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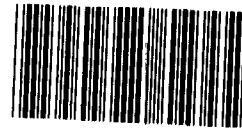
United States General Accounting Office

Report to the Chairman, Subcommittee
on Water Resources, Committee on
Public Works and Transportation, House
of Representatives

July 1992

WATER RESOURCES

Future Needs For Confining Contaminated Sediment in the Great Lakes Region



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United States
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Washington, D.C. 20548

**Resources, Community, and
Economic Development Division**

B-246689.2

July 17, 1992

The Honorable Henry J. Nowak
Chairman, Subcommittee on Water Resources
Committee on Public Works
and Transportation
House of Representatives

Dear Mr. Chairman:

This report responds to your request that we review the status of the confined disposal facilities (CDF) currently being used in the Great Lakes, the long-term need for CDFs in the region, and difficulties in locating sites for future CDFs.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the Secretaries of Defense and the Army; the Chief, U.S. Army Corps of Engineers; and the Director, Office of Management and Budget. Copies will also be made available to others on request.

This report was prepared under the direction of James Duffus III, Director, Natural Resources Management Issues, who can be reached at (202) 275-7756 if you or your staff have any questions. Other major contributors to this report are listed in appendix I.

Sincerely yours,

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

Navigation on the Great Lakes provides a major link in the nation's transportation system and benefits many sectors of the economy. To facilitate commercial shipping and recreational navigation in the Great Lakes, the U.S. Army Corps of Engineers has constructed over 100 harbor, channel, and waterway projects for the region. These projects need to be maintained through periodic dredging to remove and dispose of accumulated bottom sediment. This sediment often contains contaminants, such as chemicals from industry or agricultural runoff, that may require special handling.

When the Corps determines that the dredged material is contaminated, the Corps stores it in confined disposal facilities (CDF) rather than dumping it back into the open water and potentially causing harmful environmental effects. The Congress envisioned the need for CDFs as short-lived when it authorized the CDF program for the Great Lakes in 1970, expecting federal water pollution programs to eventually eliminate the source of contamination.

Concerned about a continuing need for CDFs, the Chairman, Subcommittee on Water Resources, House Committee on Public Works and Transportation, asked GAO to develop information on (1) the status of the CDFs being used in the Great Lakes, (2) the long-term need for CDFs in the region, and (3) difficulties in locating sites for future Great Lakes CDFs.

Background

Dredged material is removed from river or lake bottoms during the construction or maintenance of navigation projects. Until the 1970s, almost all dredged material was disposed of by open-water dumping. The Rivers and Harbors Act of 1970 authorized the CDF program to provide for the disposal of the contaminated material dredged from the Great Lakes. Besides the more common in-water CDFs, a few CDFs are built on land.

The Environmental Protection Agency (EPA), in conjunction with the Corps, establishes sediment testing guidelines that the Corps uses to decide whether dredged material can be disposed of in the open water or should be placed in a CDF. EPA also sets sediment criteria for the amount of toxins that pose a risk to the environment.

Results in Brief

The Corps has constructed 26 CDFs since 1974 under the program. Six CDFs are now filled to capacity, and all but 2 of the other 20 are expected to be filled by 2006. Twelve more CDFs have been proposed or are in various

stages of planning. Corps headquarters officials are now deciding whether the costs of these new CDFs should be the responsibility of the Corps or the local sponsors, such as state or local governments.

More CDF sites will be needed in the foreseeable future. Great Lakes harbors and channels still contain significant amounts of contaminated sediment not yet dredged; pollutants continue to be discharged; and forthcoming sediment testing guidelines and sediment criteria are likely to be stricter, requiring confinement of more material. Economically feasible alternatives to CDFs do not currently exist.

Construction of additional CDFs is at a virtual standstill. Because of concerns from communities and environmental interests, locating disposal sites for the contaminated dredged material has been difficult and time-consuming. As a result, the Corps has deferred some dredging, and commercial and recreational navigation in some areas has been adversely affected.

Principal Findings

Program Status

Of the 26 federally funded CDFs built as of June 1992 under the 1970 program, 6 are filled to capacity and all but 2 will be full by 2006. In-water CDFs account for 18 of the 26 existing sites. Through June 1992, about 47 million cubic yards of material dredged from federal projects in the Great Lakes were contained in the 26 CDFs.

Two more facilities are proposed under the 1970 program by the Corps' field offices but have not yet been approved by Corps headquarters. Ten other new CDFs, replacements, or expansions are in various stages of planning.

Corps headquarters officials said that the funding of new and replacement CDFs is currently undergoing a policy and legal review. Given the emphasis on cost sharing in the Water Resources Development Act of 1986, they said that future CDFs may be the responsibility of the local sponsors, except where the project's authorizing legislation specifically mandates the Corps to bear or share the cost. Information provided by the Corps' field staff on their interpretation of the authorizing legislation showed that replacements for the 28 CDFs built or proposed would be the full or partial

responsibility of local sponsors for 13, and the Corps would bear the cost of replacing the other 15.

Need for CDFs Will Continue

The pollution of sediments in the Great Lakes has not been stopped or reversed over the last 20 years, and more dredged material is being directed toward CDFs. Past GAO and EPA reports suggested that it would take many years, at great cost, to stop this contamination and to clean up what already exists. (See Related GAO Products.)

Economical and technically feasible alternatives to CDFs for disposal or treatment of large quantities of contaminated sediment do not currently exist. They cannot be expected to be available in the near future because their development is just getting under way, according to EPA. The lack of alternatives increases the demand for CDF capacity.

A major factor regarding the number of future CDFs will be EPA's determinations on sediment testing guidelines and sediment criteria. In conjunction with the Corps, EPA is working on updating the 1975 guidelines. EPA also plans to issue the sediment criteria by November 1992 for specific levels of toxic pollutants that must be confined when found in sediment. The new guidelines and criteria are expected to be stricter than those currently in effect.

Because the guidelines and criteria are not yet available, the Corps cannot estimate the number and cost of additional CDFs that will be needed in the Great Lakes.

Sponsors and Corps Face Difficulties in Siting CDFs

Concern about the impact on the environment has led some Great Lakes states to ask the Corps to place more dredged material in CDFs than the Corps believes is justified by resulting environmental benefits. Sponsors of a number of navigation projects across the Great Lakes Region have had difficulty locating acceptable sites for CDFs because of environmental concerns. For example, the Corps has suggested sites for the Ashtabula, Ohio, project since 1982, but each one has been opposed by local groups that do not want a disposal facility for potentially toxic sediments nearby. Site selection for a CDF for Indiana Harbor, in East Chicago, Indiana, has been under way since 1972. At least 16 sites have been identified by the Corps or the local sponsor and rejected, mostly for environmental reasons.

Delays in finding acceptable sites for CDFs and disagreements between the Corps and the states on what material should be confined have resulted in the Corps' delaying dredging or not dredging some Great Lakes harbors and channels to the depths authorized by the Congress. As a result, large cargo vessels have limited ability to use certain commercial harbors and, in a few cases, recreational boats have been hampered.

Recommendation

To provide the Congress and local sponsors with information that would be useful in deliberations on the problem of future dredging and disposal of contaminated material in the Great Lakes, GAO recommends that once the revised sediment testing guidelines and criteria are issued, the Secretary of the Army—through the Chief, Corps of Engineers—estimate the capacity, locations, and cost of additional CDFs that will be needed in the Great Lakes.

Agency Comments

GAO discussed the results of its work, including the facts contained in this report and the implications of these facts, with responsible officials at the Office of the Assistant Secretary of the Army (Civil Works), the Corps headquarters Directorate of Civil Works and its North Central Division in Chicago, and EPA's Region V and Great Lakes National Program Office, who generally agreed with the facts as presented. Their comments were incorporated where appropriate. However, as requested, GAO did not obtain written agency comments on a draft of this report.

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Abbreviations

AOCs	areas of concern
CDF	confined disposal facility
EPA	Environmental Protection Agency
GAO	General Accounting Office
RAP	remedial action plan

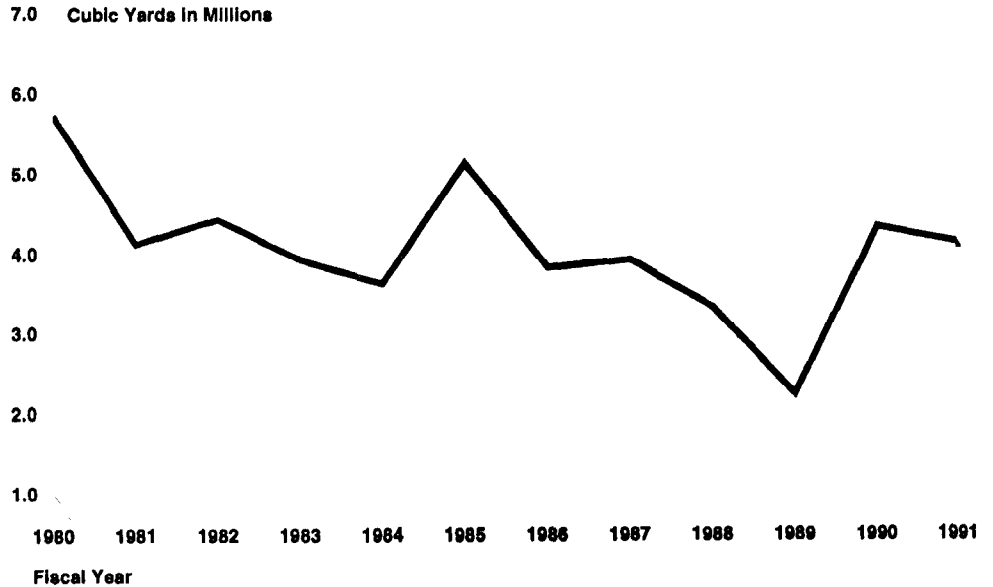
Introduction

Navigation on the Great Lakes provides a major link in the nation's transportation system and benefits many sectors of the economy. Many industries in the region were attracted or are assisted by the availability of waterborne transportation for raw materials. Recreational boating and other water-based activities depend on the Great Lakes: More than 3.3 million recreational boats, or one-third of all such boats in the United States, are registered in the eight Great Lakes states—Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. These Great Lakes navigation activities also provide significant employment opportunities.

To facilitate commercial shipping and recreational navigation in the Great Lakes, the Congress authorized the U.S. Army Corps of Engineers to construct and maintain over 100 harbor, channel, and waterway projects for the region. Most commercial harbors in the Great Lakes are authorized for water depths of 18 to 30 feet, with lengths and widths determined by the type of shipping, amount of traffic, and local geography. After initial construction, projects need to be maintained through periodic dredging. Dredging includes the removal and disposal of sediment from river and lake bottoms.

From 1980 to 1991, the dredging of these federal projects in the Great Lakes produced 48 million cubic yards of material. Figure 1.1 shows the total quantity of material dredged, which ranged from 5.7 million cubic yards in 1980 to 2.2 million cubic yards in 1989. To put the volume of dredged material in perspective, the 4.3 million cubic yards dredged in 1990 would fill 430,000 dump trucks holding 10 cubic yards each.

Figure 1.1: Volume of Great Lakes Dredging, 1980-91



Source: U.S. Army Corps of Engineers.

The Process of Dredging and Disposal

Dredged material is generated during new construction—the initial development or the widening and deepening of a navigation project—or during maintenance of such projects. Maintenance dredging is required when fine-grained sediment and sands settle out of suspension in river or lake water and gradually accumulate on the bottom or when coarse-grained sediment is eroded from shorelines to the bottom. The sediment often contains contaminants, such as chemicals from industry or agricultural runoff, that may require special handling.

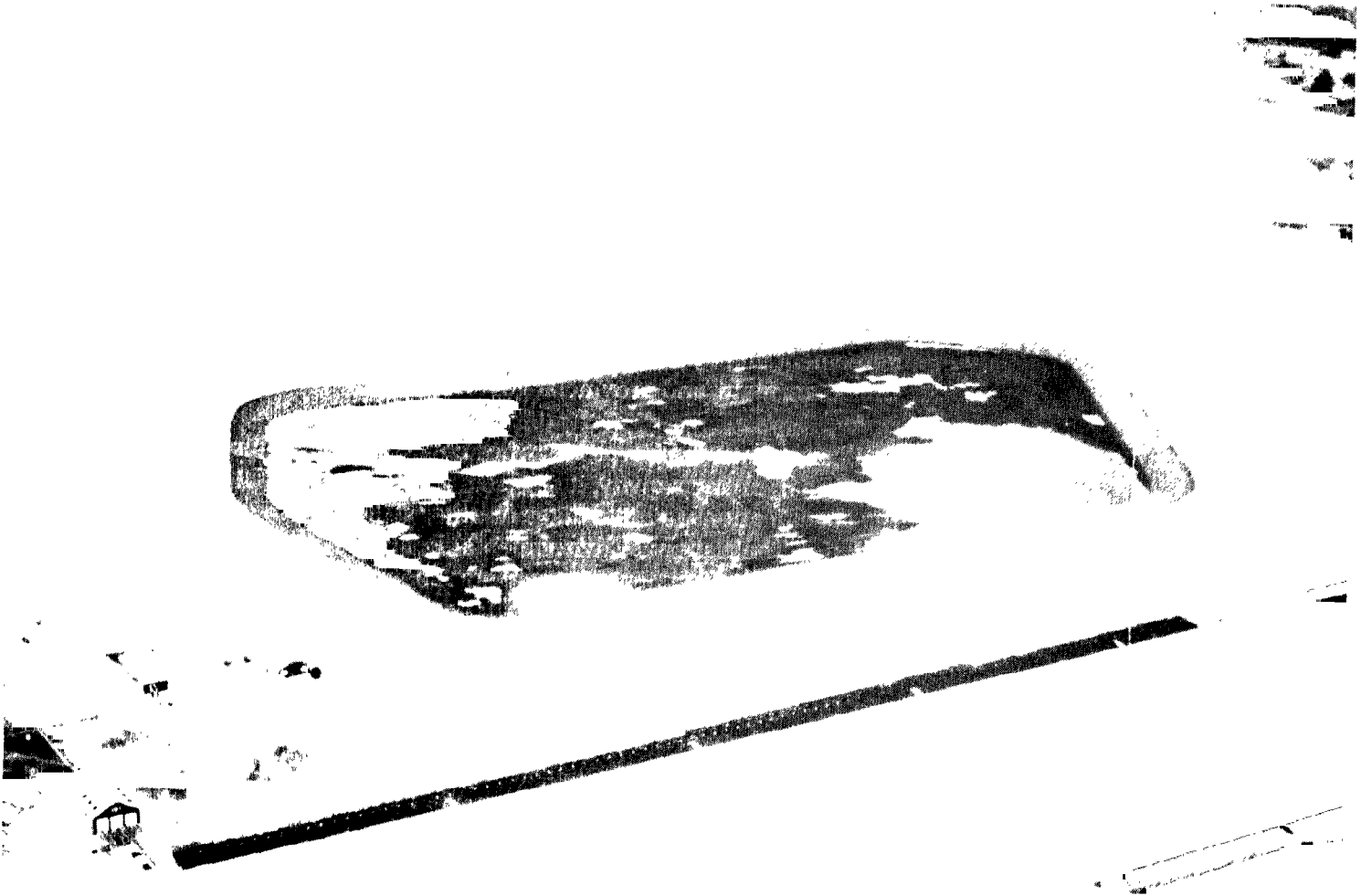
For all dredging work, the Corps determines whether the material is suitable for disposal on land or in open water—which involves placing it directly in areas of the lake or river outside of the project—or whether it requires another disposal method because of pollutants. In the latter case, a confined disposal facility (CDF) is typically used. CDFs are built as in-water or as upland sites as part of a particular navigation project or projects. In-water sites are created by diking off and filling a section of a water body with contaminated material, and upland sites usually include containment dikes built on dry land to hold the material. Figures 1.2 and 1.3 show an example of each type of site.

Figure 1.2: In-Water CDF at Green Bay, Wisconsin



Source: U.S. Army Corps of Engineers.

Figure 1.3: Upland CDF at Keweenaw, Michigan



Source: U.S. Army Corps of Engineers.

Section 404(c) of the Clean Water Act of 1977 (33 U.S.C. 1344(c)) requires that unacceptable adverse effects on the aquatic environment be avoided when dredged material is discharged in inland (non-ocean) waters. The Environmental Protection Agency (EPA) Administrator, in conjunction with the Secretary of the Army, establishes sediment testing guidelines used to

decide how to dispose of dredged material. EPA also sets sediment criteria for the amount of toxins that pose a risk to the environment. In addition, states must certify that any disposal of dredged material will not violate applicable state water quality standards.

If proposed discharges into open water would violate state water quality standards, states may decline to certify the disposal. Disposal decisions are also affected by the International Joint Commission, a U.S.-Canadian government organization established to help resolve water quality and other problems along the border of the two countries. The commission helps implement the U.S.-Canada Great Lakes Water Quality Agreement by serving as an impartial evaluator of the progress made under the agreement and by offering advice and recommendations to the U.S., Canadian, state, and provincial governments.

Typically, when the Corps identifies contaminated sediment to be moved during a dredging activity, it suggests a suitable disposal site and develops the specifications to build dikes or other structures to contain the material. The National Environmental Policy Act's section 102(2)(C) requires an environmental impact statement to accompany every proposed federal action that would significantly affect the environment. The Corps normally prepares the statement with its project feasibility report for new work or for major changes to existing projects, such as the addition of a CDF. Responsibility for obtaining, constructing, and managing disposal sites varies between the Corps and local sponsors, depending on the specific authorization language for the project.¹ Project authorizations generally give local sponsors responsibility for obtaining the necessary lands, easements, rights-of-way, and relocations. The Corps identifies and suggests potential sites, but it must rely upon the local sponsors to obtain necessary permits and to acquire the sites.

Use of a disposal site located in waters of the United States including wetlands must comply with the Clean Water Act. In the case of a federal dredging project, the Corps evaluates the disposal options using the regulations developed jointly by EPA and the Army under section 404(b)(1). The states, EPA, and other agencies provide comments and recommendations during the evaluation. For example, the Department of the Interior's Fish and Wildlife Service may comment because it is interested in preventing loss of wildlife and habitat resources. Under section 404(c), EPA may veto the use of a proposed in-water disposal site if

¹The sponsors generally are local or state governments or other public entities, such as port authorities, that initiate requests for the Corps' assistance. Also referred to as nonfederal sponsors, we will generally refer to them as "local sponsors" throughout this report.

it would have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.

After site approval, the Corps completes detailed engineering and design specifications. When the project is funded by the local sponsor and/or the Corps, according to the provisions of the authorizing legislation, construction takes place. The authorizing legislation for the project specifies whether management of the filled disposal site is the responsibility of the Corps or the local sponsor. Once filled and covered, the site may be turned back to the local sponsor, may be retained by the federal or state government, or may revert to the original owner, depending on the terms under which it was obtained. Plans may call for the site to be developed commercially, used for recreation, or preserved as a wildlife habitat.

The Great Lakes Confined Disposal Program

Until the 1970s almost all dredged material in the Great Lakes was disposed of in open water. However, sediments had become increasingly contaminated from industrial and municipal discharges, agricultural runoff, and airborne deposits, making open water disposal less desirable and subject to restrictions under the Clean Water Act.

The Rivers and Harbors Act of 1970 (P.L. 91-611) authorized the CDF Program to provide for disposal of the contaminated dredged material from the Great Lakes. The act allowed the Secretary of the Army to grant local sponsors waivers of their 25-percent share of CDF costs if EPA determined that the communities were in compliance with EPA-approved plans for waste treatment facilities and federal water quality standards were not being violated. The Congress specified that the CDFs were to have useful lives of 10 years because it expected that EPA programs would stop the inflow of pollutants into the Great Lakes.² After that period, sediments were not expected to need confinement, and the Corps would no longer need CDFs as disposal sites for dredged material.

Objectives, Scope, and Methodology

Concerned about a continuing need for CDFs, the Chairman, Subcommittee on Water Resources, House Committee on Public Works and Transportation, requested that we develop information on (1) the status of the CDFs being used in the Great Lakes, (2) the long-term need for CDFs in the region, and (3) difficulties in locating sites for future Great Lakes CDFs.

²See *Water Resources: Legislation Needed to Extend the Life of Confined Disposal Facilities* (GAO/RCED-86-145, Aug. 12, 1986).

To address these issues, we contacted officials at the following locations:

- U.S. Army Corps of Engineers headquarters in Washington, D.C.; the Corps' North Central Division in Chicago, Illinois, and Corps districts in Detroit, Michigan; Buffalo, New York; and Chicago that cover the Great Lakes; and the Waterways Experiment Station in Vicksburg, Mississippi.
- EPA headquarters in Washington, D.C., and Region V and the Great Lakes National Program Office in Chicago.
- The U.S. Fish and Wildlife Service field office in East Lansing, Michigan.
- The Great Lakes Commission in Ann Arbor, Michigan, an organization created by the federal government and the states to foster the interests of the Great Lakes Region.
- The U.S.-Canadian International Joint Commission in Windsor, Ontario.

We also spoke with state environment and/or natural resource officials from Illinois, Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin; and local officials in Ashtabula, Ohio. We also contacted private companies that use Great Lakes shipping, various port authorities that act as local sponsors for most communities, and the Great Lakes Carriers Association, which represents shipping lines. We interviewed officials of these organizations to obtain their views on dredging disposal and environmental, and related navigation issues. We also obtained relevant reports, correspondence, regulations, statistical data, public statements, and testimony for review and analysis.

To develop information on the status of the CDF program, we compiled Corps data on authorizations, costs, capacities, quantities dredged, and expected fill dates of the CDFs built and proposed to date. We also conducted field visits and held discussions with Corps personnel on the sites of seven in-water and upland CDFs and one dredging operation: Bolles Harbor, Sterling State Park (for Monroe Harbor), Clinton River, and Point Mouillee, Michigan; Cleveland (two sites) and Lorain, Ohio; and a dredging operation at Port Huron, Michigan.

To address the issue of the long-term need for CDFs, we obtained and analyzed information from Corps officials at headquarters, division, and district locations on their past, present, and planned dredging operations and the use of CDFs versus open-water dumping or other disposal alternatives; and we obtained the views of private, state, and local officials on dredging needs for navigation. We also obtained information on environmental issues related to contaminated sediment from the Corps, EPA, the Fish and Wildlife Service, and state and local officials.

We discussed the difficulties in locating future CDF sites with various Corps offices and state, local, and other interested parties and visited a proposed site in Ashtabula, Ohio.

Our work was performed between September 1990 and April 1992 in accordance with generally accepted government auditing standards. We discussed the facts contained in this report, and the implications of these facts, with responsible officials at the Corps headquarters Directorate of Civil Works and North Central Division, the Office of the Assistant Secretary of the Army (Civil Works), EPA Region V and the Great Lakes National Program Office. Corps and EPA officials generally agreed with the facts as presented and provided technical suggestions. We have incorporated their comments where appropriate. The Corps officials raised concerns about our description of sediment testing guidelines and sediment criteria in chapter 2. We made changes to respond to those concerns. As requested, we did not obtain written agency comments on a draft of this report.

Status of the Great Lakes CDF Program and Future Need for CDFs

Six of the 26 CDFs constructed in the Great Lakes since 1974 under the program are now filled to capacity, and 13 others are expected to be filled to capacity by 2000. Five will be filled by 2006 and the remaining two sites are estimated to be filled by 2010 and 2015. Two more CDFs have been proposed by the Corps field staff to be constructed under the CDF program, but have not yet been approved at the Corps headquarters level. Ten other new, replacement, or expansions of CDFs are in various stages of planning. As of June 1992, about 47 million cubic yards have been contained in the 26 existing CDFs. When filled to capacity, the 28 existing and proposed CDFs under the 1970 program would contain over 80 million cubic yards of dredged material.

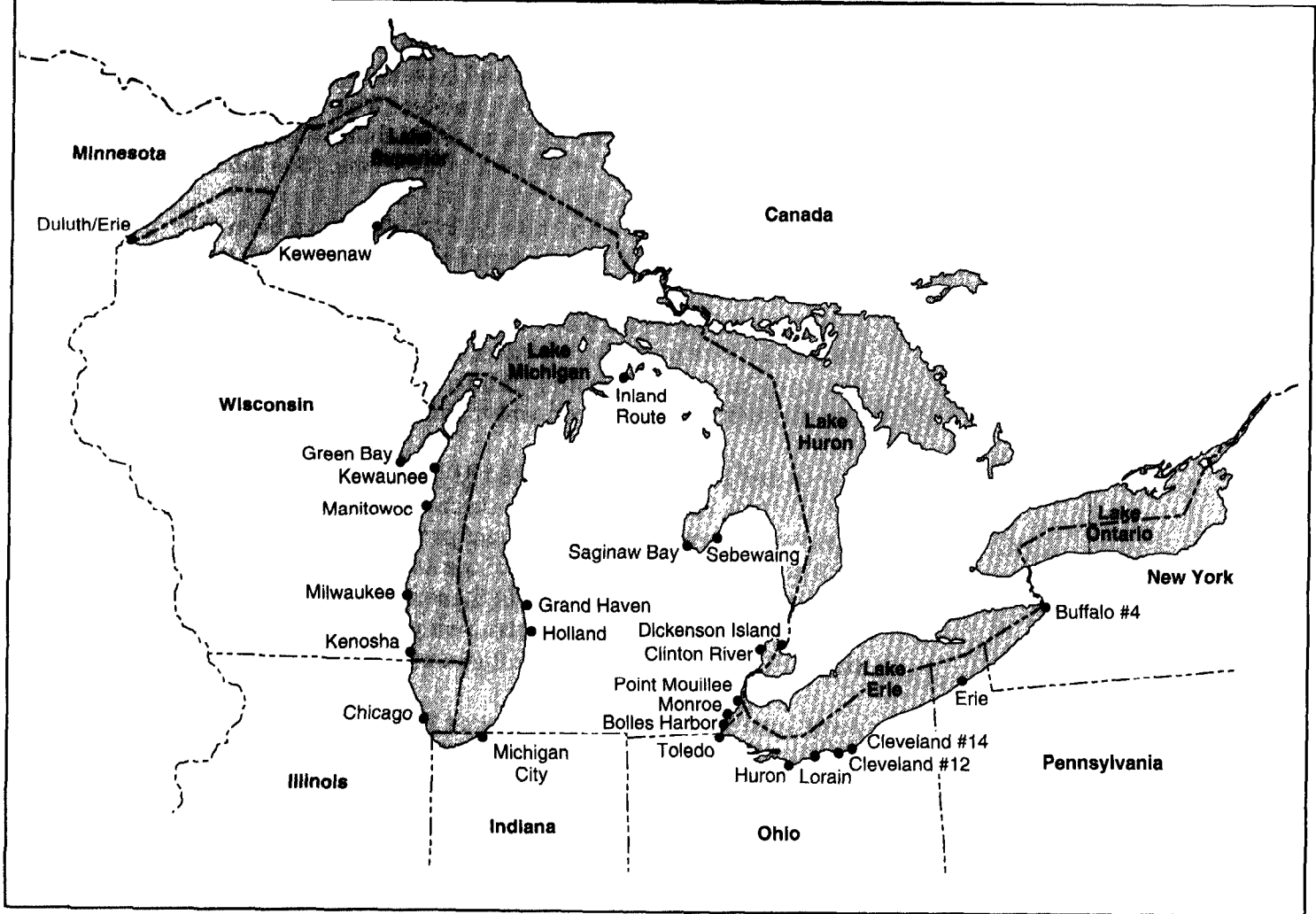
More CDFs will be needed in the foreseeable future, however. The Great Lakes harbors, channels, and waterways that must be dredged to accommodate commercial and recreational navigation still contain significant amounts of contaminated sediment. Pollutants continue to be discharged into the water because EPA and state programs have not stopped all types of pollution. And sediment that now can be disposed of in open water will probably have to be confined in the future because EPA is moving toward stricter testing guidelines for determining if sediment is clean enough to be disposed of in open water. EPA is also tending toward stricter criteria for specific levels of toxic pollutants that must be confined when in sediment.

Economically feasible alternatives to CDFs for disposal or treatment of large quantities of contaminated sediment do not currently exist. While other disposal treatment options are available, their technical feasibility for handling large volumes of dredged material has not been proven.

Status of the CDF Program

CDFs have been constructed in all eight of the Great Lakes states by the Detroit, Chicago, and Buffalo Districts of the Corps. Figure 2.1 shows the existing CDF locations, which generally are situated at the major commercial ports in the region.

Figure 2.1: Location of the 26 CDFs Built Under the Great Lakes CDF Program



The 26 existing CDFs range in capacity from 19,500 cubic yards to 18 million cubic yards. The first was completed in 1974 and the last in 1989. Construction costs ranged from approximately \$200,000 to \$56 million, not including the costs of dredging and transporting the material to the CDFs. Of the 26 CDFs already constructed, 18 are in-water sites and 8 are upland sites. The additional two CDFs proposed by Corps field staff under the program are the expansion of the CDF at Green Bay, Wisconsin, and a CDF for the upper Saginaw River, Michigan, project. These are projected to cost a total of \$36 million; each has a design capacity of 3 million to 4

million cubic yards. Corps headquarters officials told us in December 1991 that they had not approved these two CDFs. In addition, 10 other new, replacement, or expansions of CDFs are in various stages of planning for Duluth-Superior, Minnesota; Grand Haven, Holland, and St. Joseph in Michigan; Waukegan, Illinois; Milwaukee, Wisconsin; East Chicago, Indiana; and Toledo, Cleveland, and Ashtabula in Ohio. Some of these projects are now experiencing siting problems. (See table 3.1.)

The CDF program's construction costs to date have been fully federally funded. The sponsors' 25-percent share was waived by the Corps because EPA determined that the communities were in compliance with EPA-approved plans for water treatment facilities and federal water quality standards were not being violated. Thus, the sponsors' only costs were for acquiring land and relocating utilities for the upland sites. However, the majority of the sites were in-water and had no acquisition costs.

The United States has designated 31 geographic areas of concern (AOCs) on the U.S. side of the Great Lakes Basin as having the most acute water quality and contaminated sediment problems. Eighteen of the 26 existing CDFs are located in the vicinity of the AOCs. Because none of the AOCs has yet been cleaned up, dredging in these areas will likely require CDFs for many years. EPA officials said that many other areas also have toxic pollutants that would need confinement.

As of June 1992, six of the CDFs were filled to capacity. The Corps expects that 13 of the other CDFs will be filled to capacity by 2000 and that all but 2 will be filled by 2006. Table 2.1 provides details on the 26 CDFs.

**Chapter 2
Status of the Great Lakes CDF Program and
Future Need for CDFs**

Table 2.1: Status of the Completed CDFs in the Great Lakes Region, as of June 1992

Cost and capacity in thousands

CDF location/ projects served	AOC in project vicinity?	Year completed	Construction cost	Cubic yard capacity	Percent filled	Expected or actual year filled
Buffalo District						
New York						
Buffalo #4 Buffalo/Dunkirk	Y	1977	\$16,825	6,900	52	2015
Ohio						
Cleveland #12 Cleveland/Rocky River	Y	1974	7,391	2,760	100	1979
Cleveland #14 Cleveland/Rocky River	Y	1979	30,935	6,130	79	1995
Huron Huron/Vermillion	N	1975	6,703	2,600	65	2000
Lorain Lorain	Y	1977	9,797	1,850	51	2000
Toledo Toledo	Y	1976	19,627	11,100	80	1995
Pennsylvania						
Erie Erie	Y	1979	2,066	420	10	2010
Chicago District						
Illinois						
Chicago Calumet/Chicago Rivers	N	1984	7,800	1,300	25	2000
Indiana						
Michigan City ^a Trail Creek	N	1978	300	25	100	1989
Detroit District						
Michigan						
Bolles Harbor Bolles/La Plaisance Creek	Y	1978	970	335	44	2002
Clinton River ^a Clinton River	Y	1989	3,899	370	10	2004
Dickenson Island ^a Lake St. Clair channels	Y	1975	5,072	2,000	61	1998
Grand Haven ^a Grand Haven	Y	1974	433	310	100	1993 ^b
Holland ^a Holland	Y	1978	1,583	280	100	1990
Inland Route ^a Crooked River	N	1982	176	20	32	2000

(continued)

**Chapter 2
Status of the Great Lakes CDF Program and
Future Need for CDFs**

Cost and capacity in thousands

CDF location/ projects served	AOC in project vicinity?	Year completed	Construction cost	Cubic yard capacity	Percent filled	Expected or actual year filled
Keweenaw ^a Keweenaw	Y	1987	940	308	23	2000
Monroe Monroe	Y	1983	38,400	4,200	22	2004
Point Mouillee Detroit/Rouge Rivers	Y	1979	55,800	18,000	41	2006
Saginaw Bay Saginaw River	Y	1978	14,800	10,000	82	1999
Sebewaing ^a Sebewaing	N	1979	1,300	84	100	1989
Minnesota						
Duluth/Erie Duluth/Superior	Y	1979	1,000	1,000	95	1994
Wisconsin						
Green Bay Green Bay/Fox River	Y	1979	5,560	1,200	93	1994
Kenosha Kenosha/Racine	N	1975	8,270	750	100	1987
Kewaunee Kewaunee	N	1982	2,200	500	53	2000
Manitowoc Manitowoc/Two Rivers	N	1975	4,140	800	59	2002
Milwaukee Milwaukee/Port Washington	Y	1975	5,960	1,600	70	1999
Total			\$251,947	74,842		

Note 1: A CDF in Frankfort, Michigan, was built in 1984 at a cost of \$800,000 and a capacity of 74,000 cubic yards. The CDF was never used because the contractor who was dredging the Frankfort project determined that a more convenient and economical site was available. The Corps agreed to the change since the material being dredged was not contaminated to any significant degree. The CDF has since been filled with gravel.

^aDenotes an upland site; the remainder are in-water sites.

^bThe Corps' Detroit District staff said that although the design capacity of the Grand Haven CDF has been reached, the facility will be used for disposal in one more dredging operation.

Sources: U.S. Army Corps of Engineers and EPA.

Need for CDFs Will Continue

The Great Lakes Region will need more disposal sites principally because (1) harbors, channels, and waterways still contain significant amounts of contaminated sediment not yet dredged; (2) pollutants continue to be

discharged, contaminating more sediment; and (3) forthcoming sediment testing guidelines and sediment criteria are likely to be stricter, requiring the confinement of more dredged material, according to EPA. In addition, the Corps was authorized under the Water Resources Development Act of 1990 to perform additional cost-shared dredging as part of maintenance work in order to enhance the environment and improve water quality outside navigation projects. All these activities will increase the need for CDFs. Because the guidelines and criteria are not yet available, the Corps cannot estimate the number of locations and the cost of additional CDFs that will be needed in the Great Lakes.

Pollution Control Efforts
Have Not Stopped or
Cleaned Up Contamination
of Sediments

Scientists have found that because of the Great Lakes' relatively closed circulation—less than 1 percent flows out annually—toxic pollutants tend to accumulate and remain in bottom sediments. The lakes' huge volume of water also makes existing pollution very difficult to reverse. In addition, about 30,000 chemicals are in use in the Great Lakes Basin, and more are developed each year, making it likely that additional toxic pollutants will be identified. According to EPA, advanced scientific methods will improve the ability to detect pollutants.

The central purpose of any effort to clean up the Great Lakes harbors, channels, and waterways is to reduce and eventually eliminate contaminants entering the lakes. However, we have reported over the years that the federal government's efforts to limit the discharges of contaminants from both point sources and nonpoint sources of pollution and the financial commitment to these efforts will need to improve substantially.¹ This is particularly true if the Great Lakes' water quality is to be restored. (See Related GAO Products.)

Since 1972 EPA has been implementing the Clean Water Act, which addresses municipal and industrial point sources of pollution. In recent testimony, we stated that the National Pollutant Discharge Elimination System program in the Great Lakes region is faced with many of the same problems found in our prior reviews of the program: many serious and long-standing violations of permit discharge limits; weak and sporadic enforcement against violators; and inadequate EPA oversight of states'

¹A "point" source is a single, specific location from which pollution is discharged, such as a municipal wastewater treatment plant or an industrial plant. "Nonpoint" pollution is from diffuse sources and is the by-product of a variety of land use practices, including farming, timber harvesting, mining, and construction, and of urban areas where rain washes pollutants into runoff systems.

enforcement activities.² At the end of 1990, 19 percent of the Great Lakes dischargers were in significant noncompliance with permit conditions. EPA officials told us in January 1992 that they had taken enforcement actions against all of the 19 percent in significant noncompliance. Although one of the program's long-term goals is to eliminate toxic and other harmful pollutant discharges, the program's near-term goal is to limit but not totally eliminate these discharges. For example, in 1990 alone, EPA estimated that about 7.7 million gallons of oil and grease and 91,000 pounds of lead were discharged into the lakes under the discharge permits it approved.

While the most serious problems to be addressed in the Great Lakes involve the cleanup of the 31 AOCs, many other locations also have toxic pollutants in the sediments that may harm the environment. In fact, as indicated in table 2.1, the CDFs at Huron, Chicago, Michigan City, Inland Route, Sebawaing, Kenosha, Kewaunee, and Manitowoc are used for contaminated sediment from areas without an AOC in the vicinity. These contaminated bottom sediments in the lakes can become an active source of pollution when toxins are released into the environment again by wildlife, stirred up by boats or storms, or disturbed by the dredging process. Wildlife is involved, for example, when plants or animals living in or on the bottom sediments take in some toxins and are consumed by fish or birds, thereby contaminating the natural food chain.

To plan the cleanup of toxic substances in contaminated sediment as well as to control pollution in the AOCs, public officials and other concerned parties have begun to develop remedial action plans (RAP).³ This has proven to be a complicated, slow process. As of June 30, 1991, EPA had referred 27 RAPS to the International Joint Commission for its review. Twenty of the RAPS were in phase 1—problem identification, and only 7 were in phase 2—remedial action identification.

The cleanup of the AOCs is expected to be lengthy and expensive. In our August 1988 report on Michigan's Rouge River, we reported that it would cost at least \$1.8 billion to bring the river up to the state's public health standards by 2005.⁴ For the Ashtabula River, Ohio AOC, EPA has estimated

²Water Pollution: Observations on EPA's Efforts to Clean Up the Great Lakes (GAO/RCED-92-1, Oct. 4, 1991).

³RAPs are required by the U.S.-Canadian Great Lakes Water Quality Agreement of 1978, as amended in 1987. RAPs are to address water quality problems in AOCs by defining actions and timetables and identifying responsibilities for implementing the plans. The states and provinces prepare the RAPs with assistance from EPA and are reviewed by the International Joint Commission.

⁴Water Pollution: Efforts to Clean Up Michigan's Rouge River (GAO/RCED-88-164, Aug. 10, 1988).

that more than \$62 million will be required just to clean up the Field's Brook tributary to the river.

Other pollution control programs will also be costly. In 1984, EPA reported that \$200 billion will need to be spent nationally by 2000 to further reduce the point source impact of municipal sewage treatment plants. Separately, the International Joint Commission reported in April 1988 that remediation of combined sanitary-storm sewer overflows in the Great Lakes states alone to cut point and nonpoint pollution would require an investment of \$4.6 billion.

Future Sediment Testing Guidelines and Sediment Criteria Will Likely Increase Need for CDFs

Before 1970, the principal criterion for disposal site selection and method of disposal was cost. Almost all material dredged was disposed in the most convenient and economical manner, that is, dumped into open water. New federal environmental laws changed this practice. Current EPA and state guidelines, as well as Corps regulations, require consideration of engineering feasibility, environmental factors, and all practical alternatives for dredged material disposal in addition to cost.

According to EPA, some scientists believe that the 1975 testing guidelines EPA developed in conjunction with the Corps under section 404(b)(1) of the Clean Water Act—guidelines the Corps is currently using for disposal decisions on dredged material—are technically inadequate. However, Corps headquarters officials maintain that the guidelines have evolved substantially, have been tested thoroughly, and are adequate. Both the Corps and EPA have conducted detailed research on contaminated sediment, but the agencies have not always agreed on how the research should be used to determine which sediment needs confinement. The lack of agreement occurs generally because of the difficulty in establishing clear cause-and-effect relationships between the contaminant concentration in sediment and a biological impact on humans and wildlife. Through interagency working groups at the national and regional levels, including a Great Lakes working group, EPA and the Corps are currently working on updating the 1975 testing guidelines.

As part of a national strategy to manage contaminated sediment under development by EPA, EPA officials said that sediment criteria will be issued by November 1992 for specific levels of toxic pollutants that must be confined when found in sediment.

Both the new guidelines and criteria are expected to be stricter than those currently in use.

Environmental Dredging Could Add to Need for CDF Capacity

Section 312 of the Water Resources Development Act of 1990 gives the Secretary of the Army a new authorization to perform "environmental dredging" to enhance the environment and improve water quality to meet the requirements of the Clean Water Act. The section allows the Corps to dredge contaminated sediments from additional areas adjacent to navigation channels as part of maintenance dredging of a navigation project; the Corps may also remove contaminated sediment from nonproject navigable waters for the same purposes. The contaminated material removed would likely require disposal in a CDF. The local sponsor must request the work and pay 50 percent of the removal cost and 100 percent of the disposal cost. Although \$10 million per year has been authorized for this new program, funds had not been appropriated as of January 1992. Corps headquarters officials said that no local sponsors had expressed an interest in such work as of January 1992.

Alternatives to CDFs Are Limited

For disposal of most contaminated dredged material, economically feasible alternatives to CDFs do not currently exist. Alternatives for disposing of the contaminated material include constructing sediment traps, which are pits designed to capture the polluted sediment; capping the contaminated sediment with clean material, either at the original site or after moving it to another area of the lake or river; or processing and/or recycling the contaminants and sediment by separating the contaminated material or extracting and destroying the contaminants with heat.

All of these alternatives are more costly than CDF disposal, which the Corps estimates to be at least \$10 per cubic yard for the facility; costs for land acquisition, dredging, and transporting the material to the CDF are additional. In contrast, the Corps estimates the alternatives are much more costly. For example, extracting or destroying the contaminants can range from \$150 to \$750 per cubic yard. A Corps division official said that none of the alternatives are capable of treating all contaminants, and almost every process would require a CDF for storage, pretreatment, and residue disposal. EPA has not yet decided whether the alternatives mentioned are technically feasible for handling large volumes of dredged material. EPA is evaluating these treatment and disposal alternatives under its Assessment and Remediation of Contaminated Sediments Program. The 1987 amendments to the Clean Water Act in Section 118(c)(3) authorized EPA's

Great Lakes National Program Office to conduct the program by studying and demonstrating appropriate treatment of toxic pollutants in bottom sediments.

Conclusions

Most CDFs currently in use will be filled to capacity by 2006, and additional CDF capacity is needed if the Corps is to continue dredging Great Lakes harbors, channels, and waterways. Pollutants continue to enter the lakes, and contamination already in bottom sediments has not been cleaned up. The sediment testing guidelines EPA is revising in conjunction with the Corps and EPA sediment criteria for determining which sediment must be confined are likely to be stricter. More CDF capacity will also probably be needed if the Corps' new authorization to perform additional dredging to enhance the environment is implemented. Finally, cost-effective alternatives to CDFs do not exist at the present time for most contaminated dredged material.

Consequently, what had been expected to be a temporary need when the Congress established the CDF program in 1970 appears to be much more permanent. Local sponsors, states, and the federal government face large costs to provide, operate, and maintain the sites needed to deal with this continuing problem in the Great Lakes. Until EPA and the Corps issue new sediment testing guidelines and EPA issues new sediment criteria, however, the Corps cannot estimate the number, location, and cost of the additional CDFs that will be needed in the Great Lakes. This information would be useful to the Congress and cost-sharing local sponsors in their future deliberations on the problem of dredged material disposal.

Recommendation

To provide the Congress and local sponsors with information that would be useful in deliberations on the problem of future dredging and disposal of contaminated material in the Great Lakes, we recommend that once the revised sediment testing guidelines and criteria are issued, the Secretary of the Army—through the Chief, Corps of Engineers—estimate the needed CDF capacity. The estimates should include

- detailed projections of the volume of contaminated material to be generated by future Great Lakes dredging projects and
- the capacity, locations, and cost of new or replacement CDFs that will be needed in the Great Lakes for the foreseeable future.

Outlook for Locating and Funding Future CDFs

From the beginning of the Great Lakes CDF program, the Corps has had major problems in locating disposal sites for the contaminated dredged material because of local opposition and environmental restrictions. Local sponsors still have problems in identifying and obtaining approval for disposal sites, either for new or replacement CDFs. Tougher environmental regulations and more opposition from local residents and environmental interest groups have made site selection more difficult and time-consuming. In addition, the states and local sponsors tend to require that more sediment be confined than the Corps believes is necessary from an environmental standpoint. The question of who will pay for the confinement of this additional material is not yet settled among the sponsors, the states, and the Corps.

Future CDFs will be financed differently because the Corps has decided not to seek further funding under the 1970 CDF program. Corps headquarters officials said that given the emphasis on local cost sharing in the Water Resources Development Act of 1986, CDFs may be a local sponsor responsibility except where the law specifically mandates the Corps to bear or share the cost. Information provided by the Corps' field staff on their interpretation of the projects' original authorizations showed that if it were necessary to replace the 28 CDFs built or proposed, local sponsors would be required to fully or partially pay for 13 of them, and the Corps would bear the cost of replacing the other 15.

Difficulties in Finding Acceptable CDF Sites Limit Dredging and Navigation

The delays in finding acceptable sites for CDFs and the disagreements between the Corps and the states on what material should be confined have resulted in the Corps delaying dredging or not dredging some Great Lakes harbors and channels to the depths authorized by the Congress. The reduced or deferred maintenance dredging is beginning to adversely affect navigation in the Great Lakes: Large cargo vessels have limited ability to use certain commercial harbors, and in a few cases recreational boats have been hampered.

According to officials of the Lake Carriers Association, the lighter loads or smaller ships increase costs and cut the competitiveness of commercial shipping compared with other transportation modes. Although the total increase in costs has not been quantified, five companies told us that it is very significant.

Six projects for which the Corps and local sponsors have experienced significant delays in obtaining new or replacement CDF sites are at

Ashtabula and Cleveland, Ohio; Green Bay, Wisconsin; East Chicago, Indiana; and the upper Saginaw River and St. Joseph, Michigan. The lengthiest delay has occurred at St. Joseph, which has not located a site since 1970. Table 3.1 summarizes the six cases.

Table 3.1: Great Lakes Navigation Projects With CDF Siting Problems

Project	Year need for CDF first identified	Number of sites considered to date	Navigation Impeded	Status as of December 1991
Ashtabula, Ohio	1982	19	Yes	3 sites being evaluated
Cleveland, Ohio	1985	14	No	Corps and sponsor in agreement, awaiting other agency clearances
Green Bay, Wisconsin	1982	14	Yes	Proposed site is being evaluated
East Chicago, Indiana	1972	16	Yes	Proposed site is being evaluated
Saginaw River, Michigan	1979	29	No	Site identified, Corps writing an environmental impact statement
St. Joseph, Michigan	1970	15	Yes	1 site being evaluated

The following two cases illustrate the problems in obtaining sites for both new and replacement facilities.

Ashtabula, Ohio

The Ashtabula Harbor and some portions of the Ashtabula River have been dredged in recent years, but the upper portion of the river has not been dredged since 1964. Although depths of 16 to 18 feet are authorized, parts of the channel are as shallow as 1 to 2 feet. To use its docks, one company has to use older, shallow draft vessels, which are scarcer than the larger, more efficient vessels commonly used on the Great Lakes. In May 1991, a company official estimated that one-third to one-half of the potential cargo per trip was being lost because of the shallow harbor. Recreational boating in Ashtabula has also been adversely affected by the lack of dredging. Depths have been measured at less than 4 feet in the upper turning basin. Some recreational boaters have damaged their boats by running aground.

The Corps' Buffalo District began looking for a disposal site in Ashtabula in 1982 after tests concluded that the sediment was polluted and not suitable for open-water disposal. In 1982, the Corps identified several sites, but each one was opposed by local groups that did not want a disposal facility for potentially toxic sediments nearby. In March 1991, the Congress authorized dredging of the upper Ashtabula River on a one-time, interim

basis to deal with critical shoaling.¹ The small quantity of material that was to be dredged was polluted, however, and required confinement. Rather than identify a disposal site, the city relied on a Corps proposal to dispose of the material in a Cleveland CDF. The plan was canceled when Cleveland officials refused to allow the use of the CDF. As of December 1991, Ashtabula officials were still searching for a site to confine this dredged material.

East Chicago, Indiana

Indiana Harbor in East Chicago has not been dredged for about 20 years. While the Congress authorized a harbor depth of up to 27 feet, portions of the harbor are now between 8 and 15 feet deep and navigation has been adversely affected, according to Corps and industry officials. Commercial carriers using the port have to reduce the draft of each vessel by reducing the cargo loads. An official of one company using the harbor told us in April 1991 that it was light-loading each of its vessels.

The Corps began to look for a CDF site for Indiana Harbor in 1972 and identified and evaluated 16 possible sites. In 1977, the Corps proposed one site and submitted a draft environmental impact statement. However, EPA rejected the site because the disposal area as designed would not retain the dredged material.

In 1983, the Corps recommended an in-water CDF site in East Chicago, Indiana, to the sponsor and released the draft environmental impact statement in 1986. Community and environmental groups protested the plan and labeled the site "toxic island." After the state of Indiana declined to support the site, the Corps dropped the proposal.

In 1987 and 1988, the Corps held public meetings with local agencies and groups to identify acceptable sites. Local groups and the city of East Chicago recommended four sites, and the Corps selected one of them. The city is currently testing the soil at the upland site—a former oil refinery—to determine the soil's environmental condition and to gain EPA approval for construction.

**Corps Disagreement With State
Standards Has Impacted
Dredging**

Under the Clean Water Act of 1977, disposal of dredged material must be certified by the states as meeting their water quality standards. Traditionally, the Corps has selected the least costly disposal alternative that it believes is (1) consistent with sound engineering practices, (2) environmentally acceptable under the act, and (3) consistent with state

¹Shoaling occurs when a sandbank or sandbar grows and causes a harbor or channel to become shallow.

water quality standards. Corps headquarters officials said that their "multi-media" analysis for each disposal decision is to arrive at the best overall alternative for the environment.

The Corps has deferred or reduced dredging in the Great Lakes in a few instances, however, because it has disagreed with how three states—Minnesota, Ohio, and Wisconsin—apply water quality standards to dredged material. In some cases the states would require the Corps to dispose of more material in CDFs: This would cost more in federal funds than the Corps believes is justified by resulting environmental benefits. Corps officials said they oppose disposing of material determined to be "clean" into CDFs because it is costly and uses CDF space better used for contaminated material. When such requirements would exceed its budget and the sponsor is unwilling to pay the additional cost, the Corps defers or reduces the scope of the dredging project. Deferrals or reductions have occurred in all three states because of state concern over open-water disposal of dredged material that is contaminated to some extent.

In the case of the Port of Toledo, Ohio, for example, the disagreement over compliance with the Clean Water Act has contributed to the delay of a disposal decision on dredged material. State of Ohio and local sponsor officials are concerned that all of the material is too contaminated for disposal in the open waters of the shallow western end of Lake Erie and should be contained in the CDF. However, Corps officials believe some of the material is clean enough for open-water disposal. The state has withheld certification of the Corps' proposed plan for disposal of the dredged material. The Corps Director of Civil Works said the state request to place all of the clean dredged material from the Toledo harbor into the existing CDF would fill it in 1992 or 1993. He also said that following the state standards would cut the useful life of the planned replacement CDF for Toledo in half—from 22 years to less than 11 years.

More CDF Costs Expected for Local Sponsors

Many CDFs will soon be filled and more will be needed for the foreseeable future. While 26 CDFs have been built with 100-percent federal financing under the 1970 CDF program, it is possible that financing of replacement CDFs will be a local sponsor responsibility, except where the law specifically mandates the Corps to bear or share the cost. In addition, for existing harbors without a CDF, where it is determined that maintenance dredging will require a CDF, financing would be a local sponsor responsibility, except where a Corps share is specified.

Great Lakes navigation projects were authorized by the Congress in various civil works bills dating back to the turn of the century. According to Corps field staff, these authorizations differ on how project costs are allocated between the Corps and local sponsors. Costs for dredging disposal areas can be a 100-percent local, shared, or a 100-percent federal responsibility. In general, projects authorized before 1945 had 100-percent federal funding. After 1945, authorizations typically required cost sharing, while some required 100-percent local funding.

The Water Resources Development Act of 1986 generally mandates cost sharing by local sponsors of water projects authorized under that act or more recent authorization bills. Under the act, local sponsors of new navigation projects needing CDFs pay 100 percent of their site acquisition cost and 10 to 25 percent of the CDFs' construction costs. No CDFs have yet been built in the Great Lakes under the 1986 act. The Duluth-Superior harbor expansion, authorized in the 1986 act, is an example of new work that will require a new CDF for disposal.

According to Corps district and division officials, Corps headquarters decided in 1990 that it would no longer request funds under the 1970 program for CDFs needed by existing navigation projects because of the new legislative emphasis on cost sharing in the 1986 act. Instead of federal funding under the 1970 program, the officials said, financing of CDFs for existing projects is to be determined by the projects' original legislative authorization, which may give particular costs and responsibilities to the local sponsor.

Corps headquarters officials said in January 1992 that the future financing of CDFs is currently undergoing a policy and legal review. They said the 1986 act's cost-sharing provisions support the position that CDF costs should be considered a local sponsors' responsibility unless otherwise specified in a project's authorizing legislation. In fact, the headquarters officials said, it is possible that CDFs will be made a local sponsor responsibility in all cases except where the authorization specifically makes it a project cost shared between local sponsors and the Corps. Where the authorization is silent, they expect CDFs will be considered a responsibility of the local sponsors.

The headquarters officials said the Office of Chief Counsel would be preparing a legal opinion on this matter as part of the policy review, but no date was given for its completion. Until the review is completed, there is some uncertainty about the funding of future CDFs. For example, Corps

field staff have proposed two additional CDFs for full federal funding under the 1970 Great Lakes CDF program, and 10 other new, replacement, or expansions of CDFs are in various stages of planning for Great Lakes projects.

According to records and statements from the Corps' North Central Division and District officials on the projects' original authorizations for the 26 existing and 2 proposed CDFs under the 1970 CDF program, the Corps would be responsible for funding 15 of the 28 CDFs, if they needed to be replaced. For seven CDFs, the local sponsor would have replacement responsibility, and for the remaining six CDFs the Corps and the local sponsors would share the responsibility. Table 3.2 specifies the financial responsibilities for replacement CDFs determined by district and division interpretations that are currently under headquarters review.

**Chapter 3
Outlook for Locating and Funding Future
CDFs**

**Table 3.2: Financial Responsibilities
for CDFs Under Original Project
Authorizations**

Location	Responsibility
Illinois	
Chicago	Federal
Indiana	
Michigan City	Federal
Michigan	
Bolles Harbor	Local
Clinton River	Local
Dickenson Island	Federal
Grand Haven	Local/Federal
Holland	Local
Inland Route	Local/Federal
Keweenaw	Federal
Monroe	Federal
Point Mouillee	Federal
Saginaw Bay	Local
Saginaw River (Planned)	Local
Sebewaing	Federal
Minnesota	
Duluth/Erie	Local/Federal
New York	
Buffalo #4	Federal
Ohio	
Cleveland #12	Local/Federal
Cleveland #14	Local/Federal
Huron	Federal
Lorain	Federal
Toledo	Federal
Pennsylvania	
Erie	Federal
Wisconsin	
Green Bay (Existing)	Local
Green Bay (Planned)	Local
Kenosha	Federal
Kewaunee	Federal
Manitowoc	Local/Federal
Milwaukee	Federal

Source: U.S. Army Corps of Engineers, North Central Division.

**Site Maintenance May Also
Be a Long-Term
Responsibility of Local
Sponsors**

Some local sponsors may also have to maintain their CDFs after they are filled to capacity. The authorizing legislation for a project specifies who becomes responsible for site maintenance. Once filled and covered by the Corps, a site may be turned back to the local sponsor or retained by the federal or state government, or revert to the original owner.

Under the 1970 CDF program, the local sponsor is responsible for all future maintenance costs of the completed facility. Local sponsors have had only limited experience with maintenance costs and liabilities for local sponsors. As of January 1992, only the CDF at Kenosha, Wisconsin, had been turned over to local sponsors. However, these costs are expected to be minimal for such routine activities as mowing grass and periodic stone replacement.

CDFs located in water will be exposed to potentially significant damage from wave action, such as a late-1970s storm that severely damaged the dike wall at the Saginaw Bay, Michigan, CDF. Corps district and division officials said this was an extremely rare event and likely would be repaired by the Corps, as it was at Saginaw Bay for \$1 million, under the Corps' responsibility for defects in design.

Conclusions

As older CDFs near capacity and more material is designated for them, the need for new and replacement CDFs will become more critical. It takes years, however, to find acceptable sites for CDFs. Environmental regulations, community opposition, and greater scrutiny by environmental groups have all contributed to the problem of locating sites for future CDFs. Increasing state and local concern about the environmental impact of dredged material means that states may request that a greater portion of dredged material be designated for CDF disposal, as they have done in a few cases already. Disagreement between the Corps and state or local sponsors over disposal has already caused a few dredging deferrals and reductions.

The difficulties in finding acceptable sites for CDFs and the disagreements between the Corps and the states on what material should be confined have delayed maintenance dredging. This in turn is beginning to adversely affect navigation in some Great Lakes harbors and could affect the efficiency of the Great Lakes shipping industry.

Local sponsors, states, the Corps, and EPA must allow for longer lead times, expect greater costs, and recognize the need for more cooperative

consensus-building efforts as more CDF capacity is planned and constructed.

The impact of the 1986 cost sharing law on the financing of CDFs has not been finally determined but more responsibility seems likely to be shifted to local sponsors. Corps headquarters officials said that it is possible that local sponsors will have complete CDF funding responsibility except where there is a specific authorizing provision requiring the Corps to bear or share the cost. If the Corps decides to require local sponsors to fund most CDF costs, the sponsors must prepare to take on a significant financial burden because more capacity will be required for future construction and maintenance of navigation projects.

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Water Pollution: Stronger Efforts Needed By EPA to Control Toxic Water Pollution (GAO/RCED-91-154, July 19, 1991)

Water Pollution: Greater EPA Leadership Needed to Reduce Nonpoint Source Pollution (GAO/RCED-91-10, Oct. 15, 1990)

Water Pollution: Improved Coordination Needed to Clean Up the Great Lakes (GAO/RCED-90-197, Sept. 28, 1990)

Water Pollution: Serious Problems Confront Emerging Municipal Sludge Management Program (GAO/RCED-90-57, Mar. 5, 1990)

Water Pollution: Improved Monitoring and Enforcement Needed for Toxic Pollutants Entering Sewers (GAO/RCED-89-101, Apr. 25, 1989)

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Water Pollution: Efforts to Clean Up Michigan's Rouge River (GAO/RCED-88-164, Aug. 10, 1988)

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