, and then transport the material to a dredge spoil transfer site. Material is then unloaded with another crane onto the land, or directly into dump trunks that haul it to its final destination.

This is the type of dredging equipment most widely used by private contractors. Roen Salvage Co., Durosher Dock & Dredge, Harbor Marine Ltd., and E. E. Gillen Construction Co. all have mechanical dredge equipment.

B. Hydraulic Dredging

With hydraulic dredging, underwater material is agitated with a cutter device, then pumped to the surface through a "vacuum" pipeline and transported to an on-shore disposal site through a series of pipelines set on floating pontoons. If the material is to be pumped a significant distance, a boosterbarge is placd in line to boost material further distances.

Harbor Marine Ltd. has a small hydraulic dredge which they prefer to use over their mechanical dredge.

C. Suction Dredging (the Hains)

Suction dredging is a form of hydraulic dredging, but it produces a dredge spoil that is not as water-logged as most hydraulic dredge spoil. The Hains, belonging to the Army Corps and used in the past for dredging at Two Rivers, was a suction dredge. This equipment is now mothballed for the indefinite future.

V. TRANSFER SITES FOR DREDGE SPOILS

A. Transfer Sites

There are three sets of activities involved in using a transfer site that affect selection of a site:

1. Moving the dredge spoil to the on-land site from the dredging operation in the river;

2. Transferring the spoil from the river to the land and then into trucks for transport to its final destination; and

3. Moving the trucks through the City streets.

The first set of activities, a method of getting the dredge spoil to shore, will depend upon the type of dredging--hydraulic or mechanical--that is used.

If the material has been dredged hydraulically, it may be pumped through a pontoon-supported pipeline to a transfer site within a mile of the dredging operation. Hydraulic dredging would allow the use of a transfer site not directly on the shore - the pipeline can go overland and even across roads. The contractor could burrow under roads, or build ramps over pipes lain across roads, with good results.

To transport material a distance of one mile or more, mechanical dredging must be used. The material is placed in a barge, which is then moved by tug to the transfer site, where a crane then unloads the barges directly into trucks, or onto the ground.

The second set of activities, transferring the spoil from the river to the land and then into trucks, would also depend on the type of dredge used.

Hydraulic dredging would simply require the construction of a dike to contain the wet material, and some outlet to allow the excess water to drain back into the river. A front end loader would then be used to load trucks for the final journey.

Front end loaders have certain relevant characteristics. They make some noise while in use; they also work most efficiently on a firm foundation, preferably pavement. Because of the wetness of the dredge spoil, it is easy for a site's foundation material to get waterlogged. Any tendency towards muddiness should be avoided if possible, by picking a site that is paved or graveled.

Mechanical dredging might involve the use of a front-end loader for loading trucks, but it would also involve the use of a crane for off-loading the barges. More equipment noise would be produced that would impinge to some degree on close residential neighbors, if any.

The third activity, moving the trucks through the city streets, should be done as efficiently as possible. The trucks will track some sand onto the streets, and increase noise levels along their route. The shorter the distance they must travel on residential streets the better, but since a final disposal site has not been chosen as yet, this factor cannot be fully evaluated for each site.

B. Preliminary Review of Transfer Sites

This section is a discussion of the decision process whereby the sites are divided into categories, based on suitability factors. Three meetings with City officials occurred at which possible tranfer sites were discussed and divided into "unsuitable", "suitable" and "most suitable" sites.

Each list is catalogued, and the reasons for each site being on the particular list are mentioned. Those in the "unsuitable" category were only minimally investigated--the information collected on these sites is presented in Figure 6 on page 24. Those sites in the "suitable" category, presented in Figure 7 on page 25, also have some drawbacks, but could be made feasible with certain modifications. "Most suitable" sites, presented in Figure 8 on page 26, are, logically, those with the greatest number of positive features and least number of drawbacks. Those sites on the "most suitable" list are examined in greatest detail. Figure 9 on page 27 is a map of "suitable" and "most suitable" site locations.

1. Not Suitable Sites

a. Riverside Park - Water is currently too shallow, and would only be feasible if the area leading to the Park was dredged; care would have to be taken so that items constructed with federal funds would not be destroyed.

b. Mirro Plant 1 - Power lines make the site unusable. If they are relocated for some reason, the site should be re-evaluated.

c. Two Rivers Sport Marine - Site not big enough; existing business would be disrupted.

d. City Owned Lot-Madison Street - Poor access and small.

e. Eggers Sites - Eggers management currently indicates no possibility for a dredge transfer site on their property.

f. M & M Parking Lot - Site on the river is not available. The Lake Street Triangle is possible with a hydraulic dreging system.

g. Fairview Drive Site - Too much dredging needed to get to the site, and it is too far from main harbor.

h. Brick Warehouse (Crescent Woolen Mills) - Currently occupied by a building; poor truck access.

i. Schwarz Marina Parking Lot - Would interfere with existing businesses. Water too shallow.

j. Twenty-Third Street End - Site is too small.

k. Rogers Street Susie Q Truck Storage - Site is too small; and activities would interfere with surrounding land use. A building is on the site and in the way.

l. Turning Basin - Better used for marine purposes.

2. Suitable Sites

a. Mirro Plant 4 (Site Number 2) - Site currently occupied by buildings.

b. Lake Street Triangle (Site 3) - Possible from September through May only. Problems with runoff and barge access.

c. Schmitt Lumber (Site 5) - Some distance from dredging operation; may be wetland.

d. Municipal Marina (Site 6) - Site is developed for public use; would be feasible in spring when fishing demand is low.

e. Hamilton Property (Site 8) - Not best use; site is larger than needed; currently occupied by buildings.

f. Guimer Property (Site 10) - Possible wetland; some distance from dredging operation.

g. Harbor Street Park (Site 12) - Weak sea wall could be further damaged by drainage from the dredge material; poor truck access.

3. Most Suitable Sites

a. Mirro Plant 4 Parking Lot (Site Number 1) - Compatible neighbors; boats must maneuver past the Washington Street Bridge and the Railroad Bridge.

b. Sewage Treatment Plant (Site 4) - Compatible neighbors; close enough to pump spoil directly to site if using hydraulic dredge.

c. City Dock (Site 7) - convenient to dredging operation; access drive might need to be modified.

d. High School Playing Fields (Site 9) - Some distance from dredging operation; dredge spoils would destroy the grass; temporary road would have to be constructed.

e. 27th Street Boat Ramp (Site 11) - Possible wetland; some distance from dredging operation. Land would have to be acquired.

f. Coast Guard Station (Site 14) - Probably close enough to pump spoil directly if using hydraulic dredge.

Figure 6 Sites Not Suitable for Dredge Spoil Transfer

Name	Size	Truck Access	River Access	Planned Uses	Adjacent Land Uses	Modifications Needed	Environmental Regulations
Riverside Park	medium	possible	shallow water	park	residential	dredging	n.a.
Mirro Plant 1	large	good	obstructions (power lines)	abandoned (under study)	industry	remove buildings	n.a.
Two Rivers Sport Marine	medium	possible	good	marina	commercial, recreation	remove piers	n.a.
City Owned Lot - Madison Street	small	traffic problem	good	none	retail, residential	power line obstruction	n.a.
Eggers Parking Lot	medium	possible	good	as before	industry	needed by Eggers	n.a.
Log Yard & 20th Street End (Eggers & City Owned)	medium	possible	good	as before	commercial	needed by Eggers	n.a.
M & M Parking Lot	small	possible	obstructions	parking lot	commercial, recreation	remove piers	n.a.
Fairview Drive Site	large	possible	shallow water	future development	residential	dredging, lower telephone cable	possible wetland
Brick Warehouse (Crescent Woolen Mills)	small	poor	good	as before	residential	remove building	n.a.
Schwarz Marina Parking Lot	small	possible	shallow water	as before	industry	dredging	n.a.
23rd St. End (City & Privately Owned)	small	possible	shallow water	as before	residential	dredging	n.a.
Rogers Street Susie Q Truck Storage	small	possible	shallow water	none	commercial, recreation	enlarge site, faulty sea wall	n.a.
Turning Basin	medium	poor	good	as before	U.S. Coast Guard	build containment wall	n.a.

Source: Gary L. Peterson and Associates, September, 1983

Figure 7 Suitable Sites for Dredge Spoil Transfer

Site #	Name	Size	Planned Uses	Zoning	Adjacent Land Uses	Modifications Needed	Truck Access	River[1] Access	Multiple Use Possibilities	Opportunity Costs
2	Mirro Plant 4	large	industrial, but may change	I1	Industry, residential, commercial recreation	good truck access	good	h-good m-needs some dredging	needs study	needs study
3	Lake Street Triangle	small	parking lot	I1	Cement plant, restaurant, park	drainage to lake	good	hydraulic dredging only	empty lot, parking	ruin grass
5	Schmitt Lumber	large	undeveloped	I2	lumber yard, tank farm	dredge channel	okay	h-too far[2] m-needs some dredging	none	destroy wetland
6	Vets Park Launching Ramp	small	as before	park	park, utility, parking	special traffic control at bridge	good	h-too far[2] m-needs some dredging	parking and boat ramp	lose use of boat ramp for several weeks
8	Hamilton property south of 17th Street	large	industrial, but may change	I1	industry	remove buildings	good	h-good m-good	none	good commercial space
10	Guimer Property	large	undeveloped house lots	R3	residential	dredge channel	fair	h-too far m-needs much dredging	none	destroy wetland
12	Harbor Street Park	small	park	R3 & park	residential	faulty sea wall needs repair	poor	h-good m-good	none	lose use of park, ruin grass

Source: Gary L. Peterson and Associates, September, 1983

[1] h = hydraulic dredging needs
m = mechanical dredging needs

[2] The distance from the Federal Navigation Project is too far to pump without a booster barge. Using a booster barge would be possible, but more expensive.

Figure 8 Most Suitable Sites for Dredge Spoil Transfer

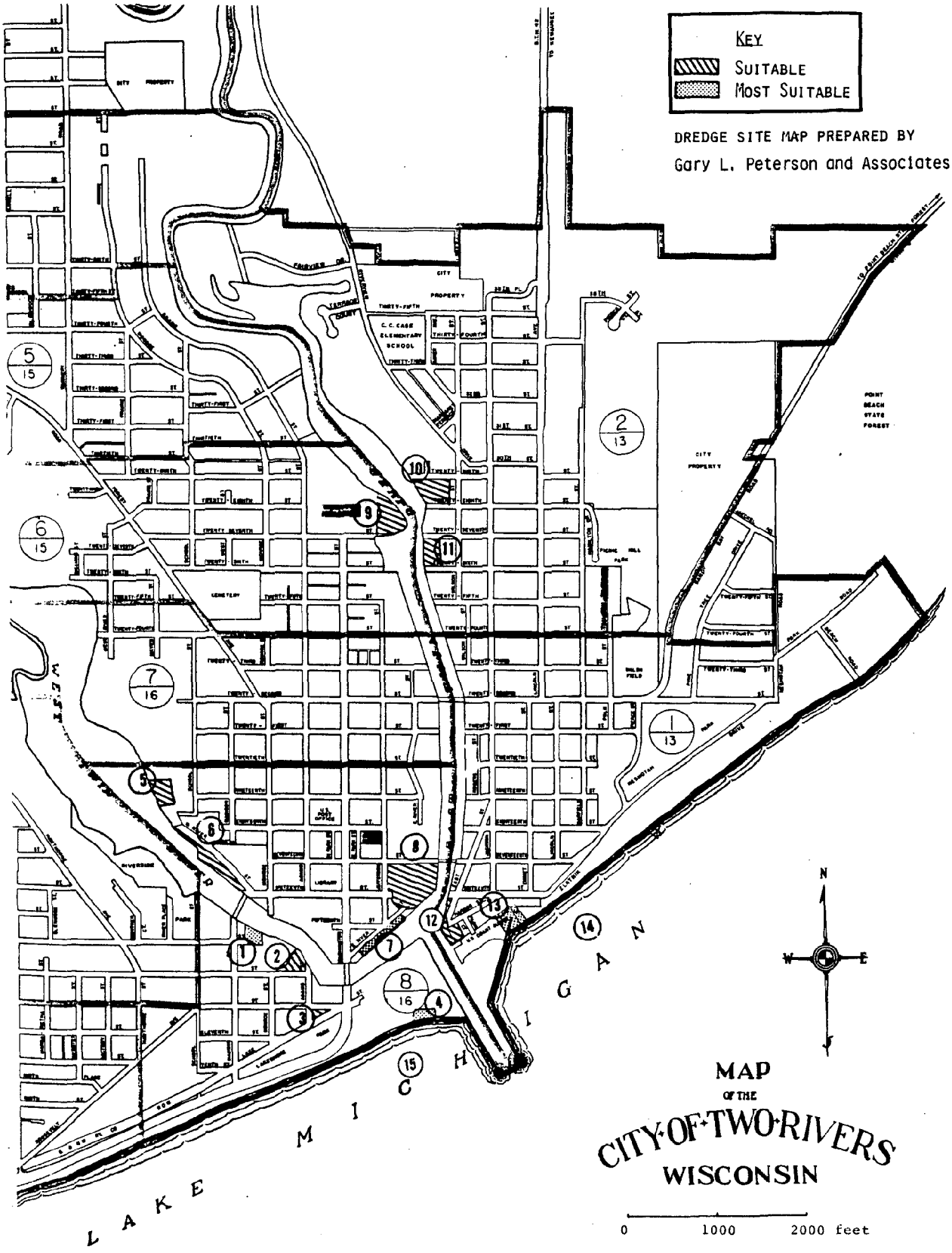
Site #	Name	Size (ft^2)	Planned Uses	Zoning	Adjacent Land Uses	Modifications Needed	Truck Access	River Access[1]	Multiple Use Possibilities	Opportunity Costs
1	Mirro Plant 4 - Parking Lot	35,000	industrial; under study	I1	residential, commercial recreation	minimal dredging	good	h-good m-needs some dredging	under study	under study
4	Sewage Treatment Plant	32,000	sand pile, undeveloped	I1	utility	none	good	h-good m-needs dredging	sand pile there now	none
7	City Dock	62,000	park	I1	residential, retail	work around steep road	steep road	h-good m-good	parking	lose parking
9	High School Playing Fields	200,000+	as before	R1	residential	build temporary road, dredge	poor	h-too far[2] m-needs much dredging	play fields after reseeding	ruin grass
11	27th St. Boat Ramp and St. Joseph's Athletic Association	65,000	vacant lot, boat ramp	R3	residential	needs much dredging	good	needs much dredging	boat ramp	destroy wetland
13	Coast Guard Property	25,000+	undeveloped	R1	residential, recreational	improve truck and barge access	poor	h-good m-needs some dredging	compatible with beach	none

Source: Gary L. Peterson and Associates, September, 1983

[1] h = hydraulic dredging needs
m = mechanical dredging needs

[2] The distance from the Federal Navigation Project is too far to pump without a booster barge. Using a booster barge would be possible, but more expensive.

Figure 9 Map of Suitable/Most Suitable Sites for Dredge Spoil Transfer



C. In-Depth Evaluation

The following information on the most suitable sites can be used, along with the information in Figure 8, to compare the sites relative advantages and disadvantages. No overall rating was given each site because of the uncertainty about when a selection will be made, and the possibility that some factors will change before that time. However, positive (+) and negative (-) ratings were given to factors that affect the site's suitability.

Mirro Plant 4 Parking Lot (Site 1)

Availability

The future use of this site is uncertain. A reuse study, just completed by Donahue and Associates, designates the parking lot of Mirro Plant 4 for continued use as a parking lot. The City might buy it, but even if the property stays in private hands, it is projected to remain a parking lot. If, as a part of redevelopment, it is in high demand as a parking lot, it would be difficult to arrange for use of the space for a dredge spoil transfer site. Therefore, obtaining an easement or acquiring the site before development occurs would ensure the use of this site for dredging operations.

Cost Estimates

No acquisition costs are involved, and the only modification needed is a minor amount of dredging.

Decision Factors

The following factors, (+) positive and (-) negative, should be considered in evaluating this site:

+ The site is located directly on the rivers and is therefore appropriate for mechanical or hydraulic dredging.

+ The site is paved, and would therefore be better for heavy equipment operation.

+ Industrial neighbors are compatible with the transfer operation.

+ Use as a parking lot could be made of the site the rest of the year; low opportunity cost.

- May be incompatible with future use of Mirro Plant 4 buildings.
- Minor extra dredging would be needed.
- This site doesn't border the Federal Navigation Project.

Figure 10 Photograph of Mirro Plant 4 Parking Lot (Site 1)

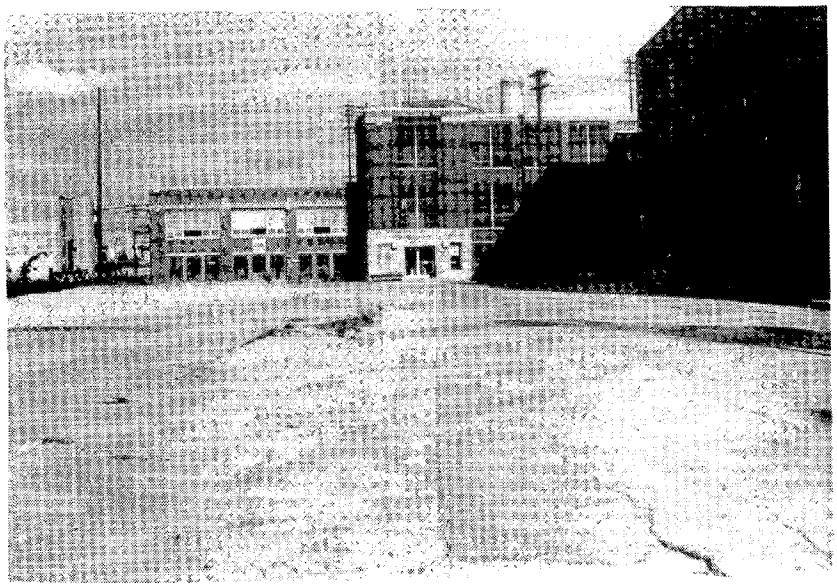
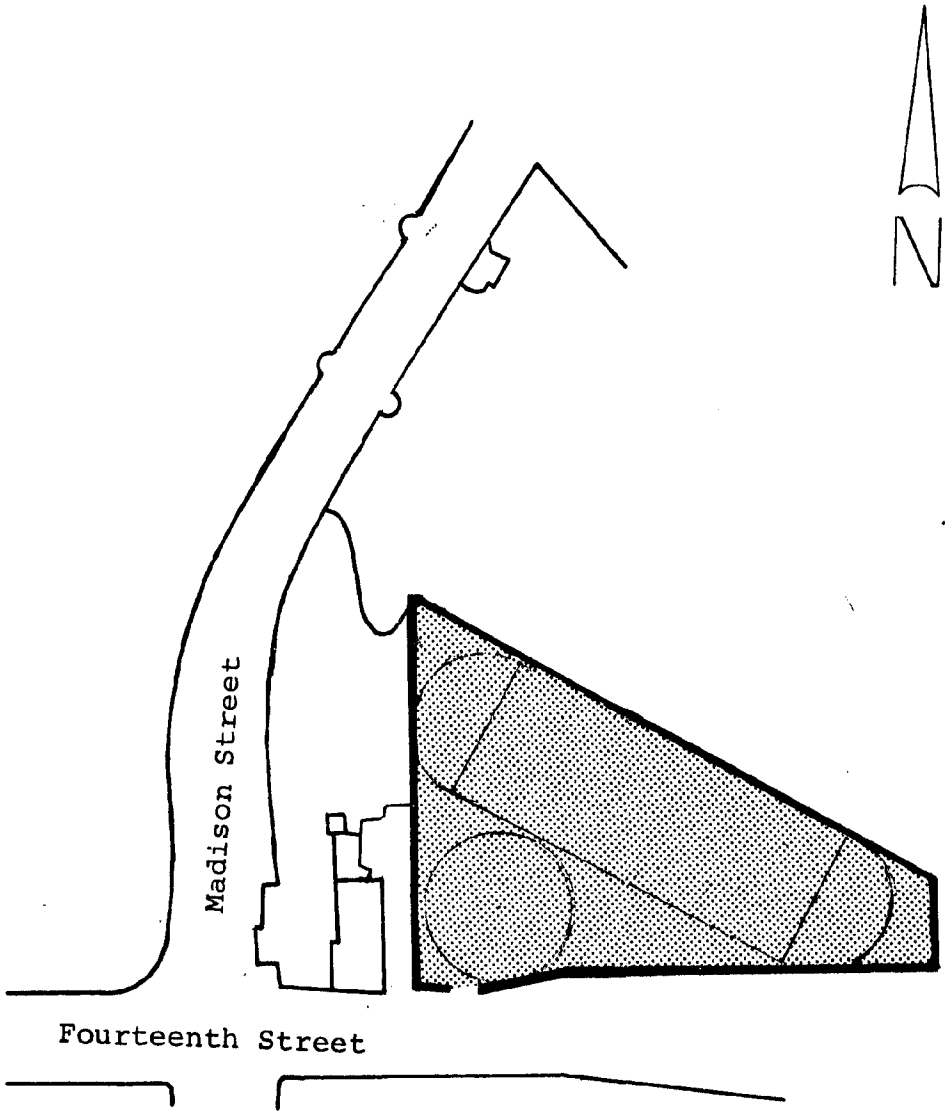


Figure 11 Site Map of Mirro Plant 4 Parking Lot (Site 1)



River frontage - 325 feet
Site area - 35,000 square feet
Possible sand volume - 8,000 cubic yards
1 inch = 100 feet

Sewage Treatment Plant (Site 4)

Availability

The property is City-owned, and therefore available.

Cost Estimates

No acquisition costs would be involved here. Barges would be needed if mechanical dredging is used and would require a moderate amount of extra dredging. Hydraulic dredging would not require extra dredging.

Decision Factors

+ Compatible adjacent uses.

+ Excellent truck access.

+ Low opportunity cost; no other uses are planned.

- Requires dredging if mechanical dredging done.

Figure 12 Photograph of Sewage Treatment Plant (Site 4)

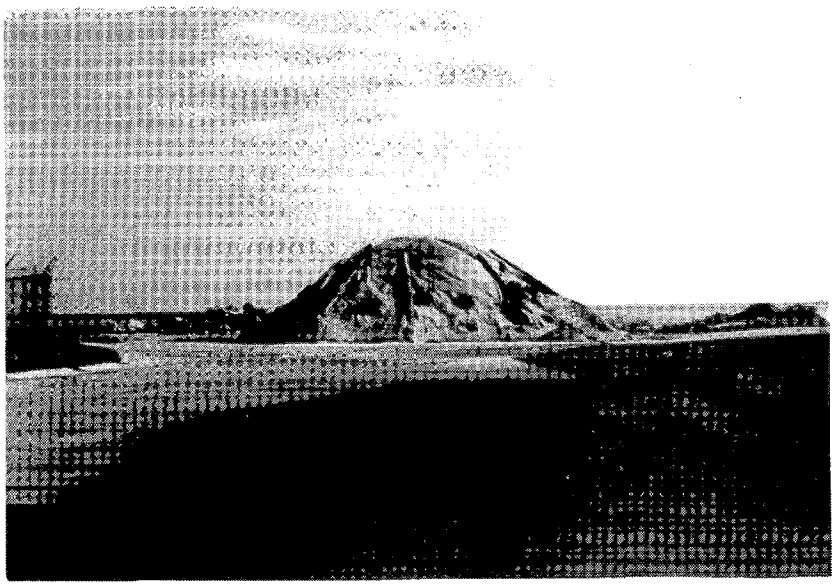
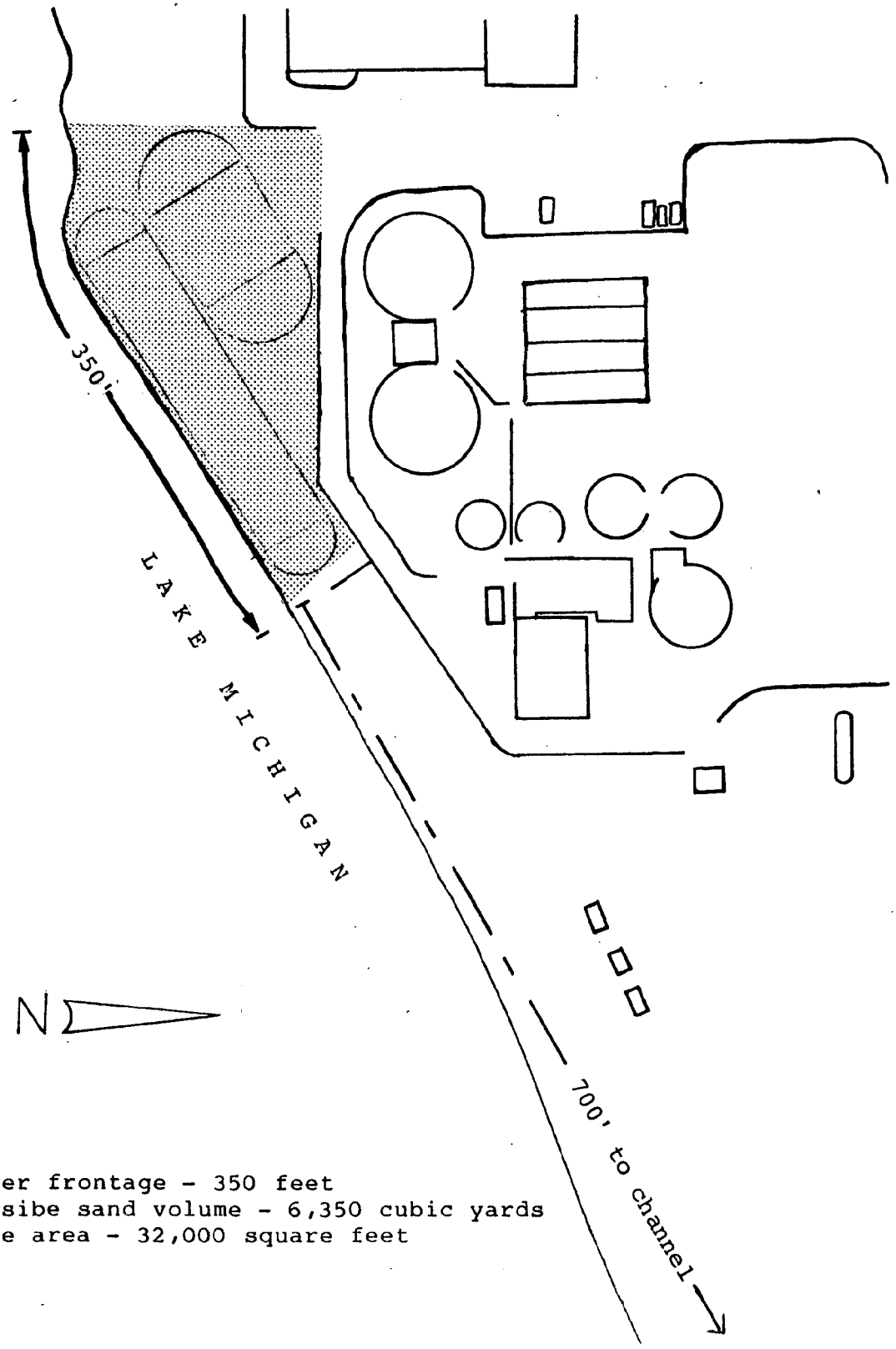


Figure 13 Site Map of Sewage Treatment Plant (Site 4)



River frontage - 350 feet
Possibe sand volume - 6,350 cubic yards
Site area - 32,000 square feet

City Dock (Site 7)

Availability

The property is City-owned. The present lease to Hamilton of the property for employee parking is no longer necessary because of their slow down in operations.

Cost Estimates

No acquisition costs and no extra dredging are needed because the site directly borders the Federal Navigation Project. The entrance road is rather steep for fully loaded trucks to ascend, but it is quite possible the trucks can be loaded at the top of the incline.

Decision Factors

+ Borders Federal Navigation Project, therefore less time must be taken by the barges to move from the dredge site to the off loading site, if a mechanical dredge is used.

- Residential and commercial neighbors will be aware of addition dirt and noise.

- Steep access road.

- Trucks will have to travel through the downtown streets to leave and enter the site.

Figure 14 Photogragh of City Dock (Site 7)

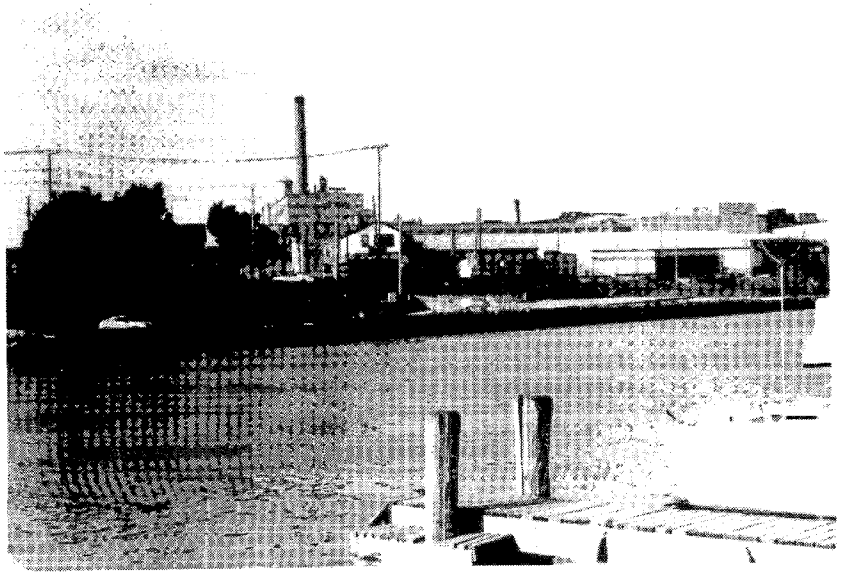
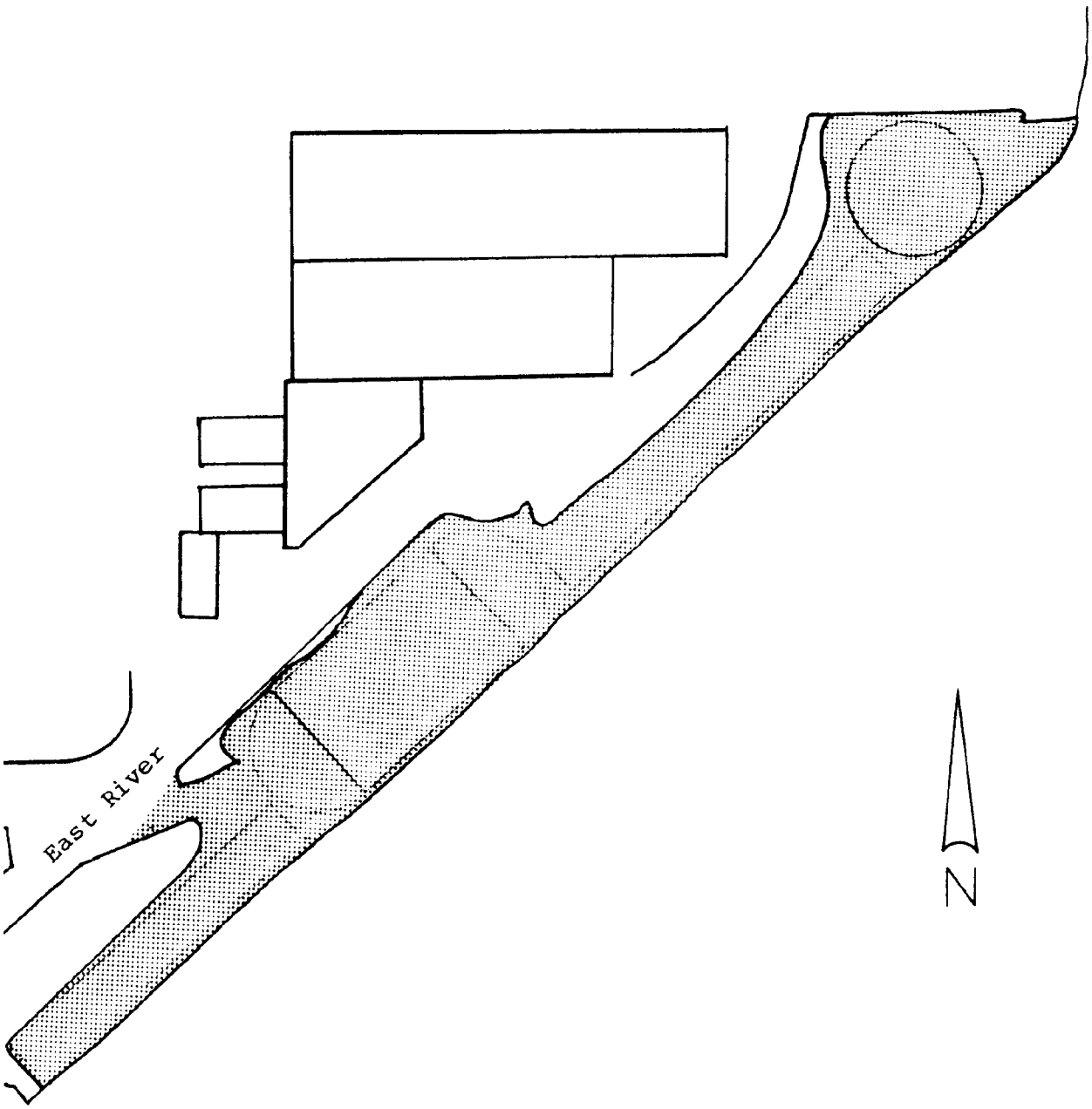


Figure 15 Site Map of City Dock (Site 7)



River frontage - 900 feet
Possible sand volume - 10,800 cubic yards
Site area - 62,000 square feet

High School Playing Fields (Site 9)

Availability

This land belongs to the City; it would not have to be acquired.

Cost Estimates

No acquisition costs are involved. Transportation costs for moving the dredge spoil up the river need to be considered. For mechanical dredging, an extra channel would have to be dredged from the end of the Federal Navigation Projejct at Twenty-Second Street to the high school. Approximately 6,250 cubic yards would have to be removed, at an estimated cost of $47,000 (using a figure of $7.50/cubic yard, and making a channel 30 feet wide.) This estimate does not include the total transport cost nor the extra time required to move the barges up and down the river. This estimate also does not include the cost of lowering the buried telephone cable at Twenty-Third Street.

For hydraulic dredging, no extra dredging would be required, but this site would require more piping and more labor. Estimates for this are not available.

Decision Factors

- School use of fields would be temporarily disrupted if dredging is done during the school year.
- Operation would destroy the grass.
- Temporary road would have to be built for trucks to climb the bank.
- Unpaved working area for heavy equipment is not optimal.
- Residential neighbors would be aware of additional dirt and noise.
- Extra dredging would be required.

Figure 16 Photograph of High School Playing Field

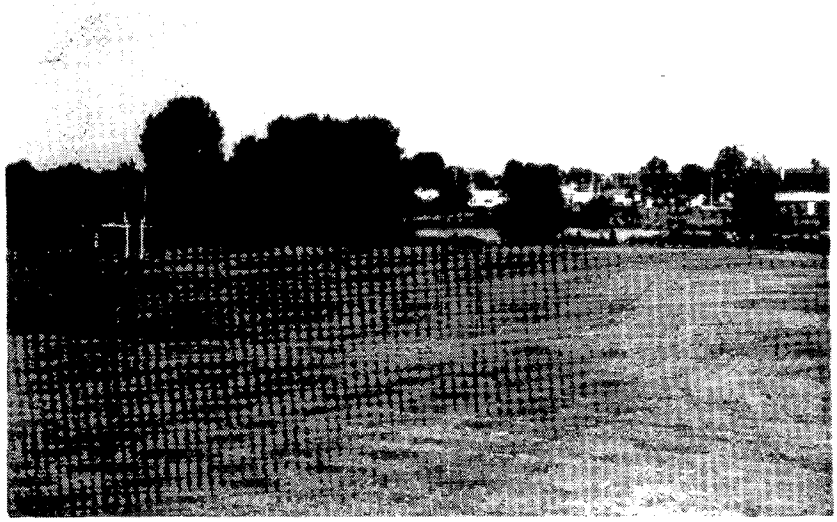
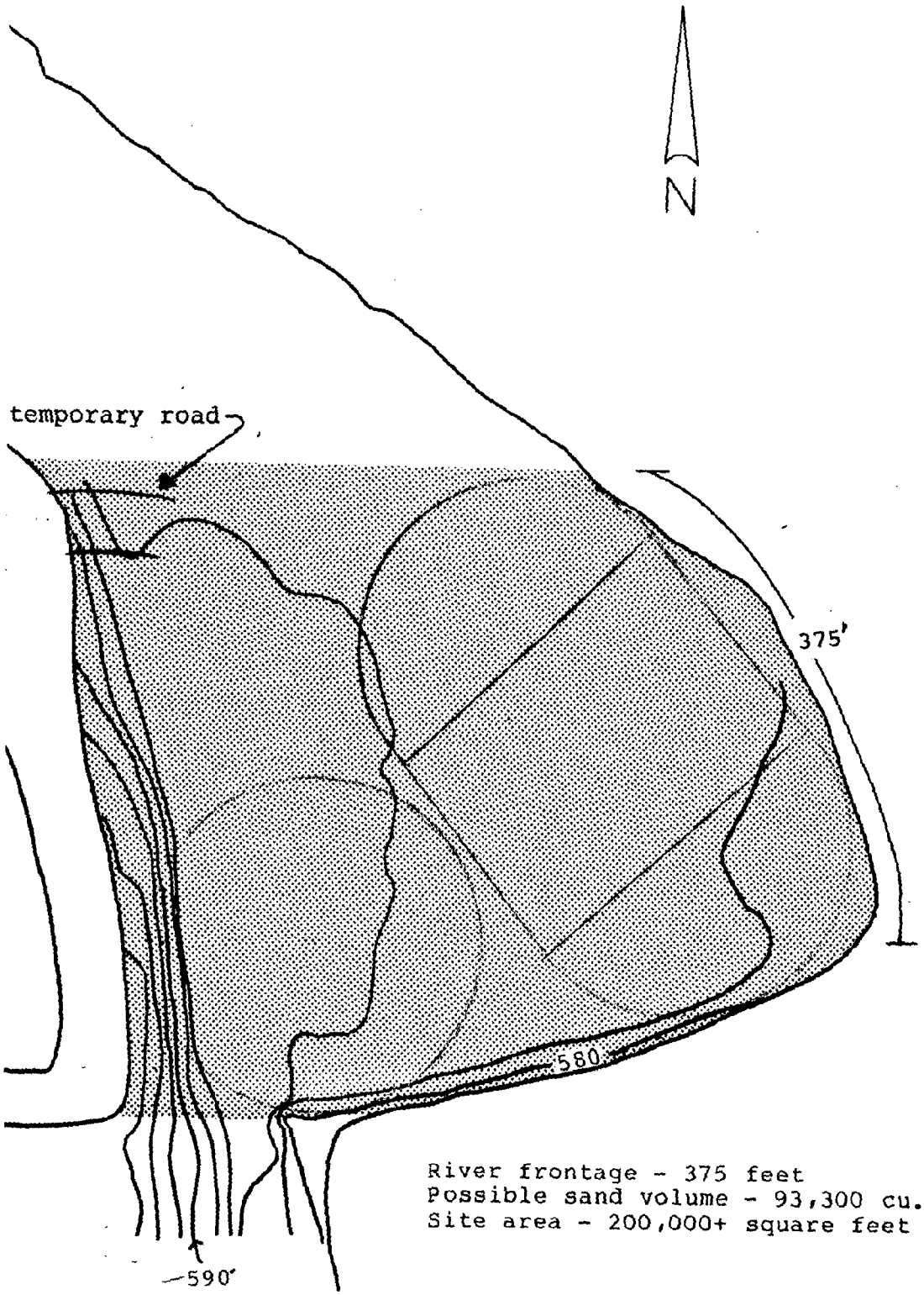


Figure 17 Site Map of High School Playing Fields (Site 9)



27th Street Boat Ramp (Site 11)

Availability

The northern section of the property is City-owned; the larger, southern portion is owned by St. Joseph's Athletic Association and is presently a field. There is some possibility that St. Joseph's will use the property for a parking lot, or sell it in the forseable future.

Cost Estimates

Acquisition of the St. Joseph land will cost about $15,000. Dredging costs for developing a channel from the edge of the Federal Navigation Project to the Twenty- Seventh Street Boat Ramp would cost approximately $47,000 (see "Cost Estimates" on page 35). This estimate does not include the cost of lowering the buried telephone cable at Twenty-Third Street.

Decision Factors

Factors to consider in evaluating this site are:

+ Truck access is good.

+ The site is directly on the river, and is therefore appropriate for mechanical or hydraulic dredging.

- The site is not paved and therefore heavy equipment operation would be made more difficult.

- The site is not wholly City-owned, and would require acquisition money.

- Residential neighbors will be aware of additional dirt and noise.

- The site does not border the Federal Navigation Project. The spoil would have to be transported to the transfer site by barge or pipe. Hydraulic dredging would probably require a booster barge, at additional expense.

- Much extra dredging would be needed for barge access.

- The field might be a wetland, and activities might require a DNR permit.

Figure 18 Photograph of 27th Street Boat Ramp (Site 11)

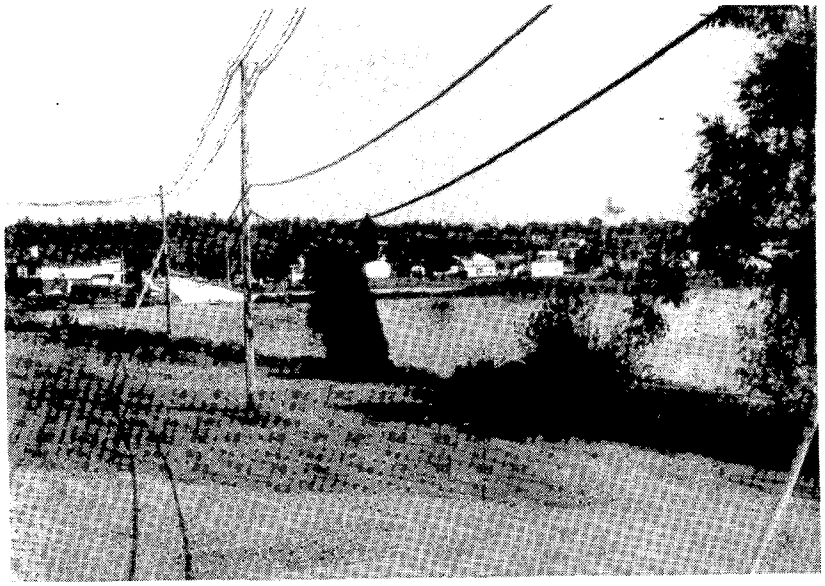
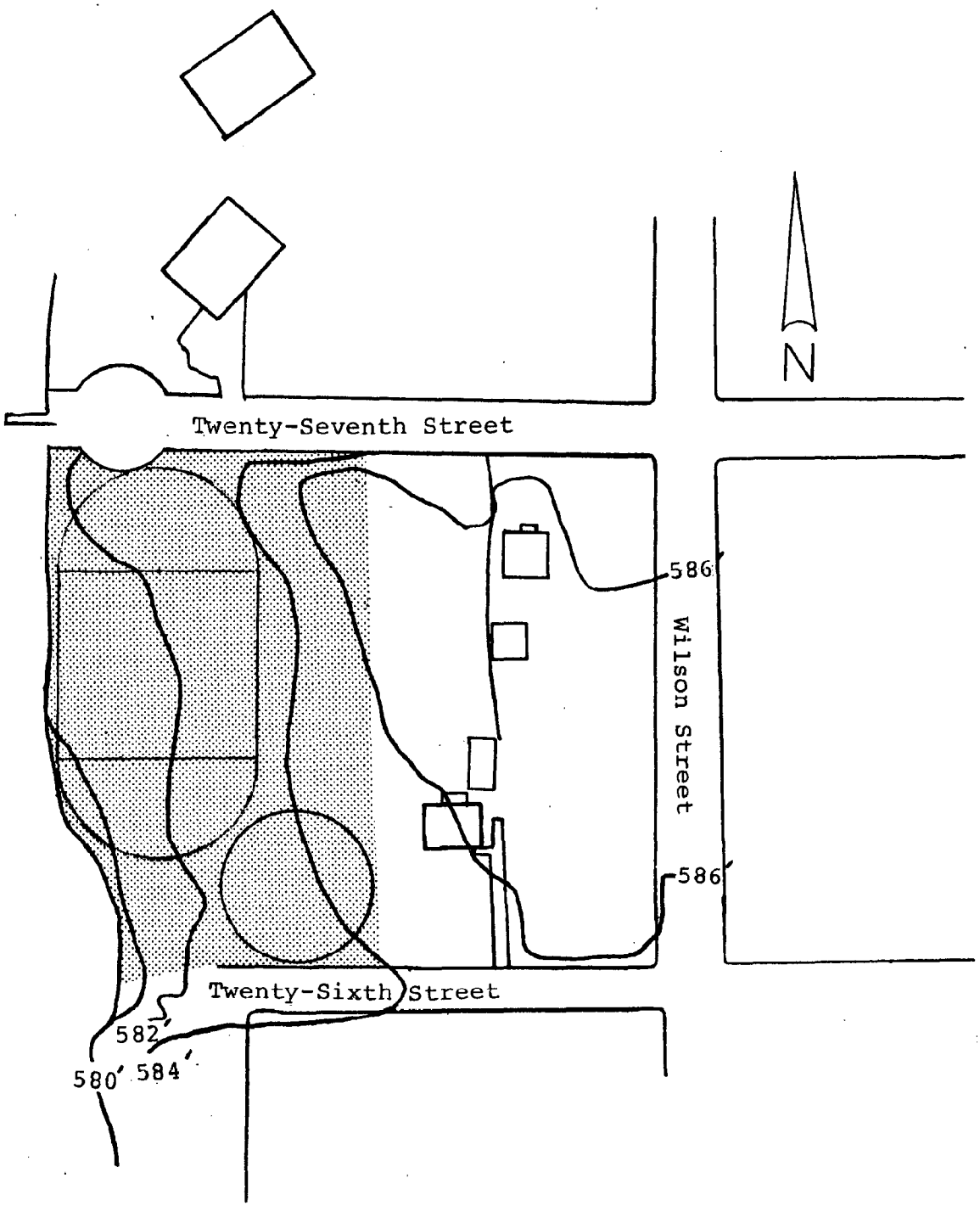


Figure 19 Site Map of 27th Street Boat Ramp (Site 11)



River frontage - 325 feet
Possible sand volume - 22,500 cubic yards
Site area - 65,000 square feet

Coast Guard Station (Site 13)

Availability

The Army Corps of Engineers presently owns the property adjacent to the Coast Guard Station. Initial conversations with Coast Guard officials indicate that the site is availabile for use.

Cost Estimates

No acquisition or modification costs are needed.

Decision Factors

+ The site borders the Federal Navigation Project, therefore less time would be required to transport the dredge spoil from the dredge site to the transfer site.

+ No other uses for the property are planned; therefore opportunity costs are low.

- Residential neighbors will be aware of additional dirt and noise.

- Truck access is poor because of narrow streets.

- The site is not paved.

Figure 20 Photograph of Coast Guard Site (Site 13)

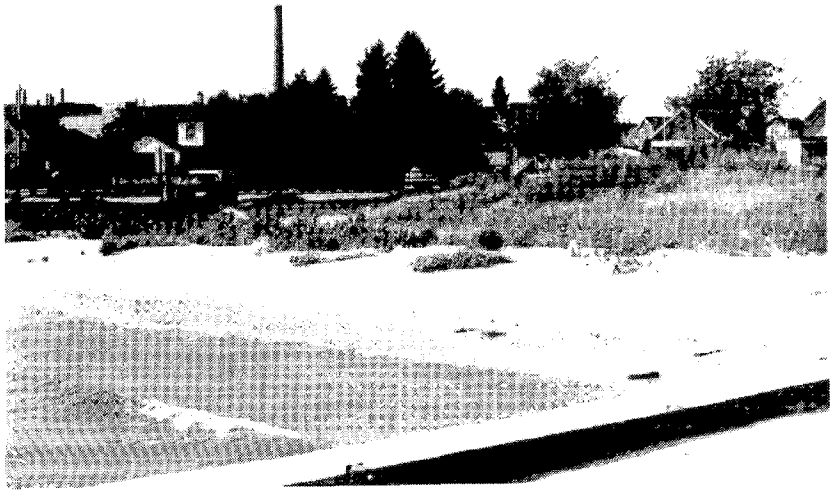
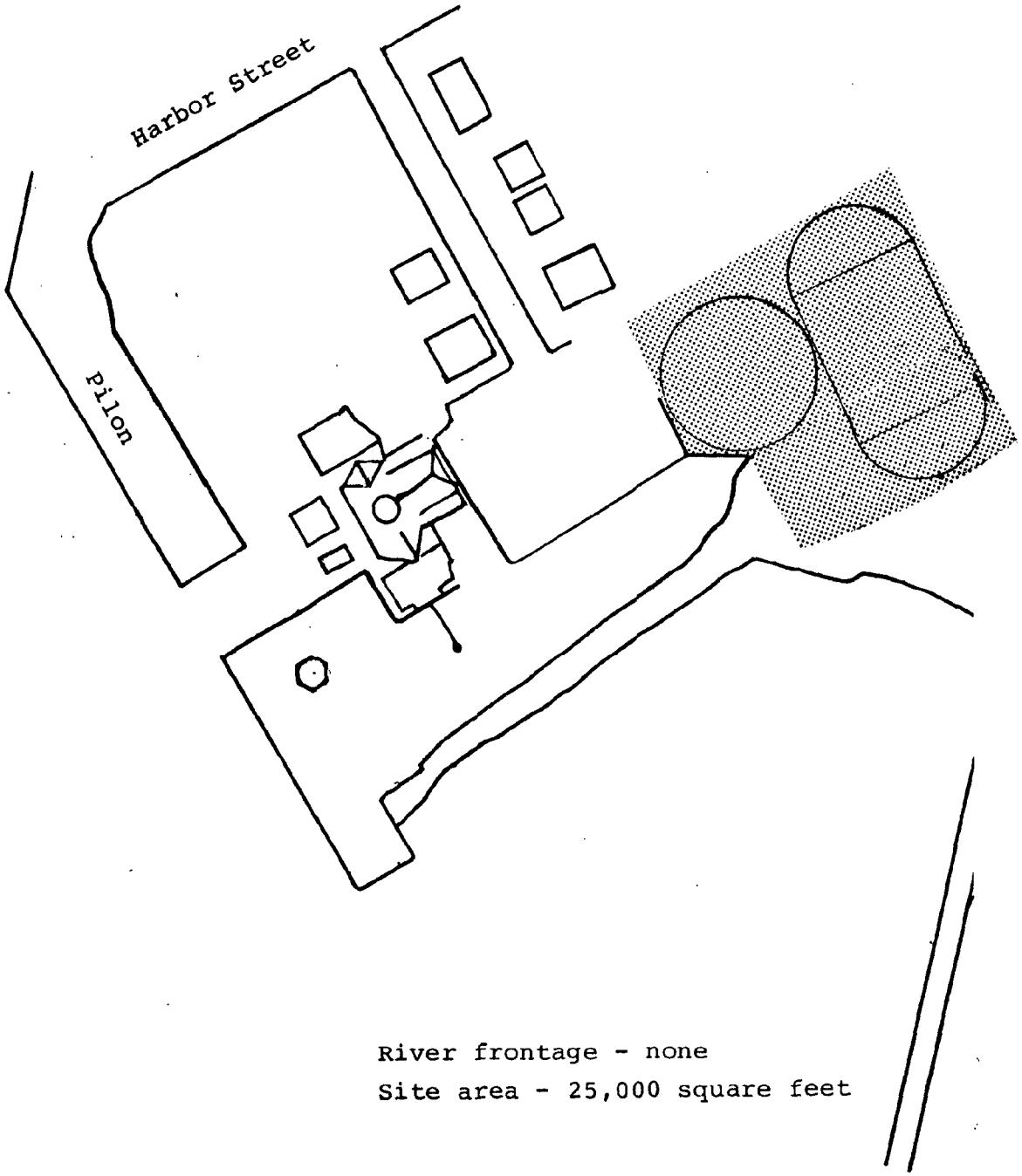


Figure 21 Site Map of Coast Guard Site (Site 13)



River frontage - none
Site area - 25,000 square feet

Water frontage - 150 feet
Possible sand volume - 8,700 cubic yards
Site area - 25,000 square feet

D. Beach Nourishment (Sites 14 and 15)

Meant to aid beaches that are badly eroded, beach nourishment is accomplished by placing compatible material on the beach and in the shallow water next to the beach. Dredge spoil from adjacent areas would likely be composed of similar sized particles, and if clean, would be compatible.

The present prohibition against beach nourishment exists for two reasons; first to preserve the ecological integrity of the Great Lakes, and second, to prevent contamination of the lake water by chemical pollutants and particulate matter.

Pilot projects in Kewaunee and Superior are being closely monitored by the DNR to determine if the prohibition should be lifted. Methods are also being developed for defining

> "the (1) critical parameters which should be measured prior to dumping and (2) the need and time for monitoring of the effects of the disposal operation." (Kewaunee Beach Nourishment Project Proposal, D.N. Edington and J.V. Klump, Center for Great Lakes Studies, University of Wisconsin-Milwaukee, April, 1982, page 2.)

Beaches on both sides of the harbor in Two Rivers could benefit from beach nourishment, and it would be an easy disposal route for clean dredge spoil.

Two Rivers will just have to wait and see what the outcome of the pilot projects will be. The DNR may continue to ban the practice, or beach nourishment may become a legitimate disposal route.

VI. SUMMARY

A comprehensive survey of possible dredge spoil transfer sites was made, and the sites divided into three categories. No one site has been recommended because of the dynamic land use situation in Two Rivers.

At the moment, the City Dock is the site that seems most suitable to recommend. But a lot could happen before dredging commences that would make other sites more suitable, or City Dock less suitable.

For instance, with the pending redevelopment of the Mirro properties, it might be necessary to use the City Dock for some related purpose. If City Dock had been recommended as the preferred site, it could then be concluded that the dredge transfer site was gone, which would not be the case.

Six sites have been recommended as most suitable for dredge spoil transfer. Beach nourishment would have been included here, except for the current statutory restrictions on this method. Each of these sites has its assets and drawbacks, and it is hoped that these qualities have been described and organized in a way that will make the final choice of a transfer site easier to make.

APPENDIX 1 - Calculation of Sand Pile Volumes

The calculation of sand pile volumes is based on the following assumptions:

1. Cubic yards of wet material will be roughly equivalent to cubic yards of dry material. This will be true if the material to be put on the transfer site is granular, and therefore dewaters rapidly.

2. The angle of repose will be 30^0. This angle is appropriate for uniform fine to medium sand, and also it turns out, for unconsolidated silt. Loose sand and gravel has an angle of repose of 32^0 to 36^0, so the figure of 30^0 is probably on the conservative side. In other words, the sand might pile higher in a given square footage than shown here, and will not pile any lower.

3. Pile shapes are based on suggestions from contractors. They provide an idea of how much sand volume will fit on the sites. Actual use of the sites might warrant somewhat different configurations.

Terms Defined

h = height

l = length

r = radius

v = volume

π = 3.14159

$\text{volume}_{(\text{cone})} = \frac{\pi r^2 h}{3}$

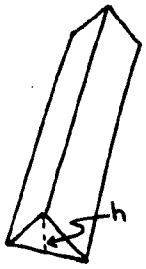
cubic yards = cubic feet/27

$h = \frac{r}{1.75}$ for 30^0 angle of repose

Calculation of Sand Pile Volume for Site 1

Long Triangular Block:

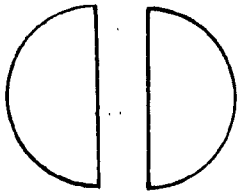
r = 37.5'
h = 21.4'
l = 200'



$$v = \frac{(h)(r)(l)}{27} = \frac{(21.4)(37.5)(200)}{27} = 6000 \text{ cubic yards}$$

2 Half Cones:

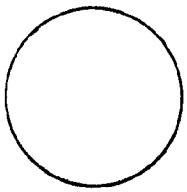
r = 37.5'
h = 21.4'
$v = \frac{(r)^2 h}{3 \times 27}$



$$v = \frac{3.14159(37.5)^2(21.4)}{81} = 1000 \text{ cubic yards}$$

Full Cone:

r = 37.5'
h = 21.4'



$$v = \frac{3.14159(37.5)^2(21.4)}{81} = 1000 \text{ cubic yards}$$

TOTAL = 8000 cubic yards

Calculation of Sand Pile Volume for Site 4

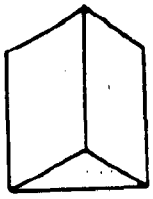
Long Triangular Block:

r = 25'
h = 14.3'
l = 230'

$$v = \frac{(h)(r)(l)}{27} = \frac{(14.3)(25)(230)}{27} = 3000 \text{ cubic yards}$$

Short Triangular Block:

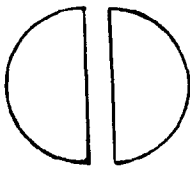
h = 21.4'
r = 37.5'
l = 62.5'



$$v = \frac{(21.4)(37.5)(62.5)}{27} = 1800 \text{ cubic yards}$$

2 Half Cones:

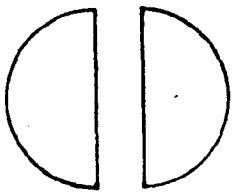
r = 25'
h = 14.3'



$$v = \frac{\pi (r)^2 h}{3 \times 27} = 350 \text{ cubic yards}$$

2 Half Cones:

r = 37.5'
h = 21.4'

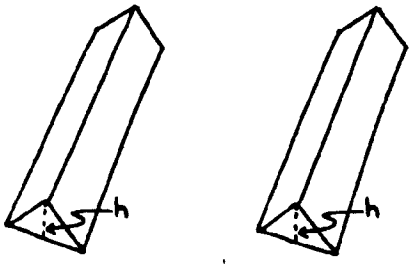


$$v = \frac{\pi (r)^2 h}{3 \times 27} = 1200 \text{ cubic yards}$$

TOTAL = 6350 cubic yards

Calculation of Sand Pile Volume for Site 7

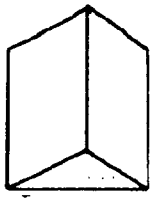
2 Long Triangular Blocks:



h = 7.1'
r = 12.5'
l = 500'

$$v = \frac{(h)(r)(l)}{27} = 1{,}600 \text{ cubic yards}$$

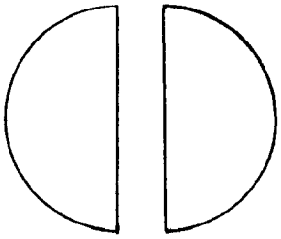
Short Triangular Block:



h = 25'
r = 44'
l = 131'

$$v = \frac{(h)(r)(l)}{27} = 5{,}400 \text{ cubic yards}$$

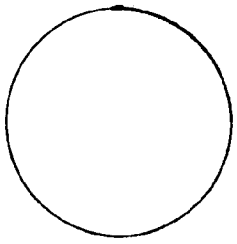
2 Half Cones:



r = 44'
h = 25'

$$v = \frac{\pi (r)^2 h}{3 \times 27} = 1900 \text{ cubic yards}$$

Full Cone:



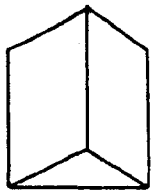
r = 44'
h = 25'

$$v = \frac{\pi (r)^2 h}{3 \times 27} = 1900 \text{ cubic yards}$$

TOTAL = 10,800 cubic yards

Calculation of Sand Pile Volume for Site 9

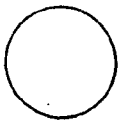
Short Triangular Block:



h = 60.7'
r = 106'
l = 169'

v = 40,300 cubic yards

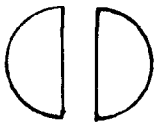
Full Cone:



r = 106'
h = 60.7'

v = 26,500 cubic yards

2 Half Cones:



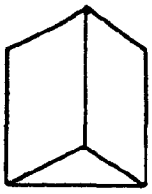
r = 106'
h = 60.7'

v = 26,500 cubic yards

TOTAL = 93,300 cubic yards

Calculation of Sand Pile Volume for Site 11

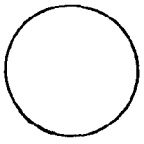
Short Triangular Block:



h = 39.29'
r = 68.75'
l = 125'

v = 12,500 cubic yards

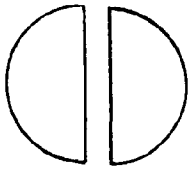
Full Cone:



r = 50'
h = 28.57'

v = 2,800 cubic yards

2 Half Cones:



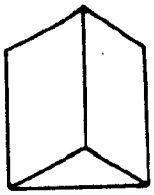
r = 68.75'
h = 39.29'

v = 7,200 cubic yards

TOTAL = 22,500 cubic yards

Calculation of Sand Pile Volume for Site 13

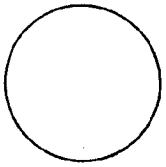
Short Triangular Block:



h = 25'
r = 44'
l = 100'

v = 4,000 cubic yards

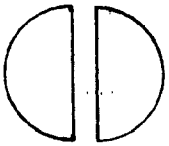
Full Cone:



r = 50'
h = 28.56'

v = 2,800 cubic yards

2 Half Cones:



r = 44'
h = 25'

v = 1,900 cubic yards

TOTAL = 8,700 cubic yards

BIBLIOGRAPHY

Great Lakes Dredging, Wisconsin Coastal Management Program, Department of Natural Resources, March, 1983.

Harbor Study - Commercial, Recreation, Bay-Lake Regional Planning Commission, November, 1982.

Industrial Needs Study for the City of Two Rivers, Gary L. Peterson and Associates, September, 1980.

Kewaunee Beach Nourishment Project Proposal, D.N. Edington & J.V. Klump, Center for Great Lakes Studies, University of Wisconsin-Milwaukee, April, 1982.

Lake Michigan Sport Fishing Support Services Sites and Facilities Study, Gary L. Peterson and Associates, September, 1980.

Reuse Study - Mirro Plants 1 and 4, Donahue and Associates, Inc., September, 1983.

Telephone Interviews conducted by Susan Jones and Cyndy Roth of Gary L. Peterson & Associates:

Robert Mundelius, United States Army Corps of Engineers, August and September, 1983.

Dale Pfeiffle, United States Army Corps of Engineers, August, 1983.

Stanley Jacek, United States Army Corps of Engineers, August 12, 1983.

Allen Shea, Wisconsin Department of Transportation, August through October, 1983.

Carol Cutshall, Wisconsin Department of Transportation, July through October, 1983.

Michael Tonys, Department of Natural Resources, August, 1983.

Rix Robinson, Harbor Marine Ltd., Ferrysburg, Michigan, October 19, 1983.

Charles March, Durosher Dock and Dredge, Cheboygan, Michigan, August 1, 1983.

John Asher, Roen Salvage Company, Sturgeon Bay, Wisconsin, October 17, 1983.

Don Jackson, E.E. Gillen Construction Company, Milwaukee, Wisconsin, October 19, 1983.