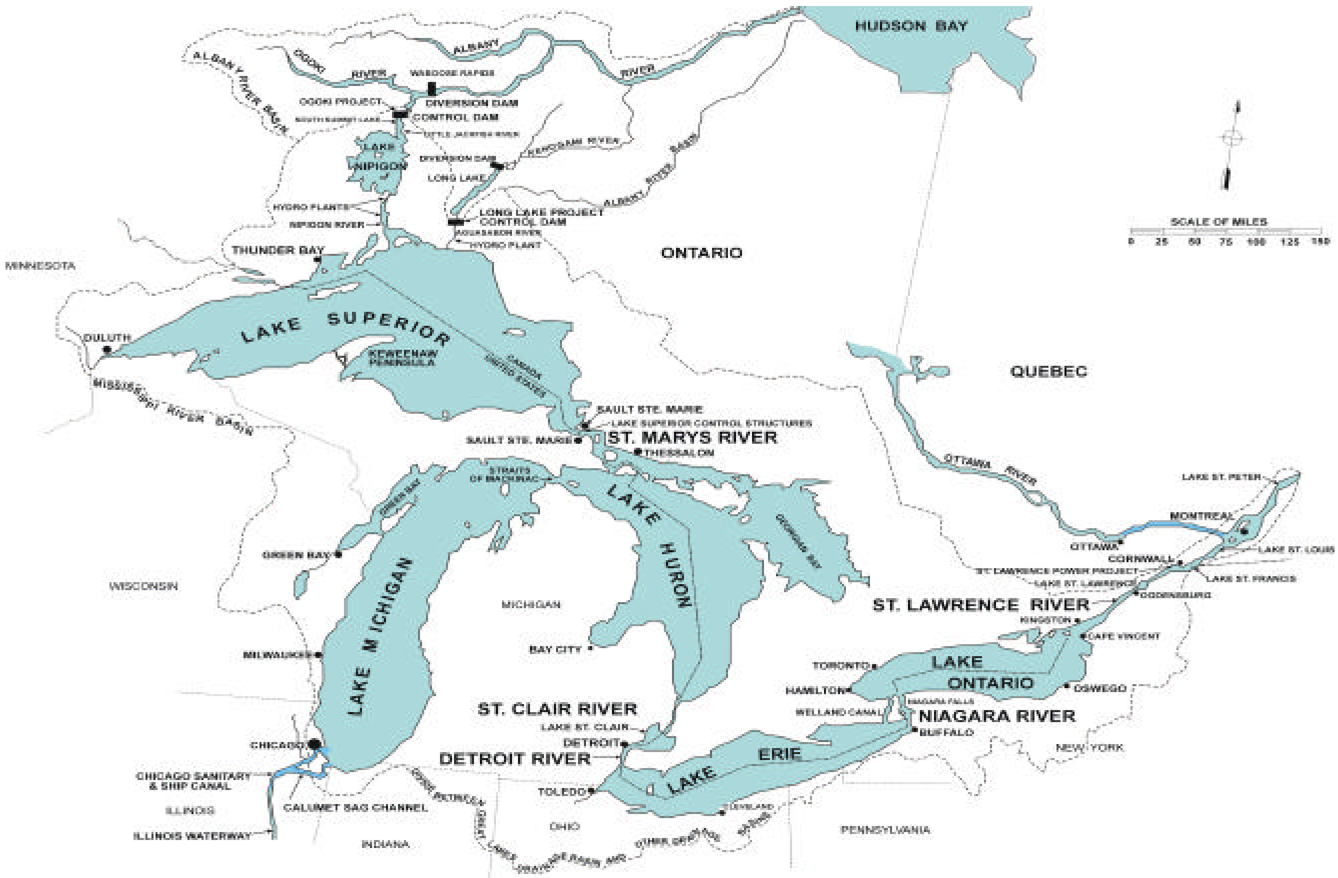
RECONNAISSANCE REPORT

JUNE 2002

GREAT LAKES NAVIGATION SYSTEM REVIEW

APPENDIX C - ENVIRONMENTAL



Great Lakes - St. Lawrence River System

US Army Corps of Engineers®

Great Lakes & Ohio River Division

EXECUTIVE SUMMARY
GREAT LAKES NAVIGATION SYSTEM REVIEW
ENVIRONMENTAL CONSIDERATIONS

The Great Lakes system is an ecological resource that continues to change as a result of human and natural forces. Global climate change has the potential to significantly influence water levels on the Great Lakes. Human inhabitation and development have resulted in changes in nutrient and contaminant loading, and the alteration of near-shore habitats. The consumptive use of resources due to over-fishing, water exportation, and mineral or energy extraction continue to be controversial issues. Introduced species, ranging from the sea lamprey and Pacific salmon to the zebra mussel and purple loosestrife, have resulted in dramatic changes in species composition and abundance, and the flow of energy through the ecosystem. As our understanding of the system grows, we anticipate that additional anthropogenic impacts can be minimized or mitigated.

The development of the Great Lakes navigation system has contributed significantly to the impacts cited above. Modification of the connecting channels has altered lake levels. Navigation system construction and related development have directly changed habitats. Industries locating in the Great Lakes due to shipping, and the resulting increase in population, have caused pollution. Opening up the system to traffic from the Atlantic Ocean has allowed the entry of a variety of invasive species. The most dramatic impacts to the ecosystem have likely already occurred, but further development of the navigation system does carry with it potential adverse effects. The environmental sustainability of the ecosystem must be considered when making decisions regarding improvements to the navigation system.

The action alternatives considered in this study share some of the same types of potential impacts. Construction activities would include building canals, locks, and water control structures, and dredging channels. Each of these activities has the potential to damage local habitat features, particularly near shore. Operation of a system that encourages use by more and larger vessels has the potential to increase aquatic habitat disruptions (through bow waves, drawdown and surge, and propeller wash) in terms of both frequency and severity. Maintenance of an enlarged system could also result in additional habitat disruptions or changes if additional maintenance dredging or disposal is required. Modification of the St. Lawrence Seaway would draw new overseas traffic that could increase the risks of introducing new exotic species. Changes in the navigation season could also potentially result in damage to restricted areas of the system.

On the positive side, improvements to the navigation system would reduce fuel consumption and atmospheric emissions related to the transportation of goods. Careful design and construction would also provide opportunities to incorporate environmentally beneficial features such as wetlands and spawning reefs which may help to restore ecological functions lost over the years. Reconstruction of locks in the St. Lawrence River may provide an opportunity for incorporating features to assist in the blockage of new aquatic nuisance species. Determining the overall significance of the proposed modifications will be a major effort requiring detailed site specific analyses of the alternatives carried into the feasibility stage, and the assessment of potential cumulative effects.

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STUDY OVERVIEW

<u>Study Authority</u>

This reconnaissance analysis was prepared as an initial response to Section 456 of the Water Resources Development Act (WRDA) of 1999, which authorized the Great Lakes Navigation System Review. The full text of the Act is as follows:

> *"In consultation with the St. Lawrence Seaway Development Corporation, the secretary shall review the Great Lakes Connecting Channels and Harbors Report dated March 1985 to determine the feasibility of undertaking any modification of the recommendations made in the report to improve commercial navigation on the Great Lakes navigation system, including locks, dams, harbors, ports channels, and other related features*."

A civil works project evolves from an examination of a perceived problem to the formulation of a solution that reflects both national and local interests. A project typically involves five phases: (1) reconnaissance, (2) feasibility, (3) pre-construction engineering and design, (4) construction, and (5) operation, and maintenance. The primary purpose of the reconnaissance phase (first phase) is to determine if there is federal interest in proceeding with the feasibility phase.

To identify problems, opportunities, and potential improvements to the navigation system, a survey was conducted which included international, federal, public and private stakeholders of the Great Lakes/St. Lawrence Seaway (GLSLS) navigation system. Proposed improvements to the St. Lawrence Seaway portion of the navigation system were identified through coordination with both the Saint Lawrence Seaway Development Corporation (U.S.) and the St. Lawrence Seaway Management Corporation (Canada). Primary concerns among stakeholders were the limitations on vessel drafts imposed by low water and restrictive channel and port depths, narrow channels (applicable specifically to the Chicago Sanitary and Ship Canal), restrictive lock sizes and channel depths on the St. Lawrence Seaway, the length of the shipping season, and the future reliability of lock structures on the Welland Canal and Montreal-Lake Ontario section of the Seaway. Alternatives were then formulated using input from surveys and discussions with these stakeholders. The primary elements around which each alternative was developed include the following:

* Deepening the Great Lakes connecting channels - this alternative proposes potential channel and port modifications to improve vessel traffic, primarily deepening the channels.

* Improvements to the St. Lawrence Seaway - this alternative proposes replacing the existing locks with larger and deeper chambers and providing channels compatible with the larger lock dimensions.

* Deepening individual ports - this alternative proposes improvements to the ports and harbors within the Great Lakes system. These improvements would include modifications to existing infrastructure and channels to accommodate deeper draft vessel traffic.

ENVIRONMENTAL SETTING

Project Area Description

The region under investigation for potential system modifications under the Great Lakes Navigation System Review includes Lakes Superior, Michigan, Huron, Erie and Ontario, the St. Lawrence River and connecting waterways. The study provides an assessment of the needs for lock, channel and harbor improvements to meet the future requirements of commercial navigation. The environmental base conditions are described on the assumption of an upper Great Lakes navigation season extending from 25 March to 15 January ± 1 week depending on ice conditions and the demands of commerce at the Soo Locks, and 24 March to December 31 for the St. Lawrence Seaway.

The Great Lakes and connecting channels form a water highway 2,342 miles long, including the St. Lawrence Seaway. The total drainage basin area is 296,000 square miles (U.S. and Canada) of which 95,000 square miles are occupied by the lakes. Connecting channels within the Great Lakes/St. Lawrence Seaway system are unregulated (free flow) except for the St Marys River, Niagara River (and Welland Canal), and the St. Lawrence River which are controlled by a series of locks, compensating works, and hydro-power facilities. The system contains 20% of the world's fresh water supply and each of the five lakes are among the world's fifteen largest. Despite their size, the Great Lakes are sensitive to the impacts pollution. This stems from their long retention times (outflows account for less than 1% of their total volume each year) and large surface area (allowing significant direct atmospheric deposition). Characteristics of the Great Lakes, connecting channels, and St. Lawrence River are listed in Table C-1.

Lake Superior- Lake Superior is the largest and deepest of the Great Lakes ranging from 600 ft. above to 700 ft. below sea level. It has a retention time of 191 years. The lake was formed from glacier cover along the southern edge of the Canadian Shield. It has a relatively small littoral zone with 80% of the lake being deeper than 240 ft. Due to the large volume and great depth, seasonal temperature changes are minimal with mean annual readings of 43 degrees F. The irregular shoreline and local wind and circulation patterns do result in near-shore areas with warmer summer waters. Winter ice coverage ranges from about 40% to 95% (average 60%) and summer stratification occurs only temporarily in unprotected waters. Much of the drainage basin and shoreline remain forested. Lake Superior is the least productive (most oligotrophic) of the Great Lakes due to its cold waters and low nutrient levels.

TABLE C-1

Project Area Statistics, Great Lakes and Connecting Channels

	LENGTH (mi)	WIDTH	DRAINAGE AREA or AVERAGE DISCHARGE
Lake Superior	350	160 mi.	81,000 sq. mi.
St. Marys River	63	300-1500 ft.	75,000 cfs
Lake Michigan	307	118 mi.	67,900 sq. mi.
Lake Huron	206	101 mi.	74,700 sq. mi.
St. Clair River	46	700-1400 mi.	187,000 cfs
Lake St. Clair	17	24 mi.	6,500 sq. mi.
Detroit River	32	300-1260 ft.	189,000 cfs
Lake Erie	241	57 mi.	33,500 sq.mi.
Niagara River	35		205,000 cfs
Lake Ontario	193	53 mi	32,060 sq. mi.
St. Lawrence River	599		251,000 cfs

Lake Michigan- Lake Michigan is the second largest of the Great Lakes by volume and the only one entirely in the United States. It is a long and relatively narrow lake that lies mostly between the states of Michigan and Wisconsin. The lake is divided into a southern and northern basin with maximum depths of 558 ft. and 923 ft. respectively. It has a net discharge to Lake Huron of about 55,000 cfs, about 74% as much as the discharge of the St. Marys River. The land portion of the watershed is small, covering only about twice the area of the lake surface. The northern part of the watershed is largely forested while the southern portion is among the most populated areas of the Great Lakes. The world's largest freshwater dunes line the lake along the south and east sides. Lake Michigan is considered oligotrophic but Green Bay is a highly productive eutrophic area.

Lake Huron- Lake Huron, formed as a result of a receding glacier 10,000 years ago, is the third largest Great Lake by volume and the fifth largest lake in the world. The surface area of Lake Huron comprises about one third of its drainage area. The lake itself is composed of three basins: the main basin, North Channel, and Georgian Bay. The main basin includes about 69% of the lake surface and averages about 200 feet in depth, with a maximum depth of 751 feet. The North Channel, along the northeastern coast of the lake, is only about 8% of the lake and averages 72 feet deep. Georgian Bay, the largest bay in the Great Lakes, includes about 23% of the lake surface and has an average depth of 167 feet. Lake Huron also includes Saginaw Bay on the western side, the second largest bay in the Great Lakes System. Lake Huron receives approximately 75,000 cfs of discharge from the St. Marys River and 55,000 cfs from Lake Michigan through the Straits of Mackinac. Thermal stratification occurs during the summer months, but usually at differing depths in the main basin and Georgian Bay. Lake Huron is considered oligotrophic with the exception of the eutrophic Saginaw Bay.

Lake Erie- Lake Erie is the smallest of the Great Lakes in terms of volume and the second smallest in terms of surface area. It is also the shallowest and warmest of the Great Lakes. Over 90% of the flow into Lake Erie comes from the Detroit River (about 189,000 cfs). The lake has three basins: the shallow western basin (average depth 24 feet), the central basin (63% of the surface area and average depth 61 feet), and the deeper eastern basin (average depth 80 feet and maximum depth 210 feet). The central and eastern basin stratifies thermally during the summer months. The western basin is bordered by a significant amount and variety of wetlands that provide extensive habitat for many species of fish and wildlife. Lake Erie has always been the most productive of the Great Lakes but decreased nutrient loading has resulted in a shift towards a mesotrophic western basin and oligotrophic central and eastern basins. The drainage basin contains fertile soils and is intensively farmed.

Lake Ontario- Lake Ontario is the smallest of the Great Lakes by surface area but is still the twelfth largest lake in the world by volume. About 91% (205,000 cfs) of the water flowing into the lake enters from the other Great Lakes via the Niagara River. The lake is divided into four basins. From west to east these are; the Niagara (maximum depth 420 feet), the Mississauga (maximum depth 659 feet), the Rochester (maximum depth 803 feet), and the Kingston (maximum depth 988 ft). The natural shoreline is variable ranging from bluffs to sandy beaches and coastal marshes. Well-defined thermal stratification occurs during the summer months. Although Lake Ontario has been considered mesotrophic in the past, decreasing nutrient loads have the open waters approaching an oligotrophic state while near-shore productivity falls towards a mesotrophic state.

Water Quality

Federal, state, and local programs exist for the purpose of maintaining or enhancing water quality in the Great Lakes basin. The U.S. Federal programs are primarily the responsibility of the United States Environmental Protection Agency. Municipal and industrial wastewater control programs, and other water quality problems such as runoff from urban and rural land, wastes from watercraft, soil erosion and sedimentation, oil spills, thermal discharges, toxic contaminants, and the disposal of dredged material are addressed under Section 208 of the Clean Water Act (P.L. 92-500, as amended). General water quality characteristics of the system are outlined below.

The open waters of Lake Superior are low in dissolved solids as the watershed is largely composed of impervious and chemically resistant rock. This along with short tributaries and the large surface area of the lake results in lake water that resembles rainwater. However, some problem areas exist in shallow bays and harbors. The general water quality of the St. Marys River is considered to be of the same excellent quality as Lake Superior.

The open waters of Lake Michigan are of generally high quality, although studies by the International Joint Commission indicate some deterioration, particularly in the southern basin. The lake is considered to be in an oligotrophic state. Problem areas exist at Green Bay and some harbors including Indiana Harbor and Milwaukee Harbor. Some substances that have been identified in the sediments of the Indiana Harbor Ship Canal include phosphorus, fecal coliforms, phenols, cyanide, sulfate, chloride, and ammonia.

The waters in the main body of Lake Huron and Georgian Bay are of good quality and meet the objectives of the Great Lakes Water Quality Agreement. Areas where the increase in plant nutrients result in undesirable eutrophic conditions are restricted to localized near-shore zones. Since 1967, water quality at the mouth of the Detroit River has improved for most parameters. However, significant degradation of water quality does occur as water passes through the St. Clair River, Lake St. Clair, Detroit River system due to discharges from the adjacent large population centers.

The water quality of Lake Erie is considered to be degraded as compared to the upper Great Lakes. Large nutrient inputs from the Detroit River, municipal and industrial discharges, and non-point sources contribute to the growth of phytoplankton and submerged aquatics. Since the invasion of the zebra mussel, water clarity has improved dramatically.

The adoption of water quality standards by all Great Lakes states facilitates the coordinated efforts to maintain and enhance water quality. As the growth of population and industry create additional pressures on water supply and quality for established uses, further emphasis is being placed on identifying areas that would require advanced waste treatment.

Geology

The basin occupied by the Great Lakes was created by the Wisconsin Glaciations during the Pleistocene Epoch. The present Great Lakes configuration with its outlets and existing lake levels, dates back less than 3,000 years, with the subsequent processes of stream and shoreline erosion making only slight changes in the original topography.

Prior to the Pleistocene or Ice Age, the Great Lakes were nonexistent, the area being traversed by the well-drained valleys and divides of several large rivers. When the continental ice cap developed over Canada, it spread southward, covering what is now the Great Lakes-St. Lawrence River basin. Bedrock was eroded and the debris entrained in the ice mass. Then, as the ice sheet retreated northward, this entrained debris was released and vast irregular deposits of overburden were laid down. The topography was changed with parts of the major pre-glacial valleys being deepened or filled, by glacial action, thus forming the basins of the five Great Lakes.

During the final northward recession of the ice front, there was pooling of the melt waters that resulted in gradually enlarging bodies of lake water. As the ice border receded, the pattern and the levels of these lakes were changed as new outlets were formed. Concurrent with the shrinking of the ice mass, there was differential uplift of the earth surface in the region. The outlets of Lakes Superior and Erie are currently controlled by bedrock at shallow depths at Sault Ste. Marie and in the Niagara River while the Lake Huron outlet control still remains in glacial overburden located below the St. Clair River.

The Great Lakes basin is underlain almost entirely by a thick succession of sedimentary rocks. The major structures include the large Michigan basin and a long, narrow structural platform, extending from Indiana to the St. Lawrence Valley. The highlands of the Lake Superior basin consist of Pre-Cambrian rock. Crystalline rocks extrude in the western Lake Superior and Adirondack regions and form a buried structural high separating the sedimentary basin and platform structures.

Glacial till and alluvial deposits cover Paleozoic bedrock in the Lake Michigan and Lake Huron basins. These deposits are as much as 1,100 feet thick, with the thickest deposits generally occurring in Michigan and locally in buried bedrock valleys of New York and Wisconsin. The deposits are thin or nonexistent on bedrock surfaces located in the southern part of the basin and on the bedrock "highs" of Minnesota, New York, and Wisconsin. The shoreline of Lake Erie consists of glacial till and sand. The deposits range in composition from clay and silt, through sand and gravel, to boulders, which are well sorted, or a heterogeneous mixture. The clay and silt deposits represent the former extent of lakes during de-glaciation and generally border the present Great Lakes. The sand and gravel deposits were formed by glacial meltwater streams that sorted the glacial materials.

Topography

The land tributary to the Great Lakes is included within the areas of two physiographic regions: The Laurentian Uplands and the Central Lowlands. Areas of the Great Lakes basin north and west of Lake Superior and north of Lake Huron are in the Laurentian Uplands and are dominated by hills, a few low mountains with summit elevations up to about 1,700 feet above sea level, and many lakes and swamps. In general, the bedrock has a shallow overburden. In the Central Lowlands portion of the basin, land is gently rolling to somewhat flat. The Great Lakes basin has a range of elevation from about 2,301 feet above sea level at Eagle Mountain in Cook County, Minnesota to about 600 feet at Lake Superior, decreasing to about 570 feet above sea level at adjoining lowlands near Lake Erie, and further to about 243 ft at Lake Ontario.

Soils

The Great Lakes basin has large areas of relatively flat land with high water table and fine-textured soils. The land areas of much of the Great Lakes basins were formed as glaciers receded to the north. During this final northward recession of the ice sheet, there was ponding of melt waters between the ice and the exposed glacial deposits. These glacial lakes occurred at several different elevations. At each lake level sediments were deposited. Patterns and levels of those lakes were repeatedly changed, as new lower outlets were uncovered. This left extensive, relatively flat areas with tight, fine-textured lakebed deposits.

These soils of glacial origin include the Iron River and Gogebic soils in Minnesota, Wisconsin, and the upper peninsula of Michigan. Also in this area are the Ontonagon and Trenary soils, which are in calcareous clays and loams. The Rubicon, AuGres, and Roscommon soils which occupy areas in Wisconsin and much of Michigan, are level to rolling, well drained to poorly drained sands. Southern Michigan, Indiana, western Ohio, and eastern Wisconsin have soils in rolling, calcareous glacial till and sand outwash materials. The Wooster-Mahoning soils occur in rolling, acid glacial till in eastern Ohio and Pennsylvania. The Ontario and Lordstown soils occupy much of western New York. The Ontario soils are in deep, calcareous glacial till and the Lordstown soils are in thin, acid glacial till over sandstone and shale.

Climate

In general, the Great Lakes basin experiences a continental to semi maritime climate, largely determined by the prevailing winds from west to east and the modifying influences of the Great Lakes. The region is normally humid throughout the year, with cold winters and cool summers in the north and warm summers in the south. The average annual frost-free season is about four months at the northern extremity of the basin and about six months at the southern extremity. Mean annual surface air temperatures over the basin range from about 4°C (39 F) on Lake Superior to 9°C (49 F) on Lake Erie. Average temperature on each of the lakes is lowest in February and highest in July.

The Great Lakes store great quantities of heat and tend to moderate temperatures on the adjacent land areas. Thus, the interiors of Michigan's upper and lower peninsulas are colder than areas nearer the lakes at the same latitude. The Great Lakes cause an increase of average annual humidity on the order of 15 percent. Short-term local variations in surface air temperatures can be extreme. Intense cells of cold arctic air can lower temperatures as much as 30 C (50 F) in one day.

Global warming resulting from the anthropogenic increase in atmospheric carbon dioxide is projected by some to significantly change climatic conditions over the next 50 - 100 years. Average temperatures in the Great Lakes Basin could increase by 2 - 4 degrees C which would significantly increase evaporation and transpiration which may in turn decrease lake levels by up to 2 meters. Climate changes could also result in drought, weather disturbances, and changes in growing seasons etc.

Annual precipitation over most of the Great Lakes Basin ranges from less than 25 to more than 40 inches, decreasing somewhat from the south to north and from east to west. Average snowfall over the region ranges from 40 to 120 inches. The lakes have a seasonal effect on precipitation patterns in the basin, with spring and summer precipitation greater over the land and winter precipitation greater over the lakes and coastal areas.

Winter Characteristics - Ice Condition

In this climatic zone, where the period of freezing temperatures is not normally long enough to cause a lake-wide ice sheet to form, the stages of ice formation and melting sometimes go on simultaneously at different points. The effects of winds, currents, and upwelling upon the ice cover cause rapid changes, making predictions of ice thickness and distribution difficult.

There are two general types of ice cover on the Great Lakes: ice formed by the rapid freezing of surface water in the absence of wind and snow, called sheet ice; and ice made of fused individual pieces generally referred to as agglomeratic ice. Agglomeratic ice usually contains ice of various ages combined with snow masses that have been welded together by new lake ice, and is formed when warm weather allows the breakup of thin, young sheet ice.

Ice cover on the lakes first occurs in the sheltered bays and harbors and in a narrow fringe along the shoreline. The effects of winds, currents and upwelling upon the ice cover causes it to change rapidly because long fetches across the lake surface allow the wind and wave forces to attain considerable strength. As the ice cover moves and changes, it rafts and forms ridges that in some areas reach a height of 25 feet. Lake ice thickness normally varies from a few inches to 3 feet or more in protected areas.

Shore Use, Erosion, and Sedimentation

Shorelands are the focus of development in the Great Lakes region for waterborne commerce, water supply, and recreation. Primary factors determining the type of shoreland use and development in a given area are geographical location, accessibility, ownership, topography, and historical development.

Structural development (industrial, commercial, and permanent residential) is predominant along lower Lakes Michigan and Huron, and Lakes Erie and Ontario. Industrial and commercial development is concentrated primarily in urban areas. Seasonal residential development is located primarily along the northern shorelands of northern Michigan, Wisconsin, and Minnesota, away from the metropolitan concentrations of the lower lakes.

Forests occupy from 23% (Lake Erie) to 80% (Lake Superior) of the U.S. Great Lakes Basin. Large tracts of wildlife and game preserves are located along many of the isolated lakeshore areas of Michigan, Wisconsin, and Minnesota. Both public and private interests administer these areas to provide habitat and cover for wildlife and to promote better hunting opportunities in the Great Lakes region.

Located along the shores of the Great Lakes are major recreational areas. The U.S. Department of Interior National Park Service oversees 1,969 square miles in the Great Lakes States including 2 National Parks, 4 National Lakeshores, one National Seashore, and numerous other areas. Environment Canada oversees 1,211 square miles of National Parks in the region. In addition, the states and provinces have extensive park land holdings.

According to the International Joint Commission Levels Reference Study Board (1993), land use in the coastal counties varies significantly around the lakes. The northern shore of the 2,724-mile Lake Superior shoreline remains virtually undisturbed and many reaches are heavily forested. Only about 22% of the Canadian shoreline and 20% of the U.S. shoreline are in residential or commercial classes.

The 1,638-mile long Lake Michigan shoreline is mostly smooth and unbroken, backed by gently rolling terrain. Dunes border the eastern and southern shores. Forested lands are primarily found in the northern portion and the central portion is largely agricultural. Dense urbanization occurs along the southern shore, with about 33% of the shoreline designated urban residential and commercial.

The Lake Huron shoreline is 3,827 miles long, including Georgian Bay, North Channel, and Saginaw Bay. The northern half is largely forested. Major urban development is centered around the Saginaw River drainage area. About 17% of the Canadian and 32% of the U.S. shoreline are in residential, commercial/industrial use.

The Lake St. Clair shoreline is about 164 miles long. Considered one the Great Lakes' most ecologically productive connecting waterways, around 10% of the shoreline is key wetland area. A major portion of the shoreline is developed with about 40% of the Canadian side and 53% of the U.S. side in residential use.

Lake Erie has about 871 miles of shoreline, with extensive agricultural development over much of the watershed. About 25% of the Canadian and 44% of the U.S. shoreline is in residential or commercial development, with heavy urban concentration at the western end. Lake Ontario has a shoreline of about 712 miles. Approximately 26% of the Canadian side and 45% of the U.S. side is residential or commercial. The 42% residential development rate on the U.S. is the highest for any of the five Great Lakes. Residential use is also high on the connecting channels and St. Lawrence River. Percentages for specific watercourses are approximately: St. Marys River 48% U.S./18% Canadian, St. Clair River 53%/40%, Detroit River 16%/29%, Niagara River 34%/6%, and St. Lawrence River 21%/35%.

Erosion is a natural occurrence along the Great Lakes shoreline. Major causes of this shore erosion include underground water seepage, frost and ice action, surface water runoff, and wave action. Wind generated wave action causes the greatest erosion damage. Wave action works directly on the beach or at the toe of the bluffs eroding away clay, silt, sand, and gravel. The intensity of damage caused by wave action varies with the magnitude of the waves generated, the elevation of the undisturbed lake level, the temporary increase in that level generated by wind or barometric pressure gradient, and the erodibility and exposure of the shorelands.

The Lake Superior shore (U.S. side) has local erosion problems at Whitefish Bay, Ontonagan, and Keweenaw Waterway. Little erosion damage occurs on the Canadian shoreline because of its height and rocky nature. The shoreline of Lake Huron, at the southern end, is subject to erosion on both U.S. and Canadian shores. Around Lake Michigan, erosion occurs near Two Rivers, Manitowoc, Racine, Kenosha, and along the entire eastern shore. Erosion problems are also present along the southern and western shorelines of Lake Erie. Surveys conducted during the Levels Reference Study (1993) indicate that approximately 60% of the residential properties bordering the Great Lakes and St. Lawrence Seaway experience some erosion.

Urban Development

The population of the Great Lakes basin is concentrated around its shorelines. Many rural areas in the region are affected by economic and social factors in nearby urban centers. The urban influence on agricultural land use may be even more dramatic in the future. In the region, more than one-third of the total cropland is located within Standard Metropolitan Statistical Areas, where most future urban growth is expected.

The problems and needs of urban and built-up areas are serious and growing in scope and intensity. Many of the land-use problems are associated with the change from rural to urban. Zoning conflicts, taxation problems, land value appreciation, and accelerated erosion are commonly associated with urban growth. These problems are concentrated around existing urban areas where most of the future growth is expected. In future years, large areas of the region will experience the impact of urban expansion. The southern portion of the region and areas along the Great Lakes will be most affected.

Agriculture

The Great Lakes basin supports diverse agricultural production. A major dairy area is located in Wisconsin. Feed grain and livestock production are important in southern Michigan, Minnesota, Wisconsin, Ohio, Illinois, and Indiana. Commercial fruits and vegetables are important in areas of Wisconsin, Michigan, and Ohio. Small grain and timber production contribute to the economy of the northern portions of the region. The growing season in the Lake Superior drainage basin is only 140-160 days. The Lake Michigan basin has a 160—200 day growing season, and the growing season in the Huron basin is 160-240 days. Lake Erie has the most farmland in the Great Lakes basin and the longest growing season, 220-240 days. The Lake Erie basin leads the region in agricultural production.

Mineral Resources

Minerals are the foundation of the heavy industry that has developed in the Great Lakes region. Virtually all of the metallic minerals, including iron, zinc, lead, silver, and copper, are found in the northwest and extreme eastern parts of the basin. Minnesota and Michigan production of iron ore account for over 95% of the national output. Mineral fuels including oil and gas, and non-metallics including limestone, dolomite, sandstone, shales, salt, gypsum, and natural brines, are found in lower Michigan, Ohio, Illinois, Indiana, and New York. Sand, gravel, clay, marl, and peat are generally found throughout the region. Only a small amount of coal is in the area, but in adjacent regions there are many large coal-mining operations, the output of which affects the economy of the region.

Fisheries Resources

The fisheries of the region constitute one of the major natural resources. The 179 species of fish found in the waters of the Great Lakes (USFWS Great Lakes Fishery Resources Restoration Study, 1995) represent most of the important families of fresh water fish in North America. Most of these species are indigenous to the basin, having entered the lakes during the last glaciation (Wisconsin) period. In addition, exotic species are present, having been either purposely or inadvertently introduced by man. These introductions, along with past fishery management practices, have led to significant changes in the fisheries resources of the basin.

Commercial fishing in the Great Lakes, an important resource for over a century, has been declining over the years. Prior to 1950, eleven species of fish contributed significantly to the U.S. commercial catch: lake sturgeon, lake trout, lake herring, pike, chubs, lake whitefish, carp, suckers, catfish, yellow perch, and walleye. Of these, only the last seven have played a substantial role in the commercial fishery of the last four decades. Although reduction of stock due to increased mortality from sea lamprey predation and increased competitive pressures caused by the introduction of smelt and alewives (accelerated in some cases by over fishing) have resulted in the virtual elimination of the first four from the commercial fishery, they still remain as considerations in a future restored fishery. The Great Lakes Fishery Resources Restoration Study (1995) reported Great Lakes fishery related activities to be worth $6.89 billion annually.

A 1975 Great Lakes Basin Commission Study, the 1979 Fish and Wildlife Coordination Act Report for Great Lakes Extended Season Navigation, and the Great Lakes Fishery Resources Restoration Study provide data on individual Great Lakes fisheries.

Lake Superior - There are about 71 species of fish that have inhabited Lake Superior during the past 100 years. The fishery is the least altered of the Great Lakes and is dominated by coldwater species such as whitefish, herring, lake trout, and chubs. Lake trout stocks crashed in the 1950's following a sea lamprey buildup, but with a successful lamprey control program there is evidence that trout are returning.

The invasion of rainbow smelt and an intensive selective fishery also contributed to changes in the fish community of the lake, particularly the decline of the lake herring. As smelt have become the preferred food of salmonid predators, lake herring populations have rebounded since the early 1980's. Introductions of coho, chinook, and steelhead have been successful, but the long-term stability of this complex fish community is likely to depend on the coregonine forage base, especially lake herring.

St. Marys River - The bays, wetlands, and various current patterns add diversity to the fish habitat of the St. Marys River. The rapids are a unique fishery for northern pike, walleye, rock bass, bullheads, lake herring, rainbow trout, and smelt. Yellow perch and sucker are the most common inshore species.

Lake Michigan - The Lake Michigan fishery has undergone drastic changes due to the invasions of sea lamprey and alewife, over-fishing, and environmental degradation. Lake herring and deepwater coregonids were the most abundant fish in the pelagic community, while lake trout were the top piscivore. Ecological changes are pronounced in the southern basin and Green Bay, areas that formerly produced major portions of the lake's premium catches. Over-fishing and sea lamprey predation essentially wiped out the lake trout population by 1956, but by 1966 control efforts dropped spawning sea lamprey numbers by 80-90%. Trout and salmon stocking programs by Michigan, Indiana, Illinois, and Wisconsin have resulted in successful harvests of these salmonids, but continuous restocking programs are necessary to maintain fish populations. The bloater population rebounded significantly during the 1980's to the extent they are once again the most abundant forage species. Coho and chinook salmon, rainbow, lake, and brown trout, yellow perch, and whitefish comprise the majority of the current catch.

Lake Huron – The Lake Huron fish community was historically dominated by lake trout, lake whitefish, deepwater coregonids, burbot, longnose sucker, and deepwater sculpin in offshore areas. Cool water areas were dominated by walleye, northern pike, lake sturgeon, muskellunge, and yellow perch, while warm water areas supported populations of catfish, smallmouth bass, largemouth bass, bullheads, rock bass, white sucker, and freshwater drum. As in Lake Michigan, a combination of over-fishing, sea lamprey predation, competition from non-indigenous species, and habitat loss has resulted in major shifts in population abundance over the years. Over the last decade lake whitefish populations have regained stability and abundance lake-wide. Chinook salmon have also become an important component of the fish community. Lake trout are being actively managed but populations remain at depressed levels, likely due to increasing lamprey numbers in the northern part of the lake. Sea lamprey reproduction in the St. Marys River has become a major problem in the last 20 years, resulting in more parasitic sea lamprey in Lake Huron than in the other lakes combined. Yellow perch and walleye remain important components of the near-shore fish community.

St. Clair River and Lake St. Clair - The shallow marshy Lake St. Clair supports a highly productive fishery. Mayflies, oligochaetes, chironomids, aquatic plants, and pondweeds all contribute to the feeding and reproduction of many species. The St. Clair flats are spawning grounds for walleye, muskellunge, rainbow trout, lake sturgeon, smelt, coho, chinook, smallmouth bass, yellow perch, drum, and channel catfish.

Lake Erie – Over 140 species of fish have been documented from the Lake Erie basin. Lake Erie is more susceptible to environmental change than the other Great Lakes due to its shallowness and low water volume. Fish species composition in Lake Erie differs from the other Great Lakes due to a higher water temperature and more southern geographic location. Many of the valuable commercial and recreational species were greatly reduced due to accelerated nutrient input, phyto-plankton growth, over fishing, and degradation in the chemical environment of the lake. Important habitats have been lost over the years to human activities and other areas remain in danger. In recent years reduced nutrient and contaminant loadings, and the establishment of the zebra mussel have resulted in a shift towards a less eutrophic system. Major fish species found in Lake Erie include walleye, yellow perch, freshwater drum, gizzard shad, smelt, channel catfish, smallmouth and white bass, carp, and white sucker. Populations of warm water species such as carp, goldfish and gizzard shad play prominent roles in the lake's fish community. Lake Erie has recently been stocked with rainbow trout, lake trout, and chinook salmon in an effort to improve the sports fishery in areas where population pressures on recreational areas is high. Stocking efforts are being re-evaluated in light of the changing abundance of various prey species. Species composition and abundance can be expected to continue to shift as the full effect of changes in nutrient loading, non-indigenous species, and management efforts are realized.

Lake Ontario – Lake Ontario at one time supported as many as 140 species of fish. Marked changes in the species composition, productivity and energy flow dynamics have occurred and continue to occur as a result of human intervention in the basin. The system experienced significant declines in productivity in the 1980s as a result of reduced nutrient loadings. This resulted in lower forage fish production and biomass. The offshore fish community is currently dominated by non-indigenous alewife, rainbow smelt, coho and chinook salmon, and brown and rainbow trout, and reintroduced lake trout. The near-shore area currently supports bullheads, catfishes, common carp, goldfish, spottail, golden, and emerald shiners, gizzard shad, white and black crappie, yellow and white perch, walleye, northern pike, American eel, and smallmouth bass. Reduced nutrient loading resulting from water quality initiatives and the spread of zebra mussels appears to be resulting in a shift towards a more oligotrophic lake in which energy the majority of energy flows through the benthic community. Fish species composition and abundance appear to be responding to this change in the food web. The return to a more oligotrophic system may make the re-establishment of some native species more feasible.

Wildlife Resources

There are approximately 220 kinds of birds and 78 kinds of mammals in the Great Lakes basin. Upland game birds found in the basin include ring-necked pheasants, ruffed grouse, quail, and turkey. Waterfowl include several species of geese and many species of ducks. Typical shore and marsh birds include bitterns, rails, herons, loons, red-winged blackbirds, gulls, and terns. Common non-game birds include hawks, owls and many species of songbirds. Endangered bird species in the basin include the piping plover, and Kirtland's warbler.

Important game animals include the white-tailed deer, black bear, cottontail and snowshoe rabbit, squirrel, ring-necked pheasant, ruffed grouse, quail, geese and migratory waterfowl. Important fur animals in the basin are muskrat, beaver, otter, mink, martin, fisher, raccoon, grey and red foxes, bobcat, skunk, and coyote. Federal Endangered/Threatened species of the region include the gray wolf (timber wolf) and the Indiana bat.

The waters of the Great Lakes and adjacent basin areas provide a flyway route for millions of North American waterfowl and breeding territories for lesser numbers of the twenty-seven species using the Great Lakes basin. While waterfowl are distributed generally throughout the basin, there are major concentration areas serving the migrant and breeding ducks, geese, coots, and swans. These concentration areas include Tahquamenon Bay, Lake Superior; Green Bay and Big Bay de Noc, Lake Michigan; Saginaw Bay, Lake Huron; Lake St. Clair; St. Marys River; Point Pelee Marsh, Rondeau Bay, Long Point Bay, and the western end of Lake Erie. In addition, many marshes and shallow bays provide secondary concentration areas.

There are 664 miles of United States shore considered extremely valuable for fish and aquatic-oriented wildlife. The shallow waters, shoreline marshes, and wetland meadows are important nesting, resting, and feeding areas. During migrations, the deeper, semi-protected waters are heavily used by diving ducks.

In addition to waterfowl, the marshes support large numbers of commercially valuable furbearers; namely, muskrats and mink, while bordering swamp and waterlogged shrub swamps support lesser numbers of beaver and otter. Muskrats are the most common and, economically, the most important furbearer. The overall population of muskrats can vary drastically over a period of years due to epidemic disease, habitat changes, and reproductive rates. Mink populations exhibit a similar though less variable pattern. Optimum conditions for the muskrat usually occur at the water level that creates the largest inundated zone of cattail and associated plants throughout the fall and winter months.

The Fish and Wildlife Service Coordination Act Report, Final Survey Study for Navigation Season Extension (1979) provided detailed information on wildlife resources of the Great Lakes, connecting channels, and harbors. A summary of wildlife species and habitat types follows.

The pine forests, clearings, and coastal wetlands of Lake Superior are inhabited by a number of big game mammals. The white tailed deer, moose,' and black bear are abundant in the basin. Important small game mammals and furbearers include snowshoe hares, cottontail rabbits, fox and gray squirrels, beavers, opossum, muskrats, mink, red fox, and coyotes, Bobcats, lynx, otters, fishers, pine martens, and timber wolves are species protected from hunting or trapping by bordering states. Resident game birds include the ruffed grouse, spruce grouse, and woodcock. A variety of migratory waterfowl, wading birds and shorebirds nest in the basin while others use the area primarily for feeding and resting during the fall and spring migrations. Included are several species of ducks, (mallards, wood ducks, blue-winged teal, goldeneyes) geese (Canada goose, snow goose), coots shorebirds (herons, egrets, sandpipers, bitterns, terns, gulls), and raptors (hawks, ospreys, owls, eagles). There are nearly 200 species of songbirds found in the basin.

Over 60 species of mammals are found in the Lake Michigan basin, including the white-tailed deer, black hear, snowshoe hare, cottontail rabbit, squirrels, river otter, fox, coyote, beaver, mink, and muskrat. Waterfowl commonly seen in the basin include the whistling swan, Canada goose, several species of ducks, loons, gulls, terns, cormorants, egrets, raptors, and passerines. The double-crested cormorant, classified by Wisconsin as endangered and Michigan as threatened, has three nesting colonies along Lake Michigan. Federally listed endangered species include the Kirtland's warbler.

The basin area of lake Huron has many undisturbed habitats for wildlife, including Huron National Forest and Scarecrow Island Wilderness Study Area. Big game animals include white-tailed deer, black hear, and elk. Small mammals include snowshoe hares, cottontail rabbits, porcupines, opossum, grey fox, and red squirrels.

Numerous migratory birds feed, nest, or rest in the shallow waters of Lake Huron, including whistling swans, Canada geese, mallards, pintails, blue-winged teal, wood ducks, canvasback, redheads, goldeneyes, gulls, black-crowned night heron, great blue heron, and double-crested cormorants. The Kirkland warbler breeds in the watershed of the Au Sable River. The bald eagle nests actively in the Huron River basin.

The St. Clair River delta is an important marshland habitat. Over 250 species of birds have been observed in the St. Clair basin. Nutrient rich beds of vegetation are feeding areas for about 20 species of migratory and resident ducks. The delta is also used by coots, rails, egrets, herons, swans and numerous shorebirds. There is a rookery for the great blue heron on Dickinson Island. Sixty species of mammals including white-tailed deer, cottontail rabbits, muskrat, mink, and raccoons, populate the marshes.

Lake Erie provides an important migration area for more than one million eastern North America ducks and whistling swans. Wintering populations include sizeable numbers of canvasbacks and redheads. Waterfowl population surveys indicate more than one million ducks use the marshlands of western Lake Erie during migration. A rookery of black-crowned night herons, common egrets, great blue herons, and green herons exists on West Sister Island, a National Wildlife Refuge. Starve, Green, South Bass, North Bass, Ballast, Gull Island Shoals, Middle Sister, East Sister, Big. Chicken, Hen, and Pelee Islands are all listed as critical bird nesting and migration areas.

Important mammal species in the Lake Erie basin include the white-tailed deer, cottontail rabbit, muskrats, mink, foxes, opossum and squirrels. Federally endangered or threatened species, which may be found near Lake Erie, are the Indiana bat, Kirtland’s warbler, and the bald eagle.

Sites of Proposed Navigation Improvements

Lake Superior Harbors-

Taconite Harbor, Minnesota -Taconite Harbor is a non-Federal harbor located on the Minnesota Lake Superior north shore, about 76 miles northeast of Duluth, Minnesota, and 25 miles northeast of Silver Bay, Minnesota. Water depths in the harbor vary from 27 feet at the docks to 65 feet elsewhere. The topography of this area is irregular and rugged. The land-water interface is narrow cobble and gravel beach with rocky bluffs.

The type of vegetation found in the harbor area is in large part determined by the area's short growing season and shallow, coarse, relatively infertile soils. A nearly continuous second growth coniferous-deciduous forest covers the region, broken only occasionally by inland lakes, wetlands and small fields. Common upland deciduous trees and shrubs include quaking aspen, paper birch, sugar maple, mountain maple, American hazel, thimbleberry, and mountain ash. Balsam fir and white spruce are the dominant upland conifers, while white cedar and black spruce are common in the scattered wetlands. Deciduous wetland trees and shrubs include tamarack, black ash, various willows, speckled alder red-osier dogwood, and bog rosemary.

The aquatic resources of the Taconite Harbor site are typical of the Lake Superior coastal environment. Lake Superior is a large, cool, nutrient-poor freshwater lake. Its North Shore, including the project site and vicinity, is sparsely developed, with only localized loading of nutrients and pollution. The North Shore coast, including the project area, is subject to heavy wave action.

The Lake Superior fishery includes salmon, lake trout, herring, and whitefish. Fish habitats along the Taconite Harbor shoreline include sand bottom, flat bedrock bottom, open water, and rock/rubble reef. The sand and flat bedrock bottoms are the least productive of these types, offering scarce food species and little cover from predation. The open water habitat is used by game fish, with the top carnivores living in the deeper waters during the summer and migrating to the shallows in the spring and fall. Lake trout spawning occurs during the fall in the shallows. The shallows are also used for stocking juvenile lake trout, where access to the lakeshore is good. The rock/rubble reef is typically the most productive for the Great Lakes (Janssen and Quinn, 1985; Liston et al., 1985). This Lake Superior habitat is the primary spawning and nursery area for cold water game fish species, especially lake trout (Hubbs and Lagler, 1958). The Two Island River, which enters the harbor near the west end of taconite dock, provides spawning habitat for lake-run steelhead (rainbow trout), brown trout, brook trout, and probably pink salmon. Farther upstream the river provides habitat for resident brook and brown trout.

Wildlife species in the site vicinity are typical of a disturbed, but unpopulated, site along the North Shore of Lake Superior. Wildlife species present in the site vicinity are likely to include white-tailed deer, black bear, small mammals, and a variety of amphibians and reptiles. Gray wolves are not uncommon in this part of Minnesota; however, they are not likely to be present at the project site. Migratory birds, including many species of raptors and songbirds, use the North Shore as a travel corridor. During the summer, the site is used by Canada geese, and ducks such as mallards. Goldeneye and oldsquaw ducks have been observed at the site during winter. A search of the state's

Natural Heritage Data Base indicates there are herring gull (a colonial waterbird) nesting sites on Gull and Bear Islands, which are near the project site.

There are no known threatened or endangered plant or animal species on or near the project site. The state's Natural Heritage Data Base includes a 1948 record of the plant species, neat spike-rush (*Eleocharis nitida*), a wetland plant that is listed as threatened by the State of Minnesota, along Highway 61 in the NWNE of Section 15, approximately one mile from the proposed project site. Species that are Federally listed as threatened or endangered that are of known or recent (25 years) distribution in Cook County, Minnesota, include gray wolf (*Canis lupis*). This species is not expected to be present at the project site because of current and past commercial / industrial disturbances at and near the site.

<u>Silver Bay, Minnesota</u> - Silver Bay is located on the north shore of Lake Superior approximately 55 miles northeast of Duluth, Minnesota. The harbor is owned and operated by and for the Reserve Mining Company. Harbor water depths range from 27 feet at the dock to 100 feet elsewhere. The topography of the area is typical of the entire Minnesota north shore. Steep, rocky bluffs paralleling the shoreline rise up from narrow cobble and gravel beaches. Soils are generally shallow and infertile in the area. The harbor bottom is thought to consist largely of bedrock and various sizes of stone.

Area vegetation is typical of that found along the entire north shore area of Minnesota and would be classified as Boreal Forest dominated by paper birch (*Betula papyrifera*), balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). Additional common tree species include trembling aspen (*Populus tremuloides*), red maple (*Acer rubrum*) and black cherry (*Prunus serotina*). Shrub species include raspberries (*Rubus spp*.), beaked hazel (*Corylus cornuta*), red osier dogwood (*Cornus stolonifera*), and tag alder (*Alnus rugosa*).

The area wildlife community is composed of those species common to the Minnesota portion of the Lake Superior Basin. Mammal species probably include black bear (*Ursus americanus*), white-tailed deer (*Odocoileus virginianus*), porcupine (*Erithizon dorsatum*), red squirrel (*Tamiasciurus hudzonicus*), snowshoe hare (*Lepus americanus*), mink (*Mustela vison*) and various additional small mammals. A variety of migratory waterfowl, including mallards, buffleheads, scaup, Canada geese, and snow geese make stopovers in the harbor during their spring and fall migrations. Killdeer and herring gulls nest in the harbor area. The Reserve Mining Company does not allow hunting within Silver Bay Harbor or on adjacent company property. The land adjacent to Lake Superior on either side of Silver Bay is part of an extensive State Game Refuge where no hunting is allowed. Federally-protected species that may be present in the vicinity include the gray wolf (*Canis lupus*) and the peregrine falcon (*Falco peregrinus*).

In April 1981, the Reserve Mining Company began a one-year power plant impingement/entrainment study in Silver Bay. Fifteen fish species were collected, including such important game species as coho, chinook, brook trout, rainbow trout, lake whitefish, lake herring, yellow perch, and rainbow smelt. Lake trout, walleyes, and deepwater ciscos have been found on several previous occasions and likely visit the harbor from time to time. Lake trout and lake whitefish may spawn on the reefs extending outward from Beaver and Pellet Islands as well as along the south breakwater. Smelt are known to spawn along the harbor shoreline and it is likely that other fish species do so as well.

Two Harbors, Minnesota - Two Harbors is located in Agate Bay on the north side of Lake Superior approximately 26 miles northeast of Duluth and 25 miles southeast of Silver Bay, Minnesota. Agate Bay is a shallow natural embayment with a predominantly bedrock bottom and a shoreline characterized by a land-water interface of gravel beaches interspersed with rocky bluffs. Existing harbor facilities consist of three iron ore loading docks. Channels have been constructed by blasting and dredging to a depth of 28 to 30 feet in most areas. Breakwaters along the east and west sides of the entrance measure 1628 feet and 900 feet respectively. A shipwreck eligible for inclusion in the National Register of Historic Places lies adjacent to the west breakwater.

Water quality in the harbor and Agate Bay is expected to be good based on a large exchange of water with Lake Superior. Samples of bottom sediments taken from the harbor in the early 1980's indicate that sediments are composed of a mixture of silts, clays and sand. Elevated levels of arsenic were detected in the sediments at that time. This may be characteristic of the area or an indicator of pollution.

Terrestrial vegetation in the harbor area consists of sparse grasses and annual and perennial forbs. No wetlands are located within the project area. Wildlife in the vicinity of the harbor consists chiefly of a few resident herring gulls and small rodents, as well as furbearers passing through the area. Transient use of the harbor by nesting or migrant shorebirds, wading birds, waterfowl, passerines, colonial nesting species, and raptors is likely. Federally listed threatened or endangered species that may be native to the area include the gray wolf, which would not be expected in the vicinity of the harbor.

Benthic invertebrates in the harbor are dominated by oligochaetes and chironomids. The rubble mound bases of the breakwaters may provide important aquatic habitat. Smelt are known to spawn in the harbor between 1 April and 15 May. White suckers and longnose suckers may be abundant in summer and fall. Some walleye and carp are suspected to reside in the harbor, and coho and chinook salmon, rainbow trout, brook trout, and lake trout may be present during spring and early summer. Lake trout are thought to spawn in the vicinity of the harbor in October, as are lake whitefish in November. Fishing along the breakwaters is popular and expected to become more popular in the future.

Duluth-Superior Harbor, Minnesota-Wisconsin - Duluth-Superior Harbor is located at the extreme southwest end of Lake Superior between the cities of Duluth, Minnesota, and Superior, Wisconsin. Duluth, to the north, is built on a massive rock escarpment, which rises 880 feet above the harbor. In contrast, Superior, to the south, is built on a low plain of red clay, which extends several miles inland. The two cities are separated by the St. Louis River, which has a drainage basin of 3,640 square miles and an average discharge of 2,200 cubic feet per second. The river flows through ten miles of pristine estuary before entering the upper reaches of the Duluth-Superior Harbor. The Federal navigation project includes 17 miles of channels, anchorage areas, and maneuvering basins, with channel depths ranging from 20 to 27 feet. Two natural sand and gravel barriers, Minnesota Point and Wisconsin Point, separate the naturally shallow harbor from Lake Superior.

Bottom sediments are comprised of silts, sands, and fine clays. Most of the original harbor shoreline has been significantly altered, with land uses varying among municipal and industrial sites, highways and railroad tracks, commercial docks, residential areas, embayments, peninsulas of made-land, and some areas of wildlife habitat.

The harbor and the lower St. Louis River have a history of water quality problems resulting primarily from municipal and industrial discharges at and upstream from Duluth-Superior Harbor. The lower St. Louis River, including the Duluth-Superior Harbor, has been listed by the International Joint Commission (IJC) as one of forty-four Areas of Concern (AOC) within the Great Lakes ecosystem. A Remedial Action Plan (RAP) has been developed for the St. Louis River AOC. Goals of this plan include water quality maintenance, remediation of polluted sites, pollution prevention and reduction, reduced sediment loading, beneficial use of dredged material, protection and restoration of fish and wildlife habitat and wetlands, enhanced water oriented recreation, and protection and restoration of scenic beauty.

Duluth-Superior Harbor has a history of heavy industrial activity dating back to before the turn of the century. Water quality has improved markedly since 1978 when the Western Lake Superior Sanitary District (WLSSD) began treating industrial and municipal waste for a 500 square mile area. However, this plant was identified as a source of heavy metal pollution, mainly mercury, through the incineration of the wastewater sludge using municipal and industrial solid waste. The WLSSD has since taken steps to minimize further mercury pollution of the estuary. The Stage One RAP included an assessment of in-place pollutants within the harbor. Existing data from a variety of sources were analyzed. The data showed that the AOC contains a variety of contaminants, including nutrients such as oil and grease, ammonia-nitrogen, and phosphorus; inorganics (such as metals); and organic compounds such as PCBs and polycyclic aromatic hydrocarbons (PAHs). According to the RAP assessment, Mercury, PCBs, and PAHs occur widely throughout the AOC, whereas dioxins were detected in only a few areas. In the upper reaches of the harbor and upstream, the St. Louis River flows past two Superfund sites (Comprehensive Environmental Response, Compensation, and Liability Act, 1980) near the upstream end of the harbor, the St. Louis River/ Interlake/ Duluth Tar Site and the U.S. Steel Duluth Works Site. There are also several other hot spots of high contaminant levels in localized areas of the harbor.

Sediment samples, collected throughout the Federal navigation channels in 1994 and 1995, were analyzed for physical and contaminant character. Generally the sediments from the inner harbor were described as loose brown silts with various amounts of organic matter. The samples collected from the Duluth Entry were coarse sands. Other samples contained trace to moderate amounts of sand. Samples from the Superior Basin were described as having 30% sand, as were samples from near the Duluth Entry. Throughout the navigation channel, PAHs were generally non-detectable in the 1994 sampling, with the exception of several compounds that were present at very low (<0.5 mg/kg) concentrations in the western section of the South Channel. PCBs were not detected in any of the 1994 samples at detection limits averaging 0.08 mg/kg. Pesticides were non-detectable in the 1995 results at good detection limits.

Impacts of the contaminants in the dredged material on benthic organisms included water column tests, bioaccumulation studies, and benthic toxicity tests. The water column test results suggest that water column impacts from in-water placement of the dredged material would be minimal. The sediment bioaccumulation results involved exposing organisms to the sediments and then analyzing their tissues for PCB congeners; the low concentrations in the tissue samples suggest that bioaccumulation from this material would not be significant. The benthic toxicity results suggest that only the material from the Superior Front Channel demonstrated significantly greater toxicity than the reference site.

Open water areas are the largest aquatic habitat type in the Duluth-Superior Harbor. These are primarily dredged shipping channels up to 27 feet deep and shallow water areas, generally under 6 feet in depth. There are extensive stands of aquatic vegetation in scattered, sheltered areas throughout the harbor, which provide valuable habitat for a variety of plant, fish, and wildlife species. The southern half of Allouez Bay, the shallow waters around Grassy Point and other areas along protected shorelines and sheltered areas deep within narrow bays along the St. Louis River contain non-persistent macrophyte beds. Of the original 11,500 acres of estuarine habitat, over 3,000 acres of marsh and open water in the lower St. Louis River Estuary are estimated to have been lost to filling, and another 4,000 acres lost to dredging. Allouez Bay, the only remaining large wetland in the lower estuary, is a major northern pike spawning area in the lower estuary, and is a major feeding area for post-spawning adult walleye.

The Duluth-Superior Harbor area supports a large and diverse fish community of over 50 species, many of which are seasonally abundant, using the river and estuary for spawning. The St. Louis River estuary, which is considered to be the most productive fish breeding area in the western half of Lake Superior, supports a walleye stock that extends east to the Apostle Islands. Harbor sampling, conducted by the Minnesota Department of Natural Resources with gill nets indicates that in 1994 lake sturgeon, Eurasian ruffe, channel catfish, walleye, shorthead redhorse, and yellow perch, each represented at least 10 percent of catch by species. Lake sturgeon, which had been nearly eliminated from the harbor by 1978, were restored through intensive stocking. Walleye, northern pike, and muskellunge have also been stocked over the last 10 years.

In recent years a variety of exotic species have entered the harbor, including alewife, carp, Eurasian ruffe, freshwater drum, round goby, threespine stickleback, white perch, spiney water flea, and zebra mussel. Only the ruffe has become abundant in the harbor; however, MDNR sampling suggests that the ruffe has peaked in abundance in 1992 and is currently declining. The MDNR is managing predator species, in part, to control exotics. The zebra mussel has not become a problem in the harbor. This is likely due to the lack of calcium and nutrients, which are necessary for zebra mussel's growth, in Lake Superior. Purple loosestrife is an exotic wetland plant species that grows fast, is hardy, and crowds out native vegetation. It is well established throughout the harbor, with several large stands.

Wildlife in the immediate vicinity of the harbor is somewhat limited by the industrial nature of the area. However, studies in the Duluth-Superior Harbor vicinity indicate the presence of a wide variety of mammalian species including whitetail deer and black bear, small game, such as snowshoe hare, eastern cottontail, and the gray squirrel, and various furbearers, such as beaver, mink, otter and muskrats. Various species of reptiles and amphibians would be expected to occur in the harbor area. A variety of shore, marsh, and water birds also either reside in or migrate through the Duluth-

Superior Harbor vicinity. Migratory waterfowl use the harbor extensively both for breeding and as feeding and resting stops during migration. Hawks, falcons, and owls find suitable habitats in the Duluth-Superior area. The Bong Bridge over the harbor is listed on the Minnesota Natural Heritage Database as a nesting area for peregrine falcon. Relatively few birds spend the winter in the harbor area. Those that do, include the snowy and great horned owls along with a local population of ring-necked pheasant. Some hardy waterfowl winter in warm water discharge areas. Over 310 bird species have been identified within the Duluth city limits. Excluding colonial nesting birds (gulls, terns, plovers, and herons), the most heavily used areas of the harbor vicinity include the Allouez Bay, Wisconsin Point, Hearding Island, Erie Pier, Grassy Point, Hog Island, Spirit Lake, Mud Lake, Horseshoe Island, the Oliver Bridge and Morgan Park mudflats. As a group, colonial nesting birds comprise the most abundant, yet sensitive, breeding birds in the harbor area. Interstate Island is listed on the Minnesota Natural Heritage Database as a colonial waterbird nesting site used by terns and gulls.

Federally listed species that may be present in the project area include the bald eagle (*Haliaeetus leucocephalus*), threatened; piping plover (*Charadrius melodus*), endangered; and gray wolf (*Canis lupus*), endangered in Wisconsin and threatened in Minnesota. According to reports of the St. Louis River Estuary Colonial Bird Program (a program of the Minnesota and Wisconsin Departments of Natural Resources), piping plover have not been observed nesting in the harbor since 1985.

<u>Presque Isle Harbor, Michigan</u> - Presque Isle Harbor is located on the south shore of Lake Superior within the city limits of Marquette, Michigan. The harbor is 158 miles west of Sault Ste. Marie, Michigan and 255 miles east of Duluth, Minnesota. The bay that forms the harbor is an indentation of about one-half mile into the coastline of Lake Superior and extends about 1.5 miles along the shore. The harbor lies just south of Presque Isle Point and has natural depths of 20 to 40 feet. The dredged harbor of about 80 acres includes an inner harbor, having a depth of 28 feet, and an entrance with a depth of 30 feet. A breakwater protects the harbor on the eastern side. Water quality varies greatly but is generally good. The bottom of most of the harbor is sand, with some areas of gravel and cobble.

Fish use of the harbor appears to be extensive. Various studies have documented from 22 to 36 species as being present. The most common species found are spottail shiners, mottled sculpin, slimy sculpin, rainbow smelt, round whitefish, and white sucker. The Dead River, which discharges 70 to 200 cfs of water into the harbor, is used by rainbow smelt, rainbow trout, suckers, yellow perch, northern pike, and sea lamprey for spawning in the spring. Coho, pink, and chinook salmon, and rainbow and brown trout use the river in the fall. Lake trout are known to spawn in the harbor near the intake and discharge pipes of the Upper Peninsula Generating Company Power Plant, at the opening of the Presque Isle Marina, along the edge of the dock break wall, and on a reef off the Cliff Dow Chemical Company site. Lake trout spawning is also suspected on a natural rock area in the middle of Presque Isle Harbor and at the foot of the Presque Isle breakwater. Other fish that may spawn in the harbor include; white and longnose sucker, ninespine stickleback, smelt, spoonhead sculpins, slimy sculpins, mottled sculpins, yellow perch, troutperch, smallmouth bass, lake herring, lake whitefish, and round whitefish. Larvae of 12 taxa have been identified in the harbor at various times from December through August.

A variety of waterfowl use the Dead River as a spring nesting area and a winter feeding ground. During winter, roughly 100 ducks, 300-400 gulls and a few Canada geese and mergansers use Presque Isle Harbor Bald eagles, snowy owls, and the glaucous gull have also been sighted near the harbor during winter months. The harbor area is inhabited by a variety of small mammals.

Lake Michigan Harbors

Escanaba Harbor, Michigan - Escanaba Harbor is located on the west shore of Little Bay de Noc on northern Lake Michigan in Delta County, MI. The harbor is 100 miles north of Milwaukee, WI and approximately 110 miles west of the Straits of Mackinaw. Escanaba Harbor is a natural harbor that services 3 private terminals handling coal, limestone, salt, and iron ore. The Escanaba Marina is located south of the commercial docks and has a total of about 165 boat slips.

Little Bay de Noc is a small bay with a surface area of almost 28,000 acres. Although the bay has a maximum depth exceeding 100 feet, 52% of the area has depths of 24 feet or less and has a bottom composed of sand, with rock and rubble along the north and west shores. Water quality is generally good throughout the bay with the exception of the mouth of the Escanaba River where it is degraded by pulp and paper wastes.

Little Bay de Noc is a rich fishery habitat that contains high value coldwater, coolwater, and warmwater fish. Shoreline habitat and shoal areas have been reported as suitable spawning grounds for northern pike, smallmouth bass, perch, rainbow smelt, alewife, walleye, lake trout, lake whitefish, and various species of minnows. In the past the area has been important to both sport and commercial fisherman. However, commercial fishing has been greatly restricted in recent years.

The bay is considered to be an important concentration area for waterfowl largely due to the protection it provides. Mammals occupying the area include white-tailed deer, black bear, coyote, grey and red fox, and a variety of smaller mammals. Some federally listed protected species could potentially occur in the general area of Escanaba including the bald eagle, gray wolf, and peregrine falcon. The proximity of the harbor to an urban area makes it unlikely that any individuals reside at potential work sites.

Information is lacking concerning the environment of the harbor itself but is assumed that those organisms common throughout the bay will occur in the area of the harbor. The only wetland that appears close enough to the harbor to be effected by the project is the 29 acre Escanaba River Wetland.

Menominee River and Harbor, Michigan - The Menominee River forms the boundary between Northeastern Wisconsin and the upper peninsula of Michigan. The river, with its headwaters originating in both states, flows generally southeasterly for 115 miles where it empties into Green Bay in northwest Lake Michigan. The river's main stem flows between the cities of Menominee, Michigan , and Marinette, Wisconsin. The total area of the Menominee River drainage basin is approximately 4,186 square miles, over 60 percent of which is located within the state of Michigan. The Federally authorized Menominee River and Harbor project is located on the lower end of the

Menominee River at its confluence with Green Bay. The harbor is about 50 miles northeast of Green Bay, Wisconsin, and about 60 miles south of Escanaba, Michigan.

The current project is about 2.5 miles long and consists of: a 600-foot wide approach channel in Green Bay, an outer harbor formed by two parallel entrance piers 400 feet apart, an inner harbor formed by a navigable reach of varying widths and depths, and a 650-foot wide turning basin. Although authorized to deeper depths, the approach channel has been maintained to a depth of 23 feet, and portions of the lower and upper inner harbor channel to 21 feet and 19 feet respectively. Turning basin maintenance has been deferred due to the lack of an economically suitable disposal site.

The Menominee River is used for industrial processing and cooling, waste assimilation, hydroelectric production, recreation, public access, and commercial navigation. Although a commercial port, Menominee Harbor is also a recreational port that provides numerous public access points to Green Bay and Lake Michigan. A number of parks and recreational areas exist in the area, although swimming beaches along Green Bay at the mouth of the river are limited. Fishing and recreational boating are popular activities for tourists and the local population. Commercial fishing operations that use Green Bay and Lake Michigan have also been active in the area.

The International Joint Commission (IJC) identified the Menominee River watershed as one of 42 areas of concern (AOC) in the Great Lakes. The Menominee AOC includes the lower three miles of the river, the cities of Marinette and Menominee, and the adjacent near-shore area of Green Bay extending three miles north and south of the river mouth. The AOC designation resulted from the identification of impaired water resources. Contributing factors include the presence of contaminants, including arsenic and mercury, and industrial and municipal land-use changes that have occurred in the AOC over the last century.

Background data on water quality in the Menominee River AOC is limited. According to the Stage I Remedial Action Plan (RAP) report, analyses of water samples, obtained upstream of the majority of the point sources of water quality degradation, indicated water quality to be good. The concentrations of the parameters sampled did not exceed the Michigan, Wisconsin, and IJC water quality criteria for the protection of fish and aquatic life. Downstream certain parameters were exceeded on occasion, but usually during low flow conditions.

The Menominee and Marinette area is urbanized. The riverfront along the Federal project is primarily occupied by industrial development. Wetlands, historically abundant in the area, have been either eliminated or severely impacted by development along the river's edge. For this reason, fish and wildlife habitat is generally limited although small islands and undeveloped or abandoned parcels along the river do provide habitat of diminished value. Wildlife habitat is considered impaired in the AOC due to loss of wetlands from urbanization, not from water quality degradation. However, great numbers of migrating shorebirds and waterfowl are attracted to the area, particularly in the Seagull Bar Scientific Area and Green Island Natural Area. The piping plover and bald eagle, both Federally protected species, may also migrate through the area.

In spite of habitat loss and alteration, the overall fish population in the Menominee River is diverse and supports a substantial sport fishery. According to the U. S. Fish and Wildlife Service (FWS), a variety of structural features along the riverbank, including dilapidated docks, pilings, and bedrock, provide very good fish habitat. Species that have been found in the river year round or seasonally include: rainbow and brown trout, lake sturgeon, splake, northern pike, coho and chinook salmon, yellow perch, alewife, walleye, smelt, smallmouth bass, white suckers, longnose suckers, and carp. Stocked species include walleye, chinook salmon, splake, and steelhead, rainbow and brown trout. Fishing from the harbor piers is usually heavy from April to November, and fishing from small boats is extremely popular. Although a popular fishery, the lower Menominee River has been included in regional fish consumption advisories due to polychlorinated biphenyl (PCB) contamination. The RAP stage I report also indicated that mercury-contaminated fish have been documented in the AOC. However, since fish are mobile in the Green Bay area, the source of their contamination cannot be pinpointed.

Sampling of the shoaled sediments in the Federal channels has been conducted periodically since 1981 as part of the harbor operation and maintenance (O&M) program. Past COE sediment testing indicates poor sediment quality in the turning basin due to severe arsenic contamination. COE analyses of sediments since 1981 for the O&M program (excluding the turning basin which is adjacent to a superfund site and heavily contaminated with arsenic) have consistently shown that the material is chemically and physically suitable for unrestricted disposal, including in the open water. In general, the sediments in the navigation channel can be characterized as predominantly sandy, although moderate levels of silt and an abundance of wood chips have been found. Concentrations of chlorinated pesticides, PCBs, and toxic heavy metals are below levels of concern, while nutrient levels are typical of an urban watershed. Slightly elevated general organic parameters, attributable to the presence of an abundance of woody fibers in the sediments, have also been observed.

<u>Green Bay Harbor, Wisconsin</u> - Green Bay Harbor is located about 180 miles north of Milwaukee, Wisconsin and about 49 miles southwest of Menominee, Michigan. Green Bay is a relatively shallow extension of Lake Michigan that is over 100 miles long, southwest to northeast, and averages about 15 miles in width. It is located in east-central Wisconsin, and is the outlet for the 6,385 square mile drainage of the Wolf-Fox River basin. The bay and the Fox River serve a variety of interests including power generation, industrial, recreational, and deep-draft navigation. The Federal Navigation Project at Green Bay Harbor extends 7 miles up the Fox River and nearly 12 miles into the bay of Green Bay. The upper 3 miles of navigation channel in the Fox River currently is not maintained. Shoal material from maintenance dredging of the Federal channel is placed in the Bayport disposal site, which is along the shore about one mile west of the navigation channel. Significant maintenance dredging is required to keep the navigation channels at authorized depths (26 and 24 ft. in the entrance channel, 24 ft. in the lower Fox River and turning basin, 20 ft. in the middle turning basin, and 18 ft. in the upper Fox River and turning basin).

The Fox River is the major contaminant source for Green Bay. Its waters are not suitable for drinking water supplies because of the unknown risks of toxic substances to human health, taste and odor, suspended solids, bacteria and viruses, color, low water flow effect on water quality, and the high cost of water treatment (WDNR 1993). Sources of effluents entering the river include agricultural run-off, soil erosion, and other non-point sources; marine repairs and refueling;

wastewater treatment plants; and paper and pulp mill discharges. Green Bay is a large, shallow freshwater estuary that suffers from eutrophication and a biotic population impaired by PCBs, pesticides, and metals. The southern portion of the Bay and the Fox River have been designated by the International Joint Commission as a Great Lakes Area of Concern. The Bay nevertheless remains a major recreational resource in the region, providing excellent boating and outstanding walleye fishing, despite fish consumption advisories established by the state.

A recent sediment quality evaluation indicates that the material dredged from Management Units 1 (Bay Mile 1.0 to Bay Mile 5.0) and Management Unit 3 ((Bay Mile 8.0 to Bay Mile 11.5) are clearly suitable for unrestricted uses and would make a suitable material for island creation. Sediments dredged from Management Unit 2 would be suitable for beneficial uses, provided it was placed in an upland location or was capped with cleaner material. Material from the Fox River portion of the project would be expected to have higher levels of contamination.

Fish species common in Lake Michigan and its tributaries include smallmouth bass, yellow perch, walleye, lake whitefish, lake sturgeon, lake trout, and introduced brown trout and Pacific salmon. The Fox River and southern Green Bay support spawning populations of gizzard shad, rainbow smelt, alewife, lake herring, freshwater drum, rainbow trout, white bass, northern pike, carp, sucker, channel catfish, yellow perch, lake sturgeon, brown trout, lake whitefish, lake trout, Pacific salmon, and walleye (Goodyear, et. al. 1982). The Wisconsin Department of Natural Resources (WDNR) stocks select game fish in support of local sport fisheries.

Vegetation along the shores of Green Bay in the project vicinity is typical of a flood-plain forest, interrupted by grasslands, rivers, and wetlands. Common tree species include silver maple, box elder, eastern cottonwood, willow, tag alder, and green ash. Typical mammals include various small rodents, fox, eastern cottontail rabbit, raccoon, and white-tailed deer. Common avian species are shorebirds, gulls, terns, various passerine birds, raptors, and waterfowl.

Federally listed species known to exist in Brown County include the bald eagle (*Haliaeetus leucocephalus*) and the dwarf lake iris (*Iris lacustris*) (USFWS 1999). Both are listed as "threatened." The project site and immediate vicinity do not appear to have habitat suitable for these species and, therefore, the ecosystem restoration project is not likely to adversely impact species Federally listed as endangered or threatened.

<u>Sheboygan Harbor, Wisconsin</u> - Sheboygan Harbor is located at the mouth of the Sheboygan River on the western shore of Lake Michigan, approximately 26 miles south of Manitowoc and 55 miles north of Milwaukee, Wisconsin. The project includes a north breakwater and south pier forming an outer basin, a 1,700-foot long entrance in Lake Michigan, and a channel extending up the Sheboygan River about 4,800 feet. Project depths range from 25 feet at the entrance to 15 feet at the head of navigation.

The Sheboygan River and Harbor is listed as an Area of Concern (AOC) by the International Joint Commission and was proposed for inclusion as a Superfund site on the National Priorities List in 1985 (Hughes, ARCS Report). The AOC includes 13.9 miles of the River and harbor. The upriver sediments are highly contaminated with PCBs. Concentrations of PCBs as high as 4,500 mg/kg have been reported, with widespread sediments found in the 200 to 1,200 mg/kg range. The harbor area shows much lower levels of PCBs (<220 mg/kg) but it also has elevated concentrations of arsenic, chromium, lead, nickel, cadmium, copper, mercury, and zinc. Contamination levels decrease closer to Lake Michigan, with sediment in the entrance channel being clean enough for use as beach nourishment in some years.

Sheboygan Harbor provides a mixing zone of river and lake water that makes for a productive fishery. Forage fish and piscivorous game species are abundant in this area. Forage species include various species of minnows, shiners, smelt, and alewife. Lake trout, walleye, lake whitefish, coho salmon, and chinook salmon are frequently sought by anglers in the harbor. A variety of birds, amphibians, reptiles, and mammals have been identified and/or are expected to occur in the vicinity of Sheboygan County. The harbor area is situated within the Mississippi flyway for waterfowl. Waterfowl use of the harbor area peaks in the fall and spring with the migration of Canada geese and a variety of dabbling and diving ducks. During the summer months the harbor area has resident populations of oldsquaw and goldeneye ducks and numerous gull species.

Milwaukee Harbor, Wisconsin - Milwaukee Harbor is located on the west shore of Lake Michigan in the City of Milwaukee, approximately 85 miles north of Chicago, Illinois and 83 miles west of Grand Haven, Michigan. It is a harbor of refuge covering 3.5 miles of shoreline with main entrance in the center and breakwaters on the north and south. The harbor consists of two distinct units: the Inner Harbor including the lower reaches of the Milwaukee, Kinnickinnic, and Menomenee River channels, and the Harbor of Refuge which is formed by the breakwaters that enclose a large area in Lake Michigan.

Historically, municipal and industrial discharges to the three rivers polluted the inner harbor to the extent that it supported no significant populations of sport or commercial fish and only pollution tolerant benthos. Portions of the outer harbor were also heavily silted and contaminated with toxic substances. Milwaukee Harbor is listed by the International Joint Commission (IJC) as an Area of Concern (AOC), and is included in the Milwaukee Estuary Remedial Action Plan (RAP). Water and sediment samples from the harbor have been found to be heavily contaminated with organic chemicals such as solvents, oil and grease, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. As some contaminants tend to bioaccumulate in the food web, consumption advisories have been issued for resident and migratory fish and some waterfowl within the AOC. However, conditions in the harbor appear to be improving based on Corps sediment sampling from 1988 and 1993.

Many Lake Michigan fish enter the outer portion of the harbor, including rainbow and brown trout, and coho and chinook salmon. These fish are actively pursued by sportsmen from harbor breakwaters. Although many species of fish utilize the relatively clean near shore areas of the open lake outside the harbor for spawning, only yellow perch have been reported as spawning in the harbor. Potential spawning habitat for other species exist within the harbor but use has been restricted by water quality. As water quality improves in the rivers and streams associated with the harbor, fish are returning to these areas as well.

Mammals found in the Milwaukee Harbor area are those of an urbanized and industrialized environment. These include the eastern cottontail, raccoon, gray squirrel, Norway rat, and other small animals. Birds and particularly waterfowl are abundant and important in the area. Gulls, terns, and raptors use the harbor during the spring and fall migrations. Thousands of waterfowl also gather there each year and about 8,000 ducks (mostly diving ducks) and about 1,000 gulls overwinter at the harbor. Milwaukee Harbor is considered the most important coastal area in Wisconsin in terms of wintering waterfowl.

Calumet Harbor and River, Illinois and Indiana - Calumet Harbor and River project is primarily located within the city limits of Chicago, Illinois but most of its breakwaters, harbor navigation channels and anchorage area are located in Indiana. The Federal project consists of an outer harbor protected by a 6,714 feet long concrete capped timber crib breakwater to the north and northeast and a 5,007 feet long stone filled steel sheet pile detached to northeast. The project also includes a 29 feet deep by 3200 feet wide harbor approach channel, a 28 feet deep by 3000 feet wide outer harbor channel and anchorage area and a 27 feet deep by 290 feet wide river entrance channel. The Calumet River portion of the project consists of a 27 feet deep navigation channel that runs about 7 miles inland to Lake Calumet. The 27 deep channel also connects to the 9 feet deep Illinois Waterway Project at 130th Street. Principal commodities transported include taconite, limestone, cement, chemical fertilizer, petroleum products, grains, steel, salt and miscellaneous freight.

The Calumet River is a navigation channel that provides minimal if any native or pre-settlement habitat. Substrate consists of contaminated silts and clays. Other features include riprap, foreign debris and other navigational structures. The most common species that utilize this canal are common carp and gizzard shad.

Lake Michigan at Calumet Harbor provides somewhat better habitat than the Calumet River due to its higher water quality. Substrate consists of lacustrine sand and gravel. Natural habitat features are mostly absent. The breakwaters of the harbor provide incidental habitat for many fish and bird species. State endangered black crowned night herons have been observed feeding at dusk on the breakwaters.

The far upstream end of the navigation channel is Lake Calumet. Lake Calumet is a large locally significant wetland complex including a night haven rookery and numerous ecosystem varieties.

The terrestrial habitat at Calumet Harbor is no longer a natural system. Shore habitat consists of beaches, mowed turf, and extremely tolerant vegetation covering a slag substrate. Only common species of reptile, bird and mammal have been observed utilizing the slag substrate and the terrestrial zone of Calumet Harbor. The most common of these species being the herring gull, American crow, and the gray squirrel. The breakwaters are utilized as forage habitat by the black crowned night herons that nest approximately 3 miles to the west at Indian Ridge Marsh, Big Marsh, or Dead Stick Pond. These birds migrate to Calumet Harbor from their nesting sites every day at about dusk, from about late spring to early fall, to forage on fish.

Historically Calumet Harbor has received contaminants from Calumet River sediments, which are mixed with Lake Michigan sediments deposited by littoral drift. Metals, nutrients and PCBs have been detected in the harbor as far back as 1967. In 1981, barium, mercury and silver were detected in Calumet Harbor at higher concentrations than in Calumet River. Sediment sampling and Analysis performed in September 2000 indicated that levels of ammonia, phosphorus, cyanide and lead exceeded Illinois Water Quality Standards. Biological effects testing was also performed and indicated significant lethality in comparison to nearby reference sites. Based on these results it was determined that dredging operations, currently underway, would include sediment disposal into the Chicago CDF, rather than into open water or as beach nourishment. Contaminant sampling and testing performed in Calumet Harbor were presumably conducted at surface levels down to the designed dredging depth. Contaminant concentrations below those depths are not known, but may be presumed to contain similar constituents.

All the material dredged from the Harbor and river requires containment in the CDF (or equal landfill). The Chicago District is charging $12.50 per cubic yard for material from outside the federal channel. With the fiscal year 2002 and 2003 dredging, the CDF will be approaching 60 percent full. The likelihood of building another CDF is small. The only space available in the harbor on the Illinois side is adjacent to the new linear park along the lakefront. Another space that is available in the harbor is on the Indiana side. Management of the material within the CDF is starting to become an issue and funding for studies to find and develop beneficial uses, mining the material for some other purpose, processing to isolate and remove the uncontaminated fraction or to expand the facility has been budgeted but not funded.

Indiana Harbor, Indiana - Indiana Harbor is located on the southwest shore of Lake Michigan in East Chicago, Indiana about 6 miles southeast of Calumet Harbor and 19 miles southeast of Chicago Harbor. The project consists of 2,324 feet long concrete capped breakwater with a 201 feet long rubblemound extension to the east and a 1,120 feet long rubblemound breakwater to the north. The project also includes a 29 feet deep by 800 feet wide lake approach channel, a 28 feet deep anchorage and maneuvering basin, 27 feet deep by 280 feet wide harbor entrance channel 22 feet deep canal channel and two 22 feet deep branch channels. Principal commodities transported include iron ore, limestone, steel, petroleum products and miscellaneous bulk products.

The aquatic habitat only consists of the channels and breakwaters that make up the harbor. Substrate consists of contaminated sands and silts. The most common species of fish is the common carp. Flocks of double crested cormorants were observed in the spring of 2001. This once threatened species is making a strong come back; however, unknown impacts to these birds may lurk in the future if they continue to consume fish from Indiana Harbor. Recently other shoreline and wading birds (e.g. Great Blue Heron) have been seen on the canal and canal extensions. No longer occur at Indiana Harbor due to historical filling. Terrestrial habitat is also non-existent. The uplands consist of fill with steel mills, scrap yards, petroleum refinery and terminals, and bulk commodity facilities.

Indiana Harbor and Canal is within the general range of the Federally listed endangered Indiana bat, and the threatened pitcher’s thistle. Two pairs of peregrine falcons were observed successfully nesting in the proposed CDF site.

Sediments in the harbor and canal are mostly silt and clay with some sand. The bulk chemistry from discrete sediment sampling events consistently shows high levels of metals, nutrients, oil, grease, and volatile solids. Sampling of the harbor and canal in 1979 and 1983 detected PCB's in concentrations between 1 and 90 parts per million. The highest PCB concentrations were detected in the deeper sediment layers in the upstream portion of the Grand Calumet River Branch and along the north bank of the main channel.

The State of Indiana has designated the Indiana Harbor and Canal as industrial water supply, warm water aquatic life waters. These waterways have a history of water quality problems and have been identified by the Inter-national Joint Commission on the Great Lakes as an AOC.

The bottom sediments in the Indiana Harbor are contaminated and not suitable for open water disposal in Lake Michigan, nor are they suitable for unconfined upland disposal. No beneficial use has been identified. Consequently, dredging to maintain adequate navigation depths has not been conducted since 1972. A comprehensive management plan for Indiana Harbor and Canal maintenance dredging and disposal activities was completed in September 1998. The selected plan included construction of a confined disposal facility (CDF). The plan further provides for maintenance dredging of polluted channel sediments, except for the presumptively hazardous sediments in the outer harbor, with disposal of the dredged material in the CDF. Dredging would be undertaken throughout the Federal navigation project to authorized project depths and widths. The construction of the CDF is scheduled to be initiated in fiscal year 2002 and is scheduled to be completed in 2004. Maintenance dredging to current authorized project depths is scheduled to be completed in 2010. Maintenance dredging will continue to use the CDF until it is filled to capacity and capped.

Buffington Harbor, Gary, Indiana - Buffington Harbor is located on the southwest shore of Lake Michigan in Gary, Indiana about 1 mile east of Indiana Harbor. The project is not a Federal maintained Harbor. Buffington Harbor's aquatic habitat consists of man made breakwaters. The most common fish species collected here is the smallmouth bass. Strange occurrences of the banded killifish and bigmouth buffalo are also documented with voucher specimens from this harbor.
No wetlands currently occur at Buffington Harbor due to historical filling. The harbor is within the general range of the Federally listed endangered Indiana bat, and the threatened pitcher's thistle.

Burns Waterway Harbor, Indiana - Burns Waterway Harbor is located on the southern shore of Lake Michigan about 22 miles southeast of Calumet Harbor in Porter County, Indiana. The nearest community is Ogden Dunes, IN, a residential community approximately 1 mile west of the harbor complex. The project consists of 2,400 feet of non-federal steel sheet-pile breakwater to the west connected to 5,830 feet of federally constructed rubblemound breakwaters to the west and north. The harbor also includes a 30 feet deep by 400 feet wide approach channel, a 28 feet deep outer harbor basin and two 27 feet deep by 620 feet wide harbor arms to the east and west. Principal commodities transported include iron ore, limestone, coal and coke.

In 1998 the Chicago District completed a submerged breakwater/reef immediately north of the north breakwater at Burns Harbor in Portage, IN. This reef will act as a vital tract of habitat due to the need of submerged rocky habitat for lake trout to spawn. Not only will lake trout utilize this structure, but also a great diversity of fish that includes stocked salmonids, mottled sculpin, smallmouth bass, rock bass and yellow perch. The total length of the reef is about ¾ mile and has created about 14.8 acres of open water fishing space.

Natural aquatic habitat is generally absent in the Federal Channel at Burns Waterway Harbor. The Indiana Department of Natural Resources (IDNR) stocks coho, Chinook salmon, rainbow trout and brown trout during the spring and winter in Burns Ditch that is located less than a mile east of Burns Harbor. These anadromous species return during the summer and fall to spawn. These spawning runs support a recreational fishery and adults are captured by the IDNR as broodstock for next year's fingerlings. Natural and stocked lake trout are also present in Burns Harbor during their spawning season in the winter months.

Remnants of the original lakeshore beach and dune communities exist near Burns Harbor. Isolated areas of oak-hickory forest are still present inland of the Harbor in parks, but have largely succumbed to urban development. The loss of fire as a natural regulator has resulted in the alteration of the native meadow communities. Due to the extensive commercial and residential development of the Burns Harbor area, there is no undisturbed natural vegetation at the Federal navigation project.

Burns Harbor is in the Mississippi waterfowl flyway and as many as 17 waterfowl species utilize the harbor area for resting and feeding during migration. The birds primarily remain on the open lake or nearby beaches, moving into the harbor only during storms. Several species remain through the winter if open water is available. Some raptor species occur near Burns Harbor particularly during the spring and fall migrations. These birds primarily use the Indiana Dunes National Lakeshore west of the harbor and are not commonly seen at the Federal navigation project. Other water-associated birds such as gulls, terns, spotted sandpiper, plovers, and Virginia rails are common in the project area; songbirds do not use the harbor extensively.

Burns Waterway Harbor is within the range of the Federally listed Indiana bat, Karner's blue butterfly, the bald eagle, and the dune thistle. There is no habitat available for the Indiana Bat at the harbor. Bald eagles are occasional winter visitors to the shoreline of Lake Michigan and at times may be observed in the general project area. Karner's blue butterflies are known on the Indiana Dunes National Lakeshore property west of Burns Waterway and south of Ogden Dunes, but they are not within the harbor areas. The dune thistle is present on the high dunes immediately west of Burns Waterway and south of the beach at Ogden Dunes; this species would not be affected.

Burns Harbor is contiguous with Lake Michigan and not served by any tributaries. Lake Michigan water is of high quality, with levels of pollutants generally below state standards. The sediment if the harbor consists of a very fine silt-like material mixed with sand. Sediments from immediately outside the harbor near the shoreline were clean medium sand typical of lakeshore deposits. The sediment is slightly contaminated with ammonia.

The preliminary assessment Dredge Material Management Plan is being prepared. Most of the material is suitable for open water disposal in Lake Michigan. If the grain size is sufficiently large, the material is beneficially used for beach nourishment. In the past ammonia concentrations have been slightly elevated. The concentrations have met the criteria for open water disposal under the Clean Water Act, but not for Indiana law and regulations. In these instances, special handling of the dredging operations has allowed the material to be placed in the open water with the increased costs borne by the State of Indiana. If, in the future, upland or contained disposal is required, the Indiana Port Commission is required under the terms of the Project Cooperation Agreement to provide all lands, easements, rights-of-way, relocations and dikes. Because of the nature of the Harbor and lack of any apparent sources of contamination, this risk is very small.

Saugatuck Harbor, Michigan - Saugatuck Harbor is located on the eastern shore of Lake Michigan, 90 miles northeast of Chicago, Illinois, and 35 miles southwest of Grand Rapids, Michigan. The Federal project extends from about 2 miles up the Kalamazoo River to about 800 ft into Lake Michigan. The project depth of 14 to 16 feet is posing a problem for the increasing number of cruise ship visits the harbor is experiencing. The harbor and lower Kalamazoo River are bordered by a lakeshore sand dune community comprised of various dune grasses and deciduous trees. Wind and pedestrian traffic contribute to erosion resulting in the sparsely vegetated character of the sand dunes. Areas of shoreline adjacent to this project have been designated Critical Dune areas under the Michigan Sand Dune Act. No large industrial developments exist in the Saugatuck Harbor or in the upstream reaches of the Kalamazoo River.

Water quality in the river and harbor has been historically good as would be expected considering the lack of industrial development. Sediment sampling and testing carried out by the Corps over the last 20 years indicate the sediments are best described as fine-grained sand. This material was found to contain low concentrations of nutrients, metals, and chlorinated organics. Although the Kalamazoo River is listed by the International Joint Commission as an Area of Concern (AOC), the contaminated section is a considerable distance upstream of the project area and it does not appear that the PCBs present in the AOC are effecting the harbor.

Lake Michigan and its tributaries commonly support fish species such as yellow perch, smallmouth bass, walleye, lake trout, brown trout, and several species of Pacific salmon. The Kalamazoo River supports spawning populations of lake sturgeon, gizzard shad, rainbow trout, slimy sculpin, troutperch, yellow perch, walleye, and lake trout. Selected game fish are stocked in the river by the Michigan Department of Natural Resources in support of the local sport fishery.

Wildlife in the area generally includes species that can adapt to human disturbance. Amphibians and turtles are likely to occur in slack water areas along the river such as coves or wetlands. Lizards and snakes would be expected in more upland areas adjacent to the river. The most common mammals would likely include small rodents, squirrels, rabbits and white tailed deer. Birds common in the area include shorebirds and gulls, pigeon and doves, various passerine birds, and waterfowl. Federally listed species known to exist in Allegan County are the Karner blue butterfly (*Lycaeides idas nabokovi*) and the Pitcher’s thistle (*Cirsium pitcheri*).

Lake Huron Harbors

Alpena Harbor, Michigan - Alpena Harbor is located at the mouth of the Thunder Bay River on the northwest shore of Thunder Bay, Lake Huron, about 100 miles southeast of Cheboygan Harbor, Michigan, and 230 miles north of Detroit, Michigan. The Federal project provides a 21 ft deep entrance channel about 7,500 feet long, and an 18.5 ft. deep river channel about 4,600 feet long, that support several commercial docks along the Thunder Bay River. These docks are primarily used for the transfer of coal, petroleum products, salt, and bulk cement. The harbor also contains a municipal marina basin about 0.25 miles southwest of the river mouth.

The cool, deep waters of Thunder Bay and Lake Huron provide a moderately diversified range of fishery habitat. The sports catch is dominated by yellow perch, and other panfish such as smallmouth bass, and bluegill. In addition, planted salmonids including brown trout, steelhead, chinook salmon, coho, and lake trout are found in the area. Other fishes present include gar, bowfin, burbot, suckers, carp, smelt and alewife. In the Thunder Bay drainage basin, many mammal and bird species reside. The inhabitants of this typical northern community include white-tailed deer, woodcock, rabbit, grouse, squirrel, beaver, and skunk. Representing the reptiles and amphibians are snakes, turtles, frogs, toads and salamanders. Ducks periodically inhabit the areas adjacent to the waterway for nesting or during migration periods. There are presently no Federally-listed endangered, threatened or proposed species in the project area.

Water and sediment conditions at Alpena are generally good. Human activities have resulted in contamination of both water and sediment in the past but conditions have been improving since the early 1970's. Bulk analysis of sediment samples take in 1995 indicate sediments are now likely to be suitable for unrestricted placement. Historically dredged material has been placed in two open water sites in Thunder Bay. Although continued use of these sites may be ecologically acceptable, the sites are part of a Michigan Bottomland Preserve and future placement there may be problematic.

Saginaw Harbor, Michigan - Saginaw Bay is a shallow inland projection of Lake Huron, approximately 51 miles long by 26 miles wide, with a surface area of 1,143 square miles. The Saginaw River is approximately 22 miles long, averages about 600 feet in width and, with its tributaries, drain approximately 6,200 square miles of land. The highly industrialized communities of Bay City and Saginaw are located along the Saginaw River. The navigation system extends from the river mouth 14 miles into Saginaw Bay and 22 miles up the Saginaw River. Project depths range from 26 feet in the bay to 16.5 feet at the head of navigation.

Water quality in the Saginaw Bay and River is degraded from wastewater, industrial discharges, agricultural runoff, and contaminated sediments. Agricultural runoff contributes to turbidity, siltation, and nutrient buildup (which cause algae blooms) in the bay, thus reducing water clarity and contributing to oxygen depletion. Recent reductions in point source discharges have resulted in water quality improvements.

The Saginaw River and Bay is a Great Lakes Area of Concern (AOC) for remediation of impaired uses of water resources. The Remedial Action Plan for this AOC discusses two impaired uses: human fish consumption and the suitability of the aquatic environment for plant and animal populations. Fish consumption advisories are in effect for certain species (particularly bottom dwelling species), owing to contaminant levels in fish tissues. Population diversity of plants and animals in the AOC is limited by the degraded water quality.

In 1994, the COE sampled sediments at 7 stations in the lower river and 17 stations in the bay navigation channels. Analytical results from these samples show silty and sandy materials with metals concentrations that are moderately elevated with respect to background levels in the surrounding Saginaw Bay sediments and upland areas. PCBs, formerly elevated in the navigation channel sediments, were not detected at detection limits below 0.16 mg/kg (parts-per-million).

The Saginaw Bay and River area contains abundant fish and wildlife habitat, including refuges and game areas, over 40,000 acres of marsh along the bay shore, extensive beds of aquatic vegetation in shallow areas of the bay, and several wetland areas along the river. This habitat supports a variety of fish and waterfowl species. The lowlands around the bay and river also support many small mammals. This abundance of habitat provides many opportunities for hunting and fishing.

Degraded environmental conditions in the Saginaw River and Bay Watershed have impacted fish and wildlife populations. Contaminant levels in Saginaw Bay fish likely are impacting wildlife that feed on these fish. One of the long-term goals of the Saginaw River/Bay Remedial Action Plan is to "Reduce toxic material levels in fish tissue so that there are no adverse impacts on piscivorous [fish eating] wildlife..." (MDNR 1994b).

The confined disposal area located near the mouth of the Saginaw River is a popular nesting site for a variety of shorebirds, gulls, and terns (order Charadriiformes). Among the species found there are ring-billed gulls (*Larus delawarenses*), herring gulls (*Larus argentatus*), black-crowned night herons (*Nycticorax nycticorax*), great egrets (*Casmerodius albus*), Caspian terns (*Sterna caspia*), and common terns (*Sterna hirundo*). A variety of waterfowl (order Anseriformes), primarily ducks and geese, have been observed using the island. Deer, toads, and small snakes have also been observed on the island.

The U.S. Fish and Wildlife Service (FWS) has indicated that there is an active bald eagle (*Haliaeetus leucocephalus*) nest within 2.5 miles of the Saginaw Bay island CDF, and that piping plover (*Charadrius melodus*) have recently been sighted along the shores of southern Saginaw Bay. Both bald eagles and piping plovers are Federally listed species. The Michigan Department of Natural Resources (MDNR), Wildlife Division, has indicated that the following state-listed species are known to occur on or near the CDF and therefore potentially could be impacted by activities in the area: Forester's tern (*Sterna forsteri*), listed as a species of special concern; Caspian tern, threatened; common tern, threatened; and black-crowned night heron, special concern.

Lake Erie Harbors

Rouge River, Michigan - The Rouge River originates in Oakland and Washtenaw Counties and flows 30 miles southeast through Wayne County joining the Detroit River about halfway between Lake St. Clair and Lake Erie at the Detroit City limits. The drainage system consists of three branches (Upper, Middle, and Lower Rouge) which combine to form the main stem of the Rouge about 9 miles upstream of the mouth. The main stem discharges into the Detroit River through an artificial waterway known as the Short-Cut Canal. About 3,000 feet long, it was constructed in 1886, and bypasses the Old Channel which is about 1.5 miles long and intersects the Detroit River about 1 mile upstream of the Short-Cut Canal. The navigation channel extends from the Detroit River through both the Old Channel and the Short-Cut Canal and up the main stem for an additional 2.5

miles. Project depths in the navigation channel range from 25 feet near the Detroit River to 21 feet upstream.

More than 60 species of fish are thought to be native to the Rouge River Basin and at least 53 species are present now. Game fish do not generally thrive in the system due to human influences on the system including degraded water quality from industrial and domestic sources, sedimentation and erosion, stream channelization, and habitat destruction. Highly variable stream flows make the Rouge River very unstable and further limit biological and recreational uses. The watershed is dominated by urban and suburban development that is responsible for much of this flow variability.

Water and sediment quality are major impediments to overall river health. The Rouge River is listed as an AOC by the International Joint Commission. The Lower Rouge River and the main stem between there and the Detroit River are the most contaminated. Water quality in the main stem is reported as poor by the MDNR due to periodically low dissolved oxygen levels and large volumes of combined sewer overflow (5 billion gallons per year). Water temperatures are high during the summer and water clarity poor. The state has designated the lower 5.5 miles of the main stem as a site of environmental contamination because of pollutants such as lead, cyanide, barium, copper, zinc, and several organic chemicals. Material dredged from the Federal channel routinely requires placement in a confined disposal facility. Fish consumption advisories are in effect for portions of the main stem.

The area adjacent to the Federal navigation project is highly developed and offers little habitat of any kind. Industrial development of shoreline areas has eliminated almost all riparian habitat. Channelization and contamination of the lower 3 to 4 miles of the river has resulted in the loss of virtually all high quality aquatic habitat in this portion of the Rouge. The use of the area by fish, wildlife, and birds is greatly limited by the current conditions.

Monroe Harbor, Michigan - Monroe Harbor is located at the western end of Lake Erie within the mouth of the Raisin River. It is about 36 miles south of Detroit, Michigan, and 14 miles north of Toledo, Ohio. The harbor project provides a channel, 21 feet deep and 16,000 feet long extending from the River Raisin mouth out into Lake Erie. It also includes a 21-foot channel and turning basin extending upstream about 8,500 feet, and a 9-foot channel extending another 3,800 feet. It also provides for two parallel jetties into Lake Erie at the river mouth. Deepening of the harbor has been previously authorized but for various reasons never completed.

Shore types in the River Raisin and Monroe Harbor area are either artificial fill or marshlands. In the general vicinity there are publicly owned recreational areas and marshlands, as well as concentrations of heavy industry. Many industries are located near the river mouth. Much of the upland area near the river mouth was created from former marshland by filling with municipal and industrial waste. The River Raisin is listed by the International Joint Commission (IJC) as an Area of Concern based on sediment contamination and subsequent degradation of the benthic community. Corps of Engineers sediment samples taken from the navigation channel in 2000 suggest that PCB levels are declining and are often below detection, but arsenic and barium levels remain elevated. The lake water near the harbor is often turbid, primarily due to the resuspension of solids. Turbidity is found to be greatest during spring and fall when wind velocity is high, causing strong wave action and sediment roiling in the shallow waters. Water clarity and quality have been gradually improving with improved runoff controls and changes in the establishment of the zebra mussel.

The flora of the western shore areas of Lake Erie is affected by man-induced contributions of nutrients. The types and numbers of primary producers are also affected by turbidity caused by wave and current action. Reduced light penetration, together with shifting unstable bottom sediments, often prevent the propagation of attached algae and rooted plants. An unattached, planktonic algal community therefore becomes abundant. Emergent vegetation found in protected parts of the project area is dominated by cattails. Other plants common to the marshes are sago pondweed, floating leaf pondwee4, arrowhead, softstem bullrush, and various rushes and sedges.

Fish populations just offshore of the mouth of the River Raisin exhibit moderate diversity. More than 20 species are known to inhabit this area of the lake. The river, however, exhibits reduced diversity due to degraded water quality. The eight main species in the harbor area are: yellow perch, white bass, goldfish, carp, alewives, gizzard shad, spottail shiner, and emerald shiner. Carp, goldfish, and perch are generally most common in the area. Recent reports, however, indicate that white bass and walleye are becoming increasingly common. The lower part of the River Raisin is considered top quality warm water fish habitat. However, fish movement up and down the river is significantly impacted by the cooling water intake of the local power plant. This facility withdraws approximately 4 times the average discharge of the river at a point about a mile upstream of the mouth.

Commercial fishing was once very intensive in the western basin of Lake Erie but has declined drastically with the loss of high value species such as cisco and whitefish. The decline of the walleye plus the discovery of toxic uptake in Lake Erie fish has also hurt the fishing industry. A consumption advisory has been issued for the area for carp and white bass.

Observations made in lake waters adjacent to the City of Monroe have revealed intensive waterfowl use at certain times of day and season. This is primarily because of the location of the basin along major migratory routes. Ducks not only use this region as a resting area, but some over winter in Monroe wetlands as well. Over wintering capability depends mainly upon availability of food and open water. Six major duck species found in the Monroe area during the fall migratory season include': common merganser, black duck, lesser scaup, ruddy duck, common goldeneye, and American widgeon. Large concentrations of canvasbacks utilize the area as a feeding ground during the spring and fall migration period. Waterfowl are not the only water-oriented birds found in such abundance in the region. Many species of marsh and shorebirds are often observed in the Erie marshlands. Among these ate coots, gallinules, pied-billed grebes, great blue herons, American egrets, black crowned night herons, doubled-crested cormorants, herring gulls, and spotted sandpipers.

The surrounding urban and wetland areas have such common mammals as the red fox, raccoon, woodchuck, and muskrat. The opossum, skunk, and weasel have also been occasionally observed. Threatened or endangered species, which may occasionally be found in the Monroe Harbor area include the bald eagle. In addition, two endangered mollusks, *Simpsoniconcha ambigua* and *Obovaria leibii* have been known to exist in the western end of Lake Erie.

Toledo Harbor, Ohio - Toledo Harbor is located at the southwestern corner of Lake Erie on Maumee Bay at the mouth of the Maumee River 42 miles south of Detroit, MI. The Maumee has the largest drainage of any of the Great Lakes rivers. The existing project was authorized by the 1899, 1910, 1935, 1950, 1954, 1958, and 1960 Rivers and Harbors Acts as a deep-draft commercial harbor. The Toledo Harbor consists of: a lake entrance channel 28 feet deep from deep water in Lake Erie to the mouth of Maumee River, a distance of approximately 18 miles; a navigation channel in the river 27 feet deep from mile 0 to mile 6.5; thence a channel 25 feet deep to the upper limit of project, mile 7; a turning basin opposite American Shipbuilding docks (mile 2.7) 20 feet deep; a turning basin just upstream from mile 6.5, 27 feet deep; and a turning basin 18 feet deep and 8.25 acres in area at upper project limit. Commercial commodities handled through the port consists of stone, coal, petroleum products, iron ore, grain, fertilizers, iron products, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified ten beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) fish tumors or other deformities, 4) degradation of benthos, 5) restrictions on dredging activities, 6) eutrophication or undesirable algae, 7) restrictions on drinking water consumption, or taste and odor, 8) beach closings, 9) degradation of aesthetics, and 10) loss of fish and wildlife habitat. These environmental problems are caused by toxic substances (heavy metals, polychlorinated biphenyls), habitat modification (channelization), bacterial contamination, cultural eutrophication (nutrient enrichment) and landfill leachate. Sources of these pollutants include urban stormwater runoff, commercial and residential development, municipal and industrial discharges, combined sewer overflow CSOs), sanitary sewer overflows, wastewater treatment plant bypass, hazardous waste disposal sites and agricultural runoff. The most significant bird deformities have been noticed in bald eagles that feed on fish from the area. Reproductive problems and deformities, such as crossed bills, have been linked to the bioaccumulation of PCBs that work their way up the food chain. The RAP has recommended that open-lake disposal be phased out completely.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. A large portion of the Lake Erie walleye population is supplied by Maumee Bay and the Maumee River. Threatened and endangered species know to use the area or have a range overlapping the area are Lake Erie water snake, Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout should not be eaten more than one meal every two months. The following advisories apply to the

Maumee River: channel catfish should not be eaten, carp and smallmouth bass should not be eaten more than one meal per month; and freshwater drum and largemouth bass one meal per week.

Sediment testing was performed in 1994, 1995, 1996, and 2000. Historically, the dredged river sediments and the harbor sediments out to Lake Mile 2 have been disposed in a CDF. This is partly because of the contaminated nature of the sediments and because of economical reasons. The current CDF is located around Lake Mile 2. CDF disposal was then extended out to Lake Mile 5 because of the contaminated nature of the sediments. Dredged sediments from Lake Mile 5 out have been open-lake disposed. The Ohio EPA stand is to eliminate open-lake disposal, although there is an agreement to allow Toledo sediments dredged from Lake Mile 2 outward to be open-lake disposed. Recent chemical and biological testing show these sediments to be comparable with the open-lake sediments. Testing of sediments from Lake 2 to Lake Mile 5 show that they are comparable and compatible with the lake sediments. The river sediments have become cleaner over the past years. The highest concentration of contaminants exists from about River Mile 1 to Lake Mile 2. The general problem is with metals and PAHs.

Currently all material dredged from river mile 7 to lake mile 5 is confined in a 140 acre CDF located on east side of the mouth of the Maumee River. Material from lake mile 5 lakeward is disposed of at an open-lake disposal area of one square mile at a depth of 20 to 30 feet located 3 ½ miles northeast of the harbor. Ohio EPA currently has a position of no open-lake disposal in the western basin of Lake Erie. The current CDF will be filled in three years. For future expansion of the harbor there will be a disposal problem and new sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

<u>Sandusky Harbor, Ohio</u> – Sandusky Harbor is located on the southeasterly shore of Sandusky Bay off of Lake Erie 55 miles west of Cleveland, OH and 52 miles east of Toledo, OH. The existing project was authorized by the 1988, 1902, 1919, 1927, 1935, 1945, and 1960 Rivers and Harbors Acts as a deep-draft commercial /recreational harbor. The Sandusky Harbor complex as completed in 1965 consists of: Moseley channel (entrance to Sandusky Bay) 26 feet deep from deep water in Lake Erie to the outer (northerly) end of the Straight Channel, a total distance of 2.1 miles; the Straight Channel 25 feet deep from its junction with the Moseley Channel to its junction with the Bay channel, a distance of one mile, then 21 feet deep to its terminus at the Dock Channel adjacent to the City waterfront docks, a distance of 4,300 feet; Dock Channel along the waterfront 5,700 feet long and 22 feet deep; a turning basin about 46 acres in area, 24 feet deep at the western end; Bay Channel extending 1,300 feet northward from the northerly limit of the turning basin, 24 feet deep, then 25 feet deep for 1,100 feet through Sandusky Bay for 7,950 feet to a junction with the Straight channel, 25 feet deep. Commercial commodities handled through the port consists of stone, coal, and miscellaneous other products.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. A large portion of the Lake Erie walleye population is supplied by Sandusky Bay and the Sandusky River.

Threatened or endangered species know to use the area or have a range overlapping the area are Lake Erie water snake, Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout should not be eaten more than one meal every two months. The following advisories apply to the Sandusky River: carp should not be eaten more than one meal per week; and channel catfish and largemouth bass one meal per month.

Sediment testing has been performed in 1990, 1996, and 2000. Sandusky Harbor is a fairly clean harbor with no problems with open-lake disposal. PCBs and pesticides have not been measured above the detection limits or estimated at concentrations below the detection limits. Metal concentrations are generally lower than those found in the reference sediments, but elevated levels of arsenic, barium and copper have been detected. Arsenic levels are not high for weathering shales and the lake as a whole, but are elevated above those found just outside of Sandusky Bay. The higher barium levels are of no consequence. Copper levels are higher, but the levels can be considered comparable and compatible with the open-lake sediments. Total PAH levels are generally less than the reference range or are comparable with them. The higher levels tend to be along the city dock area with one site's totals reaching 5.5 ppm.

All dredged material is disposed of at an open-lake site that is two square miles in area in 40 to 45 feet water 3 ½ miles north northeast of the end of the east pier at the entrance of Sandusky bay to Lake Erie at Cedar Point. Expansion dredged sediments can be disposed of at the open-lake disposal area. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Huron Harbor, Ohio - Huron Harbor is located on the southern shore of Lake Erie at the mouth of the Huron River, 47 miles west of Cleveland, OH and 68 miles east of Toledo, OH. The existing project was authorized by the 1905, 1919, 1935, and 1962 Rivers and Harbors Acts as a deep-draft commercial harbor. The harbor area consists of: a lake approach channel 29 feet deep and about 7,000 feet long from deep water in the lake to a point opposite the outer end of east breakwater; an entrance channel 1,900 feet long, 28 feet deep; a river channel 1,500 feet long, 27 feet deep; and a turning basin in the Huron River at the upstream limit of deep-draft navigation with a least width of 750 feet, and a depth, westerly of the river channel of 21 feet. Commercial commodities handled through the port consists of limestone, iron ore, and miscellaneous other products. This area is not designated as an Area of Concern (AOC) and there is no Remedial Action Plan (RAP).

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. Threatened or endangered species know to use the area or have a range overlapping the area are Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout eat one meal every two months. The following advisories apply to the Huron River: freshwater drum should not be eaten more than one meal per month.

Sediment testing has been performed in 1986, 1991, 1996, and 2000. Huron Harbor is a clean harbor as far as contaminated sediments go with no problems with open-lake disposal. No PCBs or pesticides have been measured above the detection limits or estimated at concentrations below the detection limits. All metal concentrations were measured at levels below those found in the lake reference sediments, except for arsenic levels. The measured river and harbor values may be considered elevated above the lake levels, but are consistent with values found in sediments from weathering shales. Total PAH levels are below or slightly above those found for the lake with values for total PAHs approaching 1 ppm.

All dredged material is disposed of at an open-lake site one mile square at 30 feet deep, 3 miles north of the harbor. A CDF 63 acres in size is located adjacent to the western side of the west pier. Currently this CDF is not being used. Expansion dredged sediments could be disposed of in the CDF or open-lake. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples. Future bioassay may be needed.

<u>Lorain Harbor, Ohio</u> - Lorain Harbor is located on the southern shore of Lake Erie at the mouth of the Black River, 25 miles west of Cleveland, Ohio and 90 miles east of Toledo, Ohio. The existing project was authorized by the 1899, 1907, 1910, 1917, 1930, 1935, 1945, 1960, and 1965 Rivers and Harbors Acts as a deep-draft commercial harbor and Section 107 of the 1960 River and Harbor Act, as amended on 12 March 1986, authorized construction of a small boat harbor. The harbor complex as completed in 1974 includes: an outer harbor about 60 acres in area formed by converging rubblemound breakwaters; a lake approach channel with a depth of 29 feet in soft material and 30 feet in hard material; a maintained depth of 28 feet through the outer harbor to a point 2,200 feet above west pier light; a depth of 25 feet in the remaining portions of outer harbor; a channel in the Black River with a depth of 27 feet from a point 2,200 feet above West Pier Light to a point 500 feet below upstream limit of Federal project; and various turning basins. Commercial commodities handled

through the port consists of stone, sand, and gravel products, iron ore, coal, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified ten beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) fish tumors or other deformities, 4) degradation of benthos, 5) restrictions on dredging activities, 6) eutrophication or undesirable algae, 7) restrictions on drinking water consumption, or taste and odor, 8) beach closings, 9) degradation of aesthetics, and 10) loss of fish and wildlife habitat. The contaminant of concern is PAHs. The Black River mainstem and the lake near-shore areas have a history of fish tumors and other deformities. The health advisories are based on the high incidence of liver and lip cancers found in fish, particularly the brown bullhead. Following removal of the most highly contaminated sediments in 1990, the incidence of tumors has decreased dramatically. Waterfowl may become contaminated while feeding in areas of concentrated contaminants. The restrictions on dredging activities involve the placement of dredged material in a CDF or landfill. Beaches in the area have been periodically closed.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. Threatened or endangered species known to use the area or have a range overlapping the area are Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout should not be eaten more than one meal every two months. The following advisories apply to the Black River: carp should not be eaten more than one meal per month; freshwater drum and brown bullhead no more than one meal per week.

Sediment testing has been performed in 1988, 1993, 1998, 2000, and 2001. Most metal concentrations in the harbor sediments were found to be compatible with the open-lake reference sediments. Cadmium, copper, and nickel concentrations were found to be elevated. In the Black River sediments, cadmium, chromium, copper, lead, mercury, and zinc levels are elevated. Biological toxicity testing using *Hyalella azteca* and *Chironomus tentans* show no adverse toxicity for the sediments. Total PAH levels for the harbor are below 5 ppm but still higher than reference values. PAH bioaccumulation studies were preformed for the harbor sediments. Results show that the PAHs at the levels found do not bioaccumulate. The river total PAH levels were found to be higher, up to 6 ppm, except the upper end of the Federal navigation channel that had 16 ppm.

Bioaccumulation studies are being preformed on the river sediments. It is hoped that in the future that at least the harbor sediments and possibly part of the river sediments could be open-lake disposed.

All dredged material is disposed of in a CDF located adjacent to the east breakwater shoreline and is 58 acres in area. Currently this CDF is full and studies are under way to expand the CDF upwards and possibly starting to dispose some of the material at an existing old open-lake disposal area. It appears that the dredged sediments have become cleaner over the years. There may be a future problem with dredged sediment disposal for this harbor. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples. Future bioassay may be needed.

Cleveland Harbor, Ohio - Cleveland Harbor is located on the southern shore of Lake Erie at the mouth of the Cuyahoga River 191 miles southwest of Buffalo, NY and 110 miles east of Toledo, Ohio. The existing project was authorized by the 1875, 1886, 1888, 1896, 1899, 1902, 1907, 1910, 1916, 1917, 1935, 1937, 1945, 1946, 1958, 1960, and 1962 Rivers and Harbors Acts, the 1976 and 1986 Water Resources Development Acts, the 1985 Supplemental Appropriations Act, and the 1988 Energy and Water Appropriations Act as a deep-draft commercial harbor. The Cleveland Harbor area complex includes: a breakwater protected outer harbor area of about 1,300 acres; a 29-foot deep lake approach channel to the main entrance; an entrance channel 28 feet deep from the inner end of the lake approach through the outer harbor; a depth of from 28 feet in the west outer basin to 25 feet in parts of the east outer basin; a depth of 27 feet in the lower Cuyahoga River to above the junction with the Old River; a depth of 23 feet in the Cuyahoga up to about mile 5.8; a depth of 27 feet in the Old River; an east entrance channel at a depth of 31 feet and an east basin channel at a depth of 27 feet. Commercial commodities handled through the port consists of stone, coal, petroleum products, iron ore, steel products, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified ten beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) fish tumors or other deformities, 4) degradation of benthos, 5) restrictions on dredging activities, 6) eutrophication or undesirable algae, 7) beach closings, 8) degradation of aesthetics, 9) degradation of phytoplankton and zooplankton populations, and 10) loss of fish and wildlife habitat. These environmental problems are caused by cultural eutrophication (nutrients), toxic substances (heavy metals, PCBs), habitat modification, bacterial contamination, and sedimentation. Sources of pollutants include municipal and industrial discharges, bank erosion, commercial/residential development, atmospheric deposition, hazardous waste disposal, urban stormwater runoff, combined sewer overflow (CSOs), and wastewater treatment plant bypasses. The lower navigation channel in the Cuyahoga has a severe oxygen depletion problem during the summer months. This is due primarily to the exertion of sediment oxygen demand compounded by the dredged, bulkheaded morphology of this river segment and low summer flows. The two swimming beaches in the area have been periodically closed after storm events.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. Threatened or endangered species know to use the area or have a range overlapping the area are Lake Erie water snake, Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are herons, gulls, terns, cormorants, ducks, and geese. Increasing numbers of Great Blue Herons have been nesting in the area along with resident populations of black-crowned night herons. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout eat one meal every two months. The following advisories apply to the Cuyahoga River: white sucker under 11 inches should not be eaten more than one meal per week; carp, largemouth, and white sucker over 11 inches should not be eaten more than one meal per month; and brown and yellow bullheads no more than one meal every two months.

Sediment testing has been performed in 1990, 1993, 1997, and 1998. Low levels of PCBs are found in the sediments throughout the area for Aroclors 1242 and 1254 up to 200 ppb. Some organics are found throughout the system at high levels, namely, DDD, DDE, DDT, Chlordane, Endrin and derivatives, and Methoxychlor. Harbor and river metal levels are generally comparable or lower than the levels found for the open-lake reference area. High levels of copper, lead, and zinc occur through the harbor and river areas along with sporadically high arsenic levels. Total PAH levels are considered relatively high throughout the river and harbor.

Currently all dredged material is confined at a couple of CDFs. CDF #14 is 88 acres in size and is located along the Lake Erie shoreline about 3,600 feet east of the Cleveland Harbor East Entrance Channel. CDF #10B is located east of the Cuyahoga River at the mouth in the Cleveland Outer Harbor along the north side of the Burke Lakefront Airport and is 68 acres in size. Sand from the upstream end of the Federal navigation channel is sometimes disposed of at a near-shore area for beach nourishment. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Fairport Harbor, Ohio - Fairport Harbor is located on the southern shore of Lake Erie at the mouth of the Grand River, 33 miles east of Cleveland, OH and 27 miles west of Ashtabula, OH. The existing project was authorized by the 1825, 1896, 1905, 1919, 1927, 1930, 1935, 1937, and 1946 Rivers and Harbors Acts as a deep-draft commercial harbor. Fairport Harbor consists of: an outer harbor 25 feet deep and about 360 acres in area formed by a system of breakwaters; a channel in Grand River, 24 feet deep, extending from the outer harbor a distance of 3,700 feet upstream from the outer end of the pier on the east side of the river; and thence with a depth of 21 feet for 4,000 feet with an 18 foot turning basin in the middle of this section. Commercial commodities handled through the port consists of stone, sand, and gravel products, limestone, and miscellaneous other products. This area is not designated as an Area of Concern (AOC) and there is no Remedial Action Plan (RAP).

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. Threatened or endangered species know to use the area or have a range overlapping the area are Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimal impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout should not be eaten more than one meal every two months. The following advisories apply to the Grand River: carp under 22 inches should not be eaten more than one meal per week; carp 22 inches and up, freshwater drum, largemouth bass, silver redhorse, walleye, smallmouth bass, and yellow bullhead no more than one meal per month.

Sediment testing was performed in 1991, 1996, and 2000. Fairport Harbor is a clean harbor as far as contaminated sediments go with no problems with open-lake disposal. No PCBs or pesticides have been measured above the detection limits or estimated at concentrations below the detection limits. All metal concentrations were measured at levels below those found in the lake reference sediments, except for arsenic. The measured river and harbor values are just above the lake levels. Total PAH levels are below those found for the lake, except at one harbor location which slightly above but still comparable with the lake sediment levels. The 2000 sampling effort tried to obtain sediment samples upstream above the Federal navigation channel for future expansion but failed because of a rocky substrate.

All dredged material is disposed of at an open-lake disposal area that is an one mile square at a depth of 50 to 60 feet 3 ½ miles north northeast of the harbor. There is a near-shore disposal area directly north of Painesville-on-the-Lake that is 320 acres in water 15 to 25 feet. There should be no problem with open-lake disposal or the near-shore area unless contaminant levels are found that are not consistent with past levels. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Ashtabula Harbor, Ohio - Ashtabula Harbor is located on the southern shore of Lake Erie at the mouth of the Ashtabula River, 55 miles east of Cleveland, OH. The existing project was authorized by the 1896, 1905, 1910, 1919, 1935, 1937, 1945, 1960, and 1965 Rivers and Harbors Acts as a deep-draft commercial harbor. The harbor as completed in 1978 consists of: an outer harbor of about 185 acres protected by breakwaters; an entrance channel 29 feet deep from Lake Erie; a channel through the outer harbor 28 feet deep; a channel from inside the inner breakwater to a point 2,000 feet upstream from the mouth of Ashtabula River, to depths of 27 feet; a deepening and enlarging of turning basin to depths of 22 feet; in the outer harbor a 700 foot-wide access channel leading southeastward from harbor channel and terminating in a basin dredged to a depth of 28 feet; a channel in Ashtabula River upstream of terminus of the lower 27-foot deep river channel, to a depth of 16 to18 feet. Commercial commodities handled through the port consists of stone, gravel, coal, limestone, iron ore, steel products and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified six beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) fish tumors or other deformities, 4) degradation of benthos, 5) restrictions on dredging activities, and 6) loss of fish and wildlife habitat. These environmental problems are caused by sedimentation, cultural eutrophication (nutrients), toxic substances (heavy metals, PCBs, chlorinated organic compounds), and habit modification (marina construction, commercial shipping). There is concentrated industrial development around Fields Brook and east of the river mouth. Sources of these contaminants include bottom sediments, municipal and industrial discharges, commercial development, hazardous waste disposal, combined sewer overflow (CSOs), Fields Brook discharge, coal handling facilities and rail yards. Mismanagement of hazardous waste has caused the river’s sediments to become contaminated degrading its biological communities. Regular dredging of much of the harbor is being prevented due to the contaminated sediments, seriously impeding both commercial and recreational navigation. Sediments in much of the Ashtabula River AOC are classified by the USEPA as “heavily polluted” due to heavy metals, PCBs, and chlorinated organic compounds, which preclude open-water disposal. Accordingly, much of the lower river has not been dredged since 1962. Disposal of the “heavily polluted” sediments, at or above 50 ppm of PCBs, is regulated under the Toxic Substances Control Act (TSCA). The TSCA material must be disposed in a confined disposal facility, for which the area stakeholders are currently developing plans. Fields Brook, which flows into the lower Ashtabula River above the Fifth Street Bridge, is a Superfund Site. Contaminants from this area include organics, PCBs, and possible radiological contamination.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. Threatened or endangered species know to use the area or have a range overlapping the area are Lake Erie water snake, Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimal impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are herons, gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout should not be eaten more than one meal every two months. The following advisories apply to the

Ashtabula River: smallmouth bass should not be eaten more than one meal per week; carp, largemouth bass and walleye should not be eaten more than one meal per month; and carp and channel catfish no more than one meal every two months. The River advisories are based on PCB and mercury levels in fish tissues. Fish studies conducted in the area have found brown bullheads to have tumors and deformities.

Sediment testing has been performed in 1989, 1990, 1992, 1993, 1995, 1998, and 2000. Dredging in the Ashtabula River is limited to the area downstream from the vicinity of the U.S. Coast Guard station. Above this area the primary contaminants are metals, PCBs, PAHs, and possibly a few organics. Recently concerns have risen concerning radiological contamination. Testing has been performed on the sediments in the designated Federal navigation channel and harbor area although river dredging is limited due to the contamination levels

Currently all material dredged from uncontaminated parts of the harbor is disposed of at an open-lake disposal site one mile square in size located 2 ¼ miles north of the harbor. Because of the contaminated nature of the sediment in the area only the harbor and lower river sediments upstream to a point about where the overhead conveyor crosses the river at the Coast Guard Station are dredged. Upstream of this point the sediments are highly contaminated with PAHs, heavy metals, and PCBs. Although there is some commercial shipping above this point to the Fifth Street Bridge, no dredging is allowed.   Because of the contaminated nature of the sediments there would be problem of sediment disposal for harbor expansion. New sediment studies would have to be conducted for expansion/deepening purposes.

Conneaut Harbor, Ohio – Conneaut Harbor is located on the southern shore of Lake Erie at the mouth of the Conneaut River in Ashtabula County, Ohio. The existing project was authorized by the 1910, 1917, 1935, and 1962 Rivers and Harbors Acts as a deep-draft commercial harbor. The harbor consists of: an outer harbor of about 142 acres in area formed by a system of breakwaters with a depth of 28 feet in the eastern portion of the outer harbor, and for a depth of 22 feet in the remaining triangular area of the outer harbor; and a depth of 27 feet in soft material and 28 feet in hard material in the inner harbor for a distance of 2,450 feet upstream of the outer end of the west pier. Commercial commodities handled through the port consists of stone, sand, and gravel products, limestone, coal, limestone, and miscellaneous other products. This area is not designated as an Area of Concern (AOC).

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye.   Threatened or endangered species know to use the area or have a range overlapping the area are Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor or running up the river for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs and heavy metals. The following consumption advisories exist on eating Lake Erie fish: chinook salmon under 19 inches, freshwater drum, smallmouth bass, and walleye should not be eaten more than one meal per week; chinook salmon over 19 inches, coho salmon, carp, steelhead trout, white bass, whitefish, and white perch should not be eaten more than one meal per month; and channel catfish over 16 inches and lake trout, one meal every two months. For Conneaut Creek, smallmouth bass should only be eaten once a month.

Sediment testing was performed in 1992, 1995, and 1997. No Pesticides or PCBs have been detected in the harbor area sediments. Low concentrations of metals have been detected and were found to be lower than or compatible and comparable with the lake reference values. Total PAHs were also found at low levels and are compatible with the open-lake sediments.

All dredged material is placed at an open-lake disposal area that is 2 ½ square miles at a depth of 40 to 60 feet 4 miles northwest of the harbor. Currently this is the only disposal area available. There should be no problem with open-lake disposal unless contaminant levels are found that are not consistent with past levels. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

<u>Erie Harbor, Pennsylvania</u> - Erie Harbor is located on Presque Isle Bay along the southeastern shore of Lake Erie, in Erie County, PA. The existing project was authorized by the 1824, 1899, 1910, 1922, 1935, 1954, 1960, and 1962 Rivers and Harbors Acts as a deep-draft commercial harbor. The harbor consists of: an entrance channel 29 feet deep, a harbor basin adjacent to the easterly ore dock, 28 feet depth; a harbor area 21 feet deep; and an additional harbor area 18 feet deep. Commercial commodities handled through the port consists of stone, sand, and gravel products, limestone, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified two beneficial use impairments including 1) fish tumors or other deformities and 2) restrictions on dredging activities. However, contaminated sediments in Erie Harbor have had no impact on the commercial shipping industry. The sediment dredged from the navigation and turning basin by the U.S. Army Corps of Engineers has consistently met the requirements for open-lake disposal. Although PAHs and a few heavy metals are present in the sediments, studies indicate sediment quality is not a significant factor in abundance or diversity of the benthos. Studies also indicate the phyto- and zooplankton communities are unaffected by water quality and the presence of contaminants in the underlying sediments. However, a study of bullheads from the bay indicated 64% had skin tumors and 22% had liver tumors. It is thought that these may be due to the PAHs in the sediments.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Erie in this area is noted as a sportsman trophy (charter and recreational) fishery for smallmouth bass and walleye. The bay has a pike and muskellunge fishery along with largemouth bass. Threatened or endangered species known to use the area or have a range overlapping the area are Indiana bat, piping plover, certain terns, and bald eagles. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the bay for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Erie fish are due to PCBs. The following consumption advisories exist on eating Lake Erie fish: freshwater drum and walleye under 23 inches should not be eaten more than one meal per week; walleye over 23 inches, coho salmon, steelhead, white perch, smallmouth bass, white bass, lake whitefish, and carp under 20 inches should be eaten only one meal per month; lake trout and channel catfish one meal every two months, and carp should not be eaten at all.

Sediment testing was performed in 1992, 1995, and 1997. Currently, dredging takes place for the lake entrance channel and the channel between the mainland and the spit. The inner bay area is rarely dredged. No PCBs have been detected in the dredged area sediments. The only pesticide detected was DDE. Concentrations were estimated at levels below the detection limits except at one bay site along the city docks that was just above the detection limit. Metal levels found in the entrance channel sediments are comparable and compatible with the open-lake reference area sediment levels. Metal values were found to be higher in the bay area, especially along the city dock area. This area had elevated levels of cadmium, chromium, copper, lead, mercury, nickel, and zinc. At this time because of the high metal levels, these sediments cannot be considered compatible with the lake sediments without biological toxicity testing. Total PAH levels for the entrance channel is consistent with the open-lake reference levels. The bay has higher PAH levels, especially along the city dock area. Here total PAH levels are found from 5 to 15 ppm. For possible open-lake disposal of these sediments, bioaccumulation studies for organics would have to be preformed.

All dredged material is currently disposed of at an open-lake disposal area one half mile on a side located 3 1/3 miles north of the harbor. A CDF does exist but is currently not being used. The CDF is located adjacent to the landward side of the south pier area and is 23 acres in size. It has been used sparingly in the past for some of the bay sediments. Currently the only sediments being dredged are those in the entrance channel. There should be no problem with open-lake disposal unless contaminant levels are found that are not consistent with past levels. There is always an option of using the CDF. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

<u>Dunkirk Harbor, New York</u> - Dunkirk Harbor is located on the southern shore of Lake Erie 40 miles southwest of Buffalo, NY and 30 miles northeast of Erie, PA. The existing project was authorized as a deep draft navigation project by the 1827, 1867, 1896, 1910, and 1945 Rivers and Harbors Acts and as small boat harbor authorized in December 1970 under provisions of Section 201 of the 1965 Flood Control Act. The harbor complex for the deep-draft navigation project as completed in 1951 consists of: an outer entrance channel with depths 17 feet in earth and 18 feet in rock, 190 feet wide just inside harbor structures flaring to 320 feet wide 600 feet lakeward; an inner entrance channel and basin with depths of 16 feet and a small boat harbor. Commercial commodities handled through the port consists of mainly of coal for a power plant and miscellaneous other products. This area is not designated as an Area of Concern (AOC).

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. This area of Lake Erie is noted as a sportsman trophy (charter and recreational) walleye and smallmouth bass fishery. A limited seasonal fishery exists for trout and salmon. Area streams are stocked annually with trout and salmon. Lake sturgeon are found in the area and are listed as a New York State threatened species. Dredging operations in the harbor would have a minimum impact on the fisheries except the fish that use the harbor as a spawning area. Dredging activities should have minimum interruption to the commercial and recreational boating traffic. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting. There are no fish consumption advisories for the area.

Sediment testing was performed in 1990, 1991, 1994, 1995, 1999,and 2000. Testing of the Dunkirk Harbor sediments have shown them to be compatible with the lake reference sediments. Other than low levels of DDD & DDE just above the detection limits found at some harbor sites and the lake reference area, no other pesticides were detected in the sediments. No PCBs were detected in the sediments. Most metal concentrations found for the harbor sediments were comparable and compatible with the lake sediments. Copper, lead, and mercury were slightly elevated at a couple of sites. PAHs were generally found to be low in concentrations, except at one location along some docks. Two other areas had total PAH levels 1 to 2 ppm above reference totals.

Sediments for the three areas in question were tested using bioassays. Toxicity tests using Hyalella azteca and Chironomus tentans show no adverse sediment toxicity. Organic bioaccumulation testing using Lumbriculus variegatus showed no bioaccumulation of PAHs. All testing indicate all sediments are suitable for open-lake disposal.

All dredged material is currently disposed of at an open-lake disposal area one half mile on a side located 1mile north of the harbor at a 50 to 60-foot depth. There currently is a study on moving the disposal a half of a mile eastward. There are also two near-shore nourishment areas identified. There should be no problem with open-lake disposal unless new contaminant levels are found that are not consistent with past levels. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

<u>Buffalo Harbor, New York</u> - Buffalo Harbor is located on the eastern shore of Lake Erie at the mouth of the Niagara River. The existing project was authorized by the 1826, 1866, 1874, 1896, 1899, 1900, 1902, 1907, 1909, 1910, 1912, 1919, 1927, 1930, 1935, 1945, 1960, and 1962 Rivers and Harbors Acts and the 1986 and 1988 Water Resources Development Acts as a deep-draft commercial harbor. As completed in 1965 the harbor consists of: an outer harbor about 4-1/2 miles long and 1,600 feet wide with depths ranging from 23 to 28 feet; a south entrance channel consisting of an outer channel 30 feet deep, an inner channel 29 feet deep, a north entrance channel 25 feet deep, and channels 22 feet deep in the Buffalo River and ship canal. Commercial commodities handled through the port consists of stone, sand, and gravel products, cement, gypsum products, petroleum products, gasoline, grain, manufactured equipment, and miscellaneous other products.

The Buffalo River is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified five beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) fish tumors or other deformities, 3) degradation of benthos, 4) restrictions on dredging activities, and 5) loss of fish and wildlife habitat. Fishing and survival of aquatic life within the AOC have been impaired by PCBs, Chlordane, and PAHs. Fish and wildlife habitats have been degraded by navigational dredging of the river and by bulkheading and other alterations of the shoreline. Low dissolved oxygen and DDT are likely causes of aquatic life degradation, but they have not yet been definitively established as such. In addition, metals and cyanides in the sediment prevent open lake disposal of bottom sediments dredged from the river. The major impairment is restrictions on fish and wildlife consumption, primarily due to PCB and Chlordane contamination. These restrictions are part of a lakewide advisory for Lake Erie. Based on measurements of benthic macroinvertebrates and toxicity tests conducted in a study in 1982 and on the presence of contaminated sediment in selected areas, certain sediments were evaluated as causing a degradation of benthos. Existing restriction on open-lake disposal of contaminated sediments from the Buffalo River cause the AOC to have a dredging restrictions use impairment. The US Army Corps of Engineers currently uses a confined disposal facility (CDF) to dispose of dredge materials. Fish tumors have been observed in the Buffalo River and are believed to be caused by PAHs in the sediments. The loss of fish and wildlife habitat, due to physical disturbances such as annual river maintenance dredging and bulkheading, has been dramatic. Degradation of fish and wildlife populations, the tainting of fish and wildlife flavor and the presence of bird or animal deformities or reproductive problems will require further investigations.

The Buffalo Harbor has a prime muskellunge fishery in June, October, and November. The other important game fish for the harbor area are pike, walleye, smallmouth and largemouth bass, yellow perch, and seasonal trout and salmon. Streams in the area are stocked annually with trout and salmon. Lake sturgeon are listed as a New York State threatened species and may be occasionally found in the harbor area. Walleye, trout, and salmon make spawning runs up the river. The lower part of the river that is part of the harbor complex has limited fishing for panfish, bass, and pike. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish using the harbor and entering the river for spawning activities. However, such dredging activities could interrupt the commercial and recreational boating traffic on the river. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting. The only fish consumption restrictions listed for the Buffalo River and Harbor advise that no carp be eaten because of concerns about PCBs.

Sediment testing was performed in 1989, 1993, and 1996. The latest sediment testing results have shown that the river and harbor sediments are cleaning up. When the sediment contaminant levels are compared to those found for an open-lake reference area, harbor and river metal and PAH levels were found to be higher. No detectable concentrations of pesticides or PCBs were found in the sediments at detectable levels. The total PAHs for the dredged area sediments for the most part ranged up to about 5 ppm with three outliers as compared to 3.4 ppm for the reference sediments. The higher PAHs were found at the upper end of the river navigation channel, in the Buffalo Ship Canal, and at a harbor bay by the NFTA Small Boat Harbor. Metal concentrations also tended to be higher at these sites. Even though some metal levels are higher than reference, they can be considered compatible with the reference sediments. Elevated metal levels that can be considered different were generally found for barium, chromium, copper, mercury, nickel, and zinc.

All dredged material is currently disposed of at Buffalo CDF #4 located immediately south of the south entrance to the Buffalo Harbor and adjacent to the Bethlehem Steel Corporation Lackawannna plant. The CDF has plenty of capacity. Even though the material is confined, new sediment studies would need to be conducted for expansion/deepening purposes to get an idea of what is put in the CDF. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Lake Ontario Harbors

Rochester Harbor, New York - Rochester Harbor is located at Rochester, New York at the mouth of the Genesee River on Lake Ontario. The existing project was authorized by the 1829, 1882, 1910, 1935, 1945, and 1960 Rivers and Harbors Acts as a deep-draft commercial harbor. As completed in 1963 the harbor consists of: the lake entrance channel at the end of the piers is maintained at a depth of 24 feet out to the lake 24-foot contour; the entrance channel between the piers is 23 feet deep; the channel from here is maintained at 21 feet for a distance of about 11,800 feet upstream; an upper turning basin adjacent to the river channel about 10 acres in area is also maintained at 21 feet. Commercial commodities handled through the port consists of stone, sand, and gravel products, cement, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has identified twelve beneficial use impairments including 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) bird or animal deformities or reproductive problems, 4) degradation of benthos, 5) restrictions on dredging activities, 6) eutrophication or undesirable algae, 7) restrictions on drinking water consumption, or taste and odor, 8) beach closings, 9) degradation of aesthetics, 10) degradation of phytoplankton and zooplankton populations, 11) added cost to agriculture and industry, and 12) loss of fish and wildlife habitat. Restrictions on dredging activities is based on the request by Monroe County and the New York State Department of Environmental Conservation that the Army Corps of Engineers restrict overflow dredging in the Rochester Harbor. Restrictions on overflow dredging are needed because of the concerns for oxygen depletion, fecal coliform, ammonia, and the resuspension of contaminants that impact the nearby public beach as well as fish and wildlife habitat. Currently the harbor is dredged by clamshell.

The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Ontario in this area is noted as a sportsman trophy (charter and recreational) fishery for chinook, coho, and Atlantic salmon along with lake, brown, and steelhead trout. The Genesee River is annually stocked with these fish. This fishery exists from early spring to the end of the year. Large fishing contests are held primarily in April and end of August with others during the summer and fall. Other fisheries exist for panfish, largemouth and smallmouth bass, yellow perch, walleye, white perch, and white bass. The US Fish and Wildlife Service is going to attempt to re-establish lake sturgeon populations in river. Lake sturgeon are listed as a New York State threatened species. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish entering the river for spawning activities. However, such activities could interrupt the commercial and recreational boating traffic. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Consumption restrictions for Lake Ontario fish are due to PCBs, Mirex, and Dioxin. Consumption restrictions for wild waterfowl are due to PCB's, Mirex, Chlordane, and DDT. The following consumption advisories exist on eating Lake Ontario fish: Lake Ontario white perch, white sucker, rainbow trout, smaller lake trout, smaller brown trout, and coho salmon over 25 inches should not be eaten more than one meal per month because of PCB, Mirex, and Dioxin concerns. Lake Ontario American eel, channel catfish, carp, lake trout over 25 inches, brown trout over 20 inches, and chinook salmon should not be eaten at all because of PCBs, Mirex, and Dioxin concerns.

Sediment testing has been performed in 1990, 1991, 1994, 1995, 1999,and 2000. The latest sediment testing results have shown that the river sediments are slowly cleaning up and are compatible with the Lake Ontario open-lake reference sediments (background). PAHs are generally below or comparable with the reference sediment levels. Two areas were identified with elevated PAHs: the upstream end of the navigation channel and at the harbor mouth between the two piers. The levels at the mouth probably come from the boating traffic. Copper and barium levels were slightly higher at some locations. Silver levels were also found high at the two sites with higher PAH levels. Toxicity testing using *Hyalella azteca* and *Chironomus tentans* show no adverse sediment toxicity. Organic bioaccumulation testing using *Lumbriculus variegatus* showed no bioaccumulation of PAHs. All testing indicate all sediments are suitable for open-lake disposal.

All dredged material is currently disposed of at an open-lake disposal area one half mile on a side located 1.5 miles northeast of the harbor. There is a study underway to move the current site. There should be no problem with open-lake disposal unless contaminant levels are found that are not consistent with past levels. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

<u>Oswego Harbor, New York</u> - Oswego Harbor is located at Oswego, New York at the mouth of the Oswego River on Lake Ontario. The existing project was authorized by the 1870, 1907, 1930, 1935, 1940, 1948, 1954, and 1962 Rivers and Harbors Acts as a deep-draft commercial harbor. As completed in 1965 the harbor consists of: an outer harbor about 280 acres in area; a 27 feet deep lake approach channel from deep water in the lake to the entrance gap in the arrowhead breakwaters; a 25 feet deep channel through the outer harbor from the entrance gap and terminating in a turning basin 25 feet deep with the rest of the harbor area being at a depth of 21 feet; the river mouth area is maintained at a depth of 24 feet from the harbor turning basin area upstream to the upstream end of the Port of Oswego Authority’s east side terminal, a distance of 1600 feet. From this point the designated depth is 21 feet upstream up to the limit of the Federal project at the north line of West Seneca Street.

The Oswego River has a large flow volume with a basin that drains the Finger Lakes region and Oneida Lake areas of New York State. The flow generally keeps the river mouth area open and does not require dredging. Commercial commodities handled through the port consists of fuel oil for a power plant, cement, coke, petroleum products, salt, and miscellaneous other products.

This area is designated as an Area of Concern (AOC) and there is a Remedial Action Plan (RAP). The RAP has confirmed four areas of beneficial use impairments including 1) restrictions on fish and wildlife consumption do to PCBs and Dioxin, 2) degradation of fish and wildlife populations, 3) eutrophication and undesirable algae, and 4) loss of fish and wildlife habitat. Seven other concerns warrant further investigations and assessments. The fish and wildlife that use the harbor area and would be affected by activities in the area would be fish and bird life. Lake Ontario in this area is noted as a sportsman trophy (charter and recreational) fishery for chinook, coho, and Atlantic salmon along with lake, brown, and steelhead trout. The Oswego River is annually stocked with salmon and trout. This fishery exists from early spring to the end of the year. Large fishing contests are held primarily in April and end of August with others during the summer and fall. Other fisheries exist for panfish, largemouth and smallmouth bass, walleye, yellow perch, white perch, and white bass. However, such activities could interrupt the commercial and recreational boating traffic. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish entering the Oswego River and using the harbor for spawning activities. However, such activities could interrupt the commercial and recreational boating traffic. Currently the river has a large flow volume and does not require dredging. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Health advisories exist on eating channel catfish. For the Oswego River upstream of the harbor area for channel catfish, no more than one meal per month should be eaten because of PCB concerns. Lake Ontario white perch, white sucker, rainbow trout, smaller lake trout, smaller brown trout, and coho salmon over 25 inches should not be eaten more than one meal per month because of PCB, Mirex, and Dioxin concerns. Lake Ontario American eel, channel catfish, carp, lake trout over 25 inches, brown trout over 20 inches, and chinook salmon should not be eaten at all because of PCBs, Mirex, and Dioxin concerns.

Harbor sediment testing was performed in 1990, 1995, and 2000. Metal and PAH concentrations were found to be elevated above those found in the lake sediments, but are considered compatible with the lake sediments for open-lake disposal. The general metals of concern were: arsenic, barium, chromium, copper, and lead for the west extension area; arsenic and barium for the west side of the main harbor; and arsenic, barium, lead, and mercury for the east side of the channel. These levels were 20% or less above those found at the disposal site. No reference sediments could be obtained from the area. When the levels were compared to the Rochester Harbor open-lake reference levels, these levels were lower. PCB levels of Aroclor 1232 are found sparingly in the area up to 100 ppb. No pesticide concentrations have been detected. The total PAH distribution is low. The west harbor area and west extension area are the areas frequently dredged. In these areas the total PAHs range up to 2 ppm. The east harbor area has PAHs ranging up to 3.4 ppm, and the river mouth area, which is not dredged, has values up to 6 ppm. Toxicity testing using *Hyalella azteca* and *Chironomus tentans* show no adverse sediment toxicity of the dredged sediments. Low levels of dioxins and furans were found in the sediments. Organic bioaccumulation testing for dioxin and furans using *Lumbriculus variegatus* showed inconclusive results.

All dredged material is currently being disposed of at an open-lake disposal area that is about 320 acres in 50 feet of water located 1½ miles northwest of the harbor. If the harbor is to be expanded or deepened, this disposal area could be used provided the dredged material is comparable and compatible with the lake sediments. In the past, the state has required that the more contaminated sediments be dredged and disposed of first and covered by latter dredged material that is less contaminated. New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Ogdensburg Harbor, New York - Ogdensburg Harbor is located at Ogdensburg, New York along the Saint Lawrence River at the mouth of the Oswegatchie River 60 miles downstream from Lake Ontario. The existing project was authorized by the 1910, 1919, and 1935 Rivers and Harbors Acts as a deep-draft commercial harbor. As completed in 1935 the harbor consists of: an upper west entrance channel 19 feet deep at the river mouth; a city front channel 19 feet deep along the Saint Lawrence River city dock lines; a lower east entrance channel 27 feet deep; and an lower basin 21 feet deep extending from deep water in the river to within 50 feet of the existing dock lines. Commercial commodities handled through the port consist of coal, grain, and miscellaneous mineral products. This area is not an Area of Concern (AOC), although there is one further downstream at Massena, New York.

Fish and wildlife use the harbor area and would be affected by activities in this area. This region of the St. Lawrence River is noted as a sportsman trophy muskellunge fishery. Other recreational fisheries (commercial charter) exist for smallmouth bass, northern pike, and walleye. Additional fisheries exist for bluegill and pumpkinseed sunfish, rockbass, crappie, bullheads, catfish, largemouth bass, yellow perch, white perch, white bass. Salmonids have been stocked in the area and early spring and late fall fishery may exist for brown and rainbow trout and chinook and coho salmon. The New York State Department of Environmental Conservation is currently trying the re-establish lake sturgeon populations in the two rivers. Lake sturgeon are listed as a New York State threatened species. Dredging operations in the harbor would have a minimum impact on the fisheries except those fish entering the Oswegatchie River for spawning activities. The avian species using the area are gulls, terns, cormorants, ducks, and geese. These species would use the water area for feeding and the shoreline for nesting.

Fish consumption advisories that exist on some fish from the harbor vicinity recommend eating no more than one meal per month because of PCB, Mirex, and Dioxin concerns. For the St. Lawrence River no meals consisting of American eel, channel catfish, lake trout over 25 inches, carp, brown trout over 20 inches, and chinook salmon should be eaten. It is also advised that no more than one meal per month consisting of white perch, white sucker, rainbow trout, smaller lake trout, smaller brown trout, and coho salmon over 25 inches should be eaten.

The harbor was last tested and dredged in 1984 to accommodate harbor modifications. No detectable concentrations of pesticides were found in the sediments. PAHs were not tested for at this time. Metal concentrations were found to be higher than background levels found just outside the harbor area. High levels of cadmium, chromium, copper, lead, mercury, and zinc were found in certain areas. Limited bioassay testing was performed for survivability of certain organisms.

Survival of *Daphnia magna* (water flea) and *Pimephales promales* (minnow) was performed for sediment elutriates. Reduced survival of *D. magma* was exhibited at some of the tested sites. Dredged material at that time was disposed of at a 10-acre upland disposal area located along the St. Lawrence River near the southwest corner of the lower basin.

No open-river disposal area exists for the sediment. Also, the 10-acre upland disposal site used in the past may no longer be available. If the harbor is to be expanded or deepened, a new disposal area would have to found. Problems would exist on choosing an open-water site because of environmental impacts and sediment transport issues.   New sediment studies would have to be conducted for expansion/deepening purposes. Depending upon the depth of material to be removed, sediment core samples would probably be needed, each with multiple samples.

Connecting Channels

St. Marys River, MI - The 65 mile long St. Marys River connects Lake Superior with Lake Huron and forms a natural boundary between the United States and Canada. As the only outlet of Lake Superior, the river carries an average of 74,900 cfs to Lake Huron, descending 22 feet along the way, mostly at the St. Marys rapids. Discharge through the system is totally regulated by power canals, locks, and compensating works at the head of the St. Marys Rapids. The river forms numerous shallow bays along its main course. Four large islands, Sugar, Nebbish, St. Joseph, and Drummond, divide the river into several channels. These channels broaden out in various areas to form Lake George, Lake Nicolet, and Lake Munuscong. The United States has carried out numerous modifications to the St. Marys system under the authority of various navigation projects.

Cold water of high quality enters the river from Whitefish Bay on Lake Superior. High water quality is maintained throughout the system with the exception of a stretch along the Canadian side below an industrialized area in Sault Ste. Marie, Ontario. In general, sediment quality in the system also appears to be good with the exception of areas near domestic and industrial outfalls on the Canadian side.

The St. Marys River provides a variety of high quality habitats that are very important to the fish and wildlife of the area. Seventy-six wetlands totaling over 13,000 acres have been identified on the U.S. shoreline of the river, particularly along lakes and bays. Much of the shoreline in these areas is erodible low plain. Numerous dredge spoil islands up to 70 years old also provide shoreline habitat. These islands are covered with a variety of vegetative forms depending upon soil type, age of island, animal disturbance, changes in water level, etc. Common vegetation included willow, aspen, balsam poplar, alder, goldenrods, sedges, horsetails, white sweet clover, asters, strawberry, and cattails as well as other species. These islands probably never reach a climax vegetation stage because of erosion, but a poplar-willow sub climax stage does occur.

Aquatic macrophytes have been described as a principle component of the primary productivity in the Neebish Island area of the river. Thirty-seven species have been identified in this section in areas of moderate or low current and depths less than seven meters. These plants provide an important source of energy for the river as well as providing a living area for other organisms in the food chain. Algae also contribute to the primary productivity of the river. Diatoms and green algae dominate the phytoplankton community throughout the year. Periphyton is dense in portions of the river (St. Marys

Rapids) but appears to be absent in other areas. The importance of the production from the algal community to the ecosystem is unclear.

Above the rapids, benthic communities are characterized by a variety of species. These include 3 genera of mayflies and 4 genera of caddisflies, which are generally intolerant of pollution, as well as low densities of pollution tolerant tubificids. Below the rapids on the Canadian side the benthos is more indicative of polluted environments while benthos on the U.S. side remains unchanged. Winter studies in Lake Nicolet revealed a diverse assemblage of macrozoobenthos dominated by oligochaetes and midge larvae. Between January and April, 56 taxa of macroinvertebrates were identified at Frechette Point and Six Mile Point. These areas were dominated by midge larvae, worms, and snails. Studies centered around the Middle Neebish Channel identified 134 taxa, with the most common being midge larvae, worms, mayflies, and caddisflies. These organisms provide a valuable source of food for fish of the river.

The St. Marys River contains both warm and cold water fish species. Habitat diversity within the river, and the presence of Lakes Superior and Huron at either end ensure the propagation of both communities. Seventy-six species have been identified from the river with yellow perch, white suckers, northern pike, walleye, rock bass, brown bullhead, and smelt being the most common sport species. Seasonal migrations of lake whitefish, lake herring, rainbow smelt, lake trout, and rainbow trout also occur. Past fishery investigations have centered on Potagannissing Bay, the St. Marys River ship canal, dredge-spoil disposal areas, and the navigation channels around Neebish Island. Fish density and species composition varies throughout the river and with the time of year. An August 1975 survey revealed that above the St. Marys Rapids the river was dominated by yellow perch, white sucker, lake whitefish, and northern pike in order of descending frequency. In Lake Nicolet, white suckers, yellow perch, northern pike, brown bullhead, lake herring and walleye were most common. Raber Bay was dominated by lake herring, while rock bass, redhorse, yellow perch, northern pike, and brown bullhead were most common in Munuscong Bay. Yellow perch and white sucker dominated the fishery of Potagannissing Bay. Winter collections at Frechette Point and Six-Mile Point revealed white suckers to be most common followed by burbot and sculpin. Winter collections have also been made in the vicinity of Neebish Island with results which vary from site to site.

The St. Marys River, its tributaries, bays, and marshes undoubtedly contain important spawning areas for a variety of fish species. The St. Marys Rapids is believed by some to be an important spawning area for several species. There have been some indications that lake whitefish and herring spawn in the lower St. Marys, southern Lake Nicolet, and northern Lake Munuscong. Walleye have been reported to spawn throughout Lake Munuscong including Birch Point, Roach Point, Barbeau Point, Munuscong Island, and the Munuscong River. Fish larvae of 18 taxa were collected during May to November 1979 in the Middle Nebbish Channel. Rainbow smelt, alewife, and burbot larvae were the most abundant but larvae of whitefish and other game species were also collected. Unfortunately the river has also been found to be a major spawning site for sea lamprey, with most of lamprey of northern Lakes Michigan and Huron originating from there.

Studies have revealed numerous nesting sites (including spoil islands) for great blue heron, eagles, osprey, and gulls on the lower St. Marys River. A variety of waterfowl also inhabit the area or pass through during annual migrations. About 1000 ducks have been observed over wintering in the area during a recent year. This group was comprised primarily of mallards, common goldeneyes, and common mergansers. Critical areas during the winter included the St. Marys Rapids, the Edison Sault Hydro Plant outfall, and open areas along the Canadian shore.

A variety of mammals inhabit the St. Marys River area, particularly the West Munuscong Lake Wetland Complex. These mammals include snowshoe hare, muskrat, beaver, raccoon, weasel, white-tailed deer, moose, and coyotes. Wolves, lynx, and moose are common on the Canadian side of the river while bobcats are more common on the Michigan side. Coyotes, red fox, and deer are common on both sides. Water and ice conditions influence movements across the river.

St. Clair River and Harbor, MI - The 39 mile long St. Clair River, which is the only outflow for Lake Huron, discharges approximately 179,000 cfs of water to Lake St. Clair. Some portion of this water enters the St. Clair from the Belle, Black, and Pine Rivers of Michigan, and Clay, Bowens, and Baby Creeks in Canada. The St. Clair River has two major sections, an upper channel and a lower or delta portion. The upper channel is a relatively deep, narrow channel with only two islands (Fawn and Stag). The delta portion, commonly known as St. Clair Flats, is formed by the division of the river into four major distributaries. One of these, the North Channel, further splits into the North (61,800 cfs) and Middle Channels (37,400 cfs). Another, the South Channel branches into the Southeast Bend (33,600 cfs), St. Clair Cutoff (37,400 cfs), and Bassett Channel (7,500 cfs). The other two distributaries, Chenal Escarte and Chematogen Channel are much smaller.

The St. Clair delta is the largest delta in the Great Lakes Basin. It appears that the principal source of sediments for the delta is the shoreline of Lake Huron. These sediments, mostly sand, are transported largely as bedload to the delta. The St. Clair delta displays landforms characteristic of marine deltas. The active distributaries (North, Middle, and South) average 1,500 feet in width and 35 feet in depth. Navigation is almost entirely limited to the South Channel and the St. Clair Cutoff.

Benthic communities reflect the good water quality and relatively clean sediments, which exist through most of the river. An exception to this is on the Canadian side near Sarnia where benthic communities are less diversified and dominated by more pollution tolerant organisms. In other areas of the river mayflies and caddisflies, pollution intolerant organisms, are well represented along with a wide diversity of oligochaetes, chironomids, snails, and bivalves. Native mussels have become scarce in the system due to the establishment of zebra mussels in the Great Lakes. In most sections of the river, populations of all benthos are significantly reduced in the shipping channels. Zooplankton throughout the river reflects that found in lower Lake Huron.

Phytoplankton in the river also reflects that found in lower Lake Huron and is dominated by cold water diatoms. Aquatic vegetation is widespread but restricted to the area outside of the navigation channel as a result of bottom scouring by the propeller wash of commercial vessels. In the lower half of the delta area, various pondweeds occur in abundance. Other rooted aquatic plants in the river and delta area include wild celery, common elodea, flexible naiad, coontail, muskgrass, hardstem bullrush, common three square bullrush, redhead grass, floating pondweed, leafy pondweed, and sago pondweed.

Many of the fish species that can be found in this river move to or from Lakes Huron, St. Clair, and Erie for spawning. Some of these species include walleye, muskellunge, rainbow trout, lake sturgeon, smelt, coho and chinook salmon, smallmouth bass, yellow perch, freshwater drum, and channel catfish. More work is needed to determine the extent of fish movement throughout the complex and the conditions that keep these movements intact. The Michigan Department of Natural Resources (MDNR) has also conducted stocking programs in the St. Clair complex. The locations of fish spawning and nursery areas in the St. Clair River have not been investigated to any great extent. These areas are believed to be the marshy and shallow bay areas, shorelines, on the rocky shoals of Stag and Fawn Islands, and the channels and wetlands of the delta area. Studies conducted in 1977-78 revealed 23 taxa of larval fish in the St. Clair and Detroit Rivers.

Over 60 species of mammals may be found in the St. Clair River Basin, some of which are very important to man as game animals and furbearers. These include white-tailed deer, eastern cottontail, raccoon, red and gray fox, beaver, river otter, mink, and muskrat. Over 25 species of reptiles and 20 species of amphibians also may be seen. Over 250 species of birds have been observed in the St. Clair Basin.

The most valued wildlife habitat in the St. Clair River area is the St. Clair flats. These marshlands include 5,000 acres of wetland vegetation and provide habitat for waterfowl and many other water-related species of wildlife. Lake St. Clair is an important spring and fall staging area for a large segment of the migrating diving and puddle ducks in eastern North America. The nutrient rich beds of vegetation in Lake St. Clair and the marshes of the delta are important feeding areas for resident ducks as well. Some of the species using the area include the canvasback, redhead, mallard, black duck, baldpate, pintail, shoveller, blue winged teal, green winged teal, ruddy duck, scaup, goldeneye, and bufflehead. Others species using the marsh include the American egret, great blue heron, American bittern, least bittern, black crowned night heron, little green heron, gallinules, pied-billed grebe, whistling swan, coots, rails, and numerous songbirds.

Federally listed endangered species, which may be found in the St. Clair River Basin include the Kirtland's warbler. The bald eagle has Federal threatened status in Michigan and may occasionally be found in the river basin.

<u>Lake St. Clair,</u> <u>MI</u> - Lake St. Clair is an expansive, shallow basin characterized by low marshy shores and a flat sloping bottom. Maximum natural depth is 21 feet with an average depth of 10 feet. The lake is about 24 miles wide and has a total surface area of approximately 430 square miles with 268 square miles lying on the Canadian side of the international boundary. Most water enters the lake thorough the St. Clair River delta, but several rivers and streams also flow into the lake from the surrounding watershed. The 27.5 feet deep dredged ship channel bisects the lake and forms an important connecting link in the waterway between Lake Erie and Lake Huron. Although the American shoreline is highly urbanized, there are no large commercial, industrial, or harbor facilities in the area.

A 1971 study revealed a wide variation in the density and distribution of benthic organisms in Lake St. Clair due to differences in bottom type, water depths, and water quality. Oligochaetes and chironomids dominated in most areas, particularly in nearshore zones, along with moderate numbers of snails and mussels. Mayflies were also found in significant numbers in some areas, particularly the central portion of the lake where soft muddy sediments are common. Overall it appears that a diverse benthic fauna composed of pollution-intolerant invertebrates important in the diet of fish and wildlife are present.

Lake St. Clair is best noted for its muskellunge fishing although many other species such as walleye, northern pike, channel catfish, smallmouth bass, largemouth bass, yellow perch, black crappie, white crappie, rock bass, white bass, bluegills, and others are commonly caught. At times chinook and coho salmon, rainbow and brown trout, lake whitefish, smelt and suckers are also caught. The lake is also host to a great variety of forage fishes, sea lamprey, gar, sturgeon, and bowfin. In all over 60 species have been identified but most recent studies have revealed only about 25 species with yellow perch, walleye, and smallmouth bass being the most common sport species. Populations of sport species appear to have increased the past few years.

Limited information is available concerning spawning areas in the lake. The Anchor Bay and delta marshes are the most active spawning areas for most species. It is believed that most of the lake population of muskellunge spawn in the southwestern portion of Anchor Bay. Smallmouth bass also spawn in this vicinity. Largemouth bass, northern pike, channel catfish, yellow perch, and black crappie spawn in most of the nearshore waters of Anchor Bay between Mt. Clemens and St. Johns Marsh. The area from St. Johns Marsh through the delta marshes provide important spawning habitat for northern pike, largemouth bass, smallmouth bass, crappies, bluegill, and other sunfish. It is believed that most walleye in the St. Clair complex spawn in the Thames River, a Canadian tributary to Lake St. Clair.

The lake, delta, and other areas of the Lake St. Clair watershed are used by many species of reptiles, amphibians, birds, and mammals. Reptiles and amphibians include species of snakes, turtles, frogs, toads, and salamanders. The wetlands, beaches, nearshore areas, quiet bays and the open lake are migration or nesting habitat for water-associated birds such as sandpipers, herons, bitterns, terns, snipes, gulls, swans, geese, and ducks. There is a great blue heron rookery on Dickinson Island in the delta area. The marshes and floodplain croplands also provide valuable habitat and support many species of songbirds. Lake St. Clair is used by migrating waterfowl as a staging area for the Mississippi and Atlantic flyways. The delta marshlands also provide nesting habitat for large numbers of these ducks and other birds. Whistling swans use the Lake St. Clair drainage area as a migration route.

Mammals in upland, beach, and marsh areas include opossum, woodchuck, raccoon, skunk, weasel, mink, muskrat, fox, coyote, and deer. Species listed on the Federal list of endangered and threatened wildlife and plants that may occur in the area include the bald eagle.

Detroit River and Harbor, MI - The Detroit River is 31 miles long from its headwaters at Windmill Point Light to its mouth at Lake Erie (the Detroit River Light). The river drains a land area of about 268 square miles in the United States and approximately 648 square miles in Canada. The banks of the river are heavily populated and highly industrialized. This has had a pronounced impact on the water quality of the river. The entire 31 miles has at some time been considered substandard and the lower 20 miles of the river from the junction of the Rouge River to Lake Erie have been seriously degraded.

Located at the confluence of the Detroit and Rouge Rivers, Detroit's main sewage treatment plant serves more than 90% of the people in the Detroit area and contributes a tremendous waste load to the river. This reach of the Detroit River displays excessive levels of coliform, phenols, toxic substances, nutrients, suspended solids, and residues. However, as a result of recent pollution abatement programs, the water quality of the river is gradually being improved.

The quality of the Detroit River water is reflected in the density and diversity of the benthic and invertebrate community that it supports. The upper region of the river supports pollution-intolerant invertebrates such as burrowing mayflies, caddisflies, amphipods, and gastropods. However, the lower reaches of the river, particularly that portion below the Rouge River, are polluted and sustain only pollution-tolerant organisms such as tubificids and oligochaetes. An improved aquatic environment in the Detroit River can be expected to have beneficial effects on benthic communities.

The upper portion of the Detroit River has relatively low numbers of aquatic macrophytes due to the depth and steep slopes of the banks of the river and to the very extensive development on both sides. Likewise, the deep channels in the lower part of the river are devoid of aquatic macrophytes. However, most of the lower river does support a modestly diverse aquatic plant community. Plant communities characteristic of the lower river include: wild celery, slender pondweed, sago pondweed, waterweed, water milfoil, muskgrass, mud plantain, stubby Wapato, and Illinois pondweed.

Past surveys have identified from 45 to 67 species of fish present in the area. In the upper river, walleyes contribute very significantly to the fishery while the main sport fishes in the lower river are white bass and yellow perch. Other species frequently caught in the river include: freshwater drum, channel catfish, rock bass, and smallmouth bass. Since about 1973 the Michigan Department of Natural Resources has been conducting a stocking program in attempts to diversify the sport fishery. Species stocked include the coho and chinook salmon and the rainbow trout. As discussed in the St. Clair River section, numerous species of larval fish have been collected from the river.

The Detroit River includes habitat that is important for many species of birds, however, because of the extensive development of its banks, very little other wildlife is present. The lower Detroit River is a concentration area for waterfowl. During spring and fall migration seasons mallard, goldeneye, scaup, black duck, redhead, canvasback, and other species are attracted to the area by shoreline wetlands, beds of wild celery, and other aquatic vegetation. The river is also an important over-wintering area for ducks. Because of heated effluents, navigation, and currents, there is much open water throughout most winters. These open waters, plus aquatic vegetation beds and invertebrates, stimulate over-wintering by canvasback, redhead, goldeneye, and other duck species.

<u>St. Lawrence River</u> – As remarkable as the resources of the St. Marys River and Detroit-St. Clair complex are, the St. Lawrence River system likely provides more habitat due to its length. The St. Lawrence River carries the discharge of Lake Ontario over 1,000 miles to the Atlantic. Over this distance the river drops 225 feet and the navigation system passes through 7 locks built in the 1950s. The water levels of the St. Lawrence begin to be influenced by Atlantic tides as far up the river as halfway between Montreal and Quebec City.

The St. Lawrence has the largest discharge of any river in North America. Its shoreline is moderately populated with many of the islands and peninsulas developed. The Thousand Islands area, near the western end of the river, is a complex system of islands and channels where waves resulting from vessel passage may be of special concern. Moving east, the river narrows to a single deep channel around two miles wide. The river widens again at Lake St. Lawrence and Lake St. Francis where there are extensive shallow areas.

A variety of sport fish inhabit the river including largemouth bass, smallmouth bass, rock bass, yellow and white perch, northern pike, muskellunge, walleye, and rainbow smelt. Other species including carp, black crappie, channel catfish, pumpkinseed, brown bullhead, American eel, sturgeon, and white and redhorse sucker are also present in the area. These fish depend upon a variety of features of the river ranging from wetlands to rock outcrops for spawning and nursery areas.

Numerous bird species also make use of the St. Lawrence system including colonial nesting species such as herring gulls, double crested cormorants, great blue herons, black crowned night herons, ring billed gulls, and common and Caspian terns. Migratory waterfowl using the system include Canada geese, mallards, black ducks, northern pintail, American widgeon, teal, loons, grebes, common goldeneye, scaup, old squaw, scoter, and merganser. Shorebirds (such as sandpipers and plovers) and raptors including peregrine falcons, osprey, and bald eagles also use the system extensively.

Mammals such as otters, muskrats, beaver and mink depend upon wetlands for their survival in the region. Larger mammals including moose, deer, bear, and wolves also come to the shoreline but are not dependent on the river. Reptiles and amphibians are also associated with the shorelines but generally not found in large numbers in the St. Lawrence River.

As with the connecting channels in the upper part of the system, the loss of wetlands is a major factor affecting the river ecosystem. About half of the shoreline has been modified by agriculture and urbanization. Erosion is also a concern in the St. Lawrence with as much as a quarter of the shoreline being considered vulnerable.

ALTERNATIVES CONSIDERED

Without-project Conditions

The future without-project condition for the Great Lakes Navigation System (GLNS) assumes completion of authorized modifications at the Soo Locks and the maintenance of project depths in the connecting channels through ordinary operations and maintenance (O&M). Lock repairs may be accomplished under O&M or major rehabilitation (MR) depending upon the scope of the work.

The existing channel depths in the St. Lawrence Seaway are assumed to be maintained through normal O&M, but the aging locks will eventually need to be replaced. The locks on the Welland Canal are at least 70 years old, while the locks on the Montreal/Lake Ontario (MLO) portion are 42 years old. Maintaining the locks will result in repairs that address immediate concerns, however, these repairs may not be sufficient in scope to deal with the underlying structural problems.

The single lock configuration in most locations makes the reliability of the overall system an even greater concern. The consequences of a major lock failure likely would cause traffic disruptions of the entire waterway. It is assumed that a comprehensive program to rebuild or repair the locks on the system will be initiated.

With respect to the individual ports and harbors, the future without-project condition will be to maintain the existing project depths in the channels through ordinary operations and maintenance.

With-Project Conditions

Five broad options are proposed for future investment (see Table C-2). Each option has three components. The first component being the U.S. portion of the GLNS, the second the Welland Canal Section of the Seaway, and the third the MLO Section of the Seaway.

Option 1 - Includes the many combinations of improvement alternatives for U.S. connecting channels and harbors combined with eventual replacement of the Seaway locks.

Option 2 - Contemplates the same U.S. GLNS improvements (See Option 1 above), coupled with construction of a deeper (35’ draft) and larger (110’x1200’ lock chambers) replacement Welland Canal.

Option 3 - Builds upon Option 2 by replacing the MLO Section of the Seaway with a deeper and larger system of locks and channels, and by extending the 35’ draft system up to Detroit.

Option 4 - Is the same as Option 3, except that the 35’ draft now extends into Lake Michigan and Lake Huron by the deepening of the entire St. Clair/Detroit River system.

Option 5 - Extends the 35’ draft throughout the GLNS system as a result of deepening the St. Marys River and lowering the sill depth at Soo locks.

TABLE C-2
With-project Conditions

Alternative	**U.S. GLNS Connecting Channels & Ports**	**Welland Canal Section—Seaway**	**MLO Section--Seaway**
Option 1	Deepen up to 30’ draft	WOPC	WOPC
Option 2	Deepen up to 30’ draft	Replacement of Locks 110’x1200’, draft 35’	WOPC
Option 3	Deepen up to 30’ draft, except Detroit R. at 35’	Replacement of Locks 110’x1200’, draft 35’	Replacement of Locks 110’x1200’, draft 35’
Option 4	Deepen up to 35’ draft, except St. Marys R. at 30’	Replacement of Locks 110’x1200’, draft 35’	Replacement of Locks 110’x1200’, draft 35’
Option 5	Deepen up to 35’ draft all connecting channels	Replacement of Locks 110’x1200’, draft 35’	Replacement of Locks 110’x1200’, draft 35’

Note: WOPC is the acronym for without-project condition.

Four broad waterway investment options (Options 1, 3, 4, and 5) were evaluated; Option 2 was omitted from reconnaissance-level consideration due to the difficulty in developing necessary benefit information. Owing to funding and time constraints, only a limited set of cost estimates were developed for the with-project alternatives, specifically: for Option 1 port and connecting channel plans, for some Chicago Sanitary and Ship Canal plans, and for the St. Clair/Detroit River system operational plans.

EVALUATION OF ALTERNATIVES

General Impacts of Project Activities on Significant Resources

Significant resources defined for the project area could be influenced by improvements to the Great Lakes navigation system through the specific activities that would be carried out in the implementation and operation of the selected alternative. The proposed alternatives encompass four major types of activities; dredging, dredged material placement, the building of structures, and vessel movement. Activities related to project alternatives and the general impacts that these activities could have on the environment are described below.

Dredging

Dredging activities related to modifications of the Great Lakes navigation system would not be expected to have significant impacts upon air quality at proposed sites. However, some very localized temporary negative impacts could occur as the result of equipment operation at the time of dredging. Direct shoreland impacts of dredging would in most cases be limited to the short-term nuisance collection of scum or debris dislodged from the bottom by dredging activities. In cases where channels are dredged through previous terrestrial areas or near to shorelines some loss of terrestrial habitat may occur.

Impacts on water quality and circulation represent a major concern in relation to dredging activities. Short term direct effects of dredging on water quality can include: (1) the creation of turbidity and reduction in light penetration, (2) the resuspension of contaminated bottom material, (3) the release of nutrients and other materials trapped in the sediments, (4) the depletion of dissolved oxygen from the water column, and (5) the creation of floating scums and debris.

The extent of adverse environmental effects is often related to the grain-size of the material to be removed, and the type and operation of the dredge used. Coarse materials tend to contain few contaminants and settle quickly when disturbed thus minimizing environmental consequences. Fine grained materials tend to be associated with more contaminants than do larger grained materials, and tend to remain suspended for a longer time when disturbed. Increased turbidity is usually a short-term effect and tends to be more severe in a flowing channel than at more quiescent sites. However, colloidal and flocculated materials could remain suspended and may travel considerable distances before resettlement.

In the past it has been assumed that along with the resuspension of bottom materials indicated by increased turbidity, a significant release of toxic materials, nutrients, gases, and oxygen consuming substances from polluted sediments occurs. It is now generally believed that dredging even significantly polluted sediments is of limited environmental consequence, particularly if the water column remains aerobic. However, if severe pollution exists, there may be some short-term adverse effects at the dredging site. In severely polluted situations, concerns about threats to municipal water supplies by pollutants released during dredging operations may be warranted.

Dredging activities may result in floating debris and scums due to the physical disruption of the bottom and the dislodging of buoyant materials. Although this is unlikely to have any significant negative impacts upon the biota, the aesthetic impacts are undesirable. This effect, along with those previously described, is short term in nature.

Most long-term impacts are related to modifications of bottom geometry in areas of dredging. Those effects may be positive or negative. Dredging may improve water quality by removing contaminated sediments from an area, thus decreasing toxic substance release and oxygen demand, or by improving circulation in restricted areas. However, dredging may also have long-term negative impacts by creating pools of restricted circulation in areas of over dredging or by increasing the flushing time of polluted areas. Increased dredging in riverine areas where channels are bordered by wetlands may result in significantly decreased water flow through these important habitats. Impacts of such an action are difficult to predict but may significantly reduce wetland productivity.

Macrophytes and periphyton may be temporarily impacted by changes in water quality related to dredging activities. Increased turbidity will decrease light penetration and inhibit photosynthesis. Released toxic materials may adversely impact plant biochemistry, stunting growth or causing death. Conversely, nutrients released from the sediments may stimulate growth and reproduction. More serious long-term impacts on macrophytes and periphyton are the result of their physical removal and the alteration of local habitat. This is a major concern when conducting new dredging in shallow water areas. These areas are unlikely to be recolonized by macrophytes and periphyton due to changes in substrate, turbulence, circulation patterns, sedimentation, and water depths. Any recolonization that may occur, would probably reflect different species composition and densities. Because of this, new dredging is considered much more detrimental to the environment than maintenance dredging operations.

In addition to the short-term effects of changes in water quality previously described for macrophytes and periphyton, phytoplankton tends to respond to turbidity by sinking from the water column. Zooplankton is also affected by water quality changes resulting from dredging. Increases in turbidity may cause gill damage and retard growth. Some invertebrates are very sensitive to toxic substances, while others tend to bioaccumulate these compounds and pass them up the food chain. Changes in phytoplankton concentrations caused by dredging activities can also affect zooplankton density and species composition. Both phytoplankton and zooplankton are subject to entrainment and removal during dredging operations. Due to the high reproductive capacity of both phytoplankton and zooplankton, populations rebound quickly when water quality improves. Any long-term effects of dredging on the plankton populations are the result of habitat changes. The most likely of these is the removal of macrophytes, reducing competition for phytoplankton and cover for zooplankton.

Benthic macroinvertebrates are subject to the same water quality stresses described for zooplankton. However, due to their association with the sediment, they are much more susceptible to physical removal and alterations in habitat. As much as 75 to 100% of the benthic organisms in an area may be initially removed during dredging operations. Recolonization of the area depends upon vessel traffic, current conditions, and bottom type, and is often limited as dredged channels may be composed of substrate significantly different from that previously present. When recolonization does occur, species composition and density is often different due to the new habitat created by the dredging and vessel traffic.

Due to their mobility, fish are probably subject to less direct effect by dredging than other aquatic organisms. Despite this, they are subject to harassment, early life stages and small species may be entrained by dredging operations, and they are subject to gill irritation and stress induced by turbidity and toxic substances. Hydrocarbons and other pollutants have the potential to interfere with olfactory senses affecting food location, escape from predators, selection of habitat, and sex attraction. The noise, physical presence of equipment, and changes in water quality associated with dredging may disrupt migration patterns, interfere with spawning, and result in the smothering of eggs and burial of spawning grounds. New dredging activities may result in removal of natural shelters including macrophyte beds and reefs as previously discussed. This would act to reduce the availability of spawning, feeding and nursery areas. All changes in species diversity and population size that occur at lower trophic levels would ultimately have some impact on fish and may damage a fishery.

The removal of bedrock from channels sometimes requires blasting. This could create other potential impacts. Some harassment of fish would be likely during construction activities, and some small number of fish could be killed during blasting in the channels. It is not possible to predict the number of mortalities, but because the type of blasting which would be done would involve sinking cuts where the charge is recessed into bedrock, and most of the fish in the area are fusiform and relatively resistant to the effects of blasting, the impacts would be expected to be minimal. It is anticipated that most fish would leave the area when blasting and dredging operations are initiated and that direct mortalities would be limited to within about 100 yards of the blasting site. Harassment associated with noise and vibration could result in reduced spawning success for some species in adjacent areas during the construction period. These short-term impacts are unlikely to be significant unless blasting occurred over long periods of time.

Mammals and birds would probably suffer no direct impacts as the result of dredging in aquatic areas although loss of habitat may occur when macrophyte beds are removed. In cases where terrestrial areas are to be converted into navigation channels, drastic impacts upon terrestrial fauna may occur. In addition to the obvious direct losses of habitat, navigation channels would alter local topography and could block mammal migration routes. As discussed in relation to fish, any changes, which occur at lower trophic levels, will also ultimately affect birds and mammals of the area.

Dredged Material Disposal

A wide variety of means of disposal of dredged material have been used in the past several years. In some cases beneficial use can be made of dredged material. It may be used as fill at construction sites, sand for roads during winter, beach nourishment, or to create new valuable habitats. In other cases dredged material is a waste. Three types of disposal have been proposed for dredged materials generated by modifications to the Great Lakes navigation system; open water placement, in-water confined placement, and terrestrial placement. The impacts of these modes of disposal will be discussed in following sections. Review of possible beneficial uses of dredged material will not be discussed in this report, but will be analyzed on a site-specific bases in later stages of the project.

Open Water Placement

The least expensive alternative, if a nearby site is available, is open water placement. The impact of this type of disposal depends upon the placement site, its bottom characteristics, and the characteristics of the dredged material. Open water placement is currently restricted for polluted dredge spoils. Significant impacts on air quality or shorelands are not likely to be associated with open water placement options in this project. Water quality effects depend somewhat upon the type of discharge used, but in general are similar to those previously described for dredging operations.

Most water column effects are short-lived. Research has revealed that there is usually little release of nutrients and toxicants to the water column during settling except for ammonia, phosphorus, manganese, iron, and zinc. However, some studies indicate that through resuspension caused mostly by wind and waves, any releases that do occur may persist for some time. Some oxygen depletion may occur, especially near the sediment surface, when the spoils contain a large amount of organic materials.

Macrophytes and periphyton are unlikely to be affected as open water disposal usually takes place at water depths greater than these plants normally inhabit. In cases of shallow water placement, burial of aquatic plants is possible. The rate of recolonization would depend upon the density of macrophytes in the surrounding area, the characteristics of the spoil material, and the depth of spoil cover. Long-term changes in benthic life in the area depend upon how much the deposited spoil differs from the surrounding bottom materials.

Phytoplankton and zooplankton are likely to be affected only as long as is the water quality of the area. Likely short-term effects are those previously described for dredging activities. Turbidity may reduce phytoplankton productivity and cause sinking. Suspended materials may also irritate the gills of zooplankton. Phytoplankton may respond to an increased availability of nutrients by an increase in density. Zooplankton may then respond to an increase in phytoplankton. If any toxic materials were disposed of by this method, both zooplankton and phytoplankton may be negatively impacted for as long as these materials were in suspension.

Benthic macroinvertebrates are the most likely portion of the ecosystem to be impacted by open water placement practices. Burial of bottom dwelling organisms is possible, but recent studies have shown that once beyond the larval stage, these organisms are fairly resilient. Disposal sites can be rapidly recolonized by the establishment of new populations, by migration of organisms from adjacent unaffected areas, and by survival of buried organisms. Colonization by opportunistic species can occur within weeks and original species may return within months.

When the dredged material being placed is of the same grain-size distribution as the natural bottom, survival of existing organisms is maximized. When there is a distinct difference between the natural sediment type and that of the dredged material, the reestablished benthic population can be drastically different. The most detrimental example of this occurs where a fluid mud layer is created. This substrate is an alien environment for many organisms. Conversely, open water disposal may result in beneficial changes in bottom characteristics. Depositing rock or coarse materials in an area, which is generally featureless, may provide suitable substrate for benthos in areas where none previously existed. Such substrates are often used by some benthic species that are valuable as fish food.

Due to their close association with the sediments, benthic organisms may pick up and bioaccumulate any contaminants that exist in the dredge spoil. These contaminants may then be passed up the food chain as the benthos is consumed. Due to this possibility, deposition of spoils containing toxic materials at any concentration must be carefully evaluated.

Due to their mobility, fish are unlikely to suffer direct mortalities as a result of open water placement activities. However, they will respond to temporary changes in water quality and changes that occur at lower trophic levels. Turbidity or toxic substances may stress fish, making them more susceptible to disease or stunting their growth. Organics or other substances may interfere with olfactory processes and cause some disorientation or disrupt feeding. Decreases in zooplankton or benthic invertebrate populations may cause fish to leave the area in search of food, or stunt the growth of those fish that remain. All of the above effects would be expected to last as long as their underlying causes (i.e. changes in water quality or invertebrate populations).

In addition to these impacts, fish can be affected by the habitat changes that may result from open water disposal. If valuable fish habitat or spawning areas are buried at the disposal site, fish populations may suffer. Conversely, disposal of coarse materials or rock in areas devoid of spawning habitat may result in significant improvements in the fish populations of the area if the deposited material is suitable for spawning.

Open water placement impacts on mammals and birds are unlikely in the Great Lakes as most placement take place in deepwater areas that provide no habitat for these animals. However, the use of rock for erosion control, and sand for beach nourishment may provide some benefits for these groups.

<u>In-Water Confined Placement</u> - The impacts of confined placement in aquatic habitats depends upon the material being deposited and the natural habitat present at the disposal site. If disposal facilities are constructed near to or adjoining shore, changes in shorelands will occur. A portion of the change would be the result of the direct addition of the new land the disposal facility creates. Additional shoreland changes may result from associated alterations in near shore currents, which would affect littoral drift, sediment deposition, and erosion. The magnitude of these effects can only be judged on a site-specific basis.

Temporary declines in water quality including increased turbidity would occur near placement sites during construction of retaining walls for the structure. Additional, more serious water quality problems may be associated with confined placement facilities if construction and filling are not carried out with care. However, if facilities are filled at the proper rate to allow settling of particulates before water is discharged over weirs, fine particulate matter and pollutants associated with it would be retained and local water quality changes would be minimal.

Construction of confined placement facilities would result in habitat loss for whatever species originally occupied the area. Because these facilities are often located in shallow water areas, losses to macrophytes, periphyton, and shallow water benthic invertebrates are likely. In addition to the habitat loss suffered directly by burial, surrounding areas would be affected by changes in currents and water quality. The net result of these effects may be positive or negative. Changes in sedimentation and erosion patterns may destroy adjacent areas that were once highly productive and valuable, or placement facilities may be located so they act as barrier islands and encourage wetland growth. Periphyton and benthos would be destroyed within the facility but many species will find favorable new habitat on the riprap dikes associated with these sites. If managed properly, placement facilities themselves may become valuable macrophyte or island habitat in areas where such habitat is scarce.

Phytoplankton and zooplankton are also displaced by confined placement facilities but direct effects on these populations are probably always insignificant. Indirect effects may result from previously mentioned changes in water quality and flow. These changes may have significant short-term impacts on the plankton populations of the area.

Fish populations may be influenced by changes in all of the lower trophic levels as well as by changes in water quality, currents, and bottom configuration. Major impacts on fish populations are possible if construction takes place on a locally important spawning or nursery area, if confinement dikes provide a spawning substrate in an area where none previously existed, or if areas surrounding the placement site are drastically changed. An example of the last situation would occur if a placement facility was used as a barrier island behind which marshlands developed. Such an area could become a regionally important spawning and nursery habitat if such areas were rare in the vicinity.

Mammals and birds are likely to receive net benefits from confined placement facilities. If such facilities are attached to existing shorelands and remain undeveloped, some use by wildlife is inevitable. Rodents and other mammals that are common on the adjacent land will use the site if it is completely filled and converted to a terrestrial habitat. If the area is only partially filled and contaminants are not an issue, wetland dependent species such as muskrats, ducks, and turtles may benefit. If the site is constructed as an island, use by mammals would tend to be decreased but bird use, especially by gulls and terns, would be enhanced, due to the protection the island provides from predators. If wetlands develop around a disposal site as the result of changes in erosion etc., many wildlife species may benefit.

Problems for birds and wildlife that are associated with confined in-water placement sites are generally linked to possible poisoning. During filling of confined placement facilities, conditions favorable to botulism outbreaks occur. Although management measures can be taken to prevent major mortalities from botulism poisoning, some negative impacts on waterfowl and shorebirds are possible. Less common but of more concern is the possible contamination of wildlife by toxic materials contained in the dredged material. This may occur as vertebrates eat plants or soil invertebrates that have accumulated toxic materials. The greatest potential for this occurs where soils become acidic and heavy metals become mobile. Such problems are unlikely in light or moderately polluted situations.

As the preceding discussion illustrates, construction of an in-water confined placement facility drastically changes the habitat at that location. Analysis on a site-by-site basis is necessary to determine if the habitat tradeoffs associated with confined placement facility construction represent an improvement or degradation of the environment.

Terrestrial Placement - The impact of terrestrial placement of dredged material depends upon the character of the material being deposited and the conditions of the site prior to placement. Odors from sediments high in organic materials may contribute to local declines in air quality at placement sites. Land use in the area would probably be changed significantly by the construction of a confinement facility. If sediments are highly polluted, future use of the area may be restricted to prevent introduction of toxic materials into the food chain. Sediment characteristics may also prevent future construction on the site.

The presence of a terrestrial placement facility may influence water quality by changing runoff patterns, by discharging materials with overflow effluent, or by allowing contaminant seepage into the ground water. Changes in runoff patterns resulting from alterations in local topography due to facility construction may create pockets of stagnant water or areas of increased erosion depending upon local conditions. These impacts can be largely avoided through careful planning and construction.

Impacts more directly related to the dredged material include the possible degradation of surrounding waters by materials lost from the placement area. Unless sufficient time is allowed for settling of fine particulates before water is discharged from the site, effluents may exceed water quality standards for particulate matter and their associated pollutants. Seepage of contaminants from terrestrial placement sites into the ground water is also possible and must be considered if potentially hazardous substances are contained in the dredged material. Although these water quality problems are possible, they are also avoidable with careful design and construction.

Aquatic life forms should be largely unaffected by terrestrial placement activities. As current laws prohibit the filling of most wetlands where these organisms would exist, impacts are restricted to those associated with the changes in water quality described above. Discharged fine particulate matter could temporarily reduce light penetration and photosynthesis. Sedimentation of these materials could bury some invertebrates and irritate sensitive tissues of others. Toxic substances released into nearby bodies of water could stress aquatic animals of all taxa and cause some mortalities. All of these effects would be minor if proper design and construction are used.

Impacts would be most significant on terrestrial wildlife species. Habitats that were once unproductive such as quarries or gravel pits, can be filled and returned to a more natural state. In areas lacking natural retaining structures, constructed levees may be valuable for various birds, raccoon, mink, deer, and numerous other animals. Conversely, placement that takes place on an area that is now productive and extensively used by wildlife may result in some loss of value. If toxic materials are placed at the site, the possibility also exists that these materials may be transferred to the external environment by wildlife vectors.

Regardless of the placement site used or the characteristics of the material to be deposited, terrestrial placement involves trading the original habitat present at the site for that which will exist after the facility is filled. Judgments must be made on a case-by-case basis concerning the desirability of this tradeoff. These judgments will usually be based on the perceived relative value of the two habitats.

Building of Structures

Implementation of the various alternatives for modification of the Great Lakes Navigation System would involve building a variety of structures including locks, compensating works, confined placement facilities, breakwaters and docks. Construction of any of these structures could result in temporary declines in air quality associated with the operation of equipment and creation of dust.

Breakwaters and in-water placement disposal facilities may affect shore-lands by protecting these areas from the impact of open water wave action or by influencing littoral drift. The net result of this may be a change in erosion and deposition patterns along the shoreline.

Other impacts on shorelands are more directly related to human activities. Construction or improvement of dock facilities may result in increased development in harbor areas. Construction of in-water confined placement facilities would result in additional terrestrial areas that may be developed or used as wildlife habitat. On-land placement sites could drastically alter the habitat at the site and may affect future use of the area as has been discussed in the previous section.

During construction activities, building of all of the mentioned structures would have short-term impacts on local water quality. At worst, these impacts would be similar to those previously described for dredging as some excavation may be required. In most cases, water quality impacts would be less severe but of longer duration than those associated with dredging. Construction activities should not increase levels of nutrients or toxic materials in most cases but would probably increase turbidity. Even this effect should be relatively slight as construction activities deal mainly with the movement of rock and other inert materials.

Construction may cause changes in water flow patterns, which can drastically affect the local aquatic environment. In the case of lock replacement these changes would be largely short term, lasting only during the construction phase. Dock construction or improvement would generally occur in areas of little water circulation and in general, effects would probably not be of significance. Confined placement facilities may have significant long-term impacts. As discussed in previous sections, these impacts may be beneficial or detrimental depending on local conditions. Placement facilities may divert currents causing increased erosion or creating areas of reduced water exchange where pollutants may be concentrated. Such facilities may also be placed to protect sensitive areas from strong wave action and erosion damage.

Breakwaters and compensating works are designed to alter water flow patterns. Breakwaters are usually associated with harbor facilities. Their major impact on flow patterns often involves disruption of littoral drift and reduction of water exchange between the harbor and surrounding waters. Compensating works are designed to reduce the discharge of rivers in order to prevent changes in water levels. Fixed compensating works can result in areas of dead water immediately down-stream of the structures. The habitat in these areas can be drastically changed by such alterations in flow patterns.

Building structures can result in changes in local macrophyte and periphyton populations through changes in water quality, water flows, and available substrate. Productivity changes associated with water quality alterations have been extensively discussed elsewhere. New circulation patterns in an area may cause erosion or deposition of sediments, altering the suitability of the area for some species and resulting in changes in species composition.

The major impact of building structures is the result of directly destroying or creating habitats. The building of any structure may eliminate shallow water habitat that is suitable for macrophytes and periphyton growth. This is most evident in the case of confined in-water placement facilities that are located in shallow water zones and cover a substantial bottom area. Macrophytes and periphyton would be eliminated from this area during construction and dredged material placement. Some reestablishment may occur if sites are managed as wetland areas, but this seldom occurs in the Great Lakes. Many of the structures discussed do provide new periphyton substrate on the riprap walls associated with them. If periphyton was not abundant in the area lost to construction, a net benefit to this plant type may accrue.

Phytoplankton and zooplankton are less likely to be permanently affected by the building of structures than are the attached plants previously discussed. Short-term changes in water quality would influence these planktonic forms as would long term changes in circulation patterns resulting from the presence of structures.

Benthic invertebrates would be affected by the same water quality changes that influence zooplankton, and the same changes in habitat that impact the periphyton. Long-term impacts would be associated with altered circulation patterns and other changes in habitat. Where currents are drastically reduced due to compensating works or other structures, a shift in the species composition of the benthos would be expected. Similarly, new habitat provided by riprap near structures would also result in shifts in species composition in most cases. Net losses in benthic habitat would result from any structures that occupy a large area of the bottom.

Building structures would affect fish populations in a variety of ways. Noise, vibrations and changes in water quality would harass fish inhabiting the area during construction activities. This may be limited to just chasing fish from the area for a short period or it may interfere with a critical life period such as spawning. In the latter case long-term losses to the population may result. More permanent effects would be the result of habitat changes in the area. Changes in circulation patterns or losses of shallow water habitat are likely to result in reductions in important spawning and nursery areas.

New structures could also permanently interfere with spawning migrations in some cases. However, new spawning areas could be created along riprapped structures, and protected areas near structures may provide new nursery habitat. Additional important areas may be created if wetland development occurs as the result of protection afforded by new structures. Even when new structures do create additional fish habitat or compensate for habitat lost by their construction, changes in species composition may occur as types of spawning and nursery areas would be changed. Long-term impacts could also result from changes in invertebrate populations used as food sources.

Wildlife and birds in the vicinity of new structures would be harassed during construction but impacts would not often be significant. Increased development could result in obvious losses of wildlife habitat, particularly around dock and lock facilities. However, additional habitat could be created by other structures. Breakwaters are often used as resting sites by gulls and terns, and the quiet water areas created behind these structures are often used by waterfowl as resting and feeding areas. Similarly, compensating works may create areas of quiet water favored by some species of birds.

Development of confined placement facilities probably results in the greatest impact upon terrestrial wildlife and birds. Such facilities, when adjacent to shore, provide additional habitat for small mammals. When located offshore, these facilities often attract colonial nesting birds. New wetlands created in the lee of such structures are often found suitable for waterfowl and a large variety of other species.

Construction of Parallel Locks – The replacement or improvement of the locks of the Welland Canal and St. Lawrence River would require either the closure of the system while construction was underway or construction of new locks parallel with the existing locks. As the construction of a single lock would require several years, it seems likely that parallel locks (and canals where needed) would be constructed so that the existing system could continue to be used until the new system was completed. The construction of parallel facilities could result in the loss of valuable habitats, depending on site-specific conditions. In the case of the Welland Canal it is anticipated that an entire new canal and lock system would be constructed parallel to the existing system. This would require extensive construction and loss of terrestrial habitat. The habitat losses that would occur could be largely offset by carefully planned mitigation projects in the vicinity. In the St. Lawrence River much of the losses that could occur would be to the aquatic system. Again extensive mitigation projects would likely be required to offset habitat losses.

Changes in Navigation Season

The extension of the navigation season beyond the current season could affect future conditions through activities such as dredging, dredge material placement, winter navigation/icebreaking, construction of shore protection measures, the installation or modification of ice booms and aids to navigation, and the construction and operation of compensating works. Of these activities only winter navigation/icebreaking is unique to extension of the shipping season.

The movement of large vessels during the winter requires greater than normal power due to the resistance of the ice. Because of this, vessel movement not only creates the possibility of ice scouring of channel banks and bottoms, but also results in increased propeller wash, and drawdown and surge waves. Either of these factors could disrupt, dislodge, or destroy aquatic vegetation and benthic organisms that occur near navigation channels. Vessel movement during times of the year when fish are not normally active could induce activity and cause stress, ultimately influencing mortality rates. Spawning activities of those fish that traditionally spawn during late fall and winter months could also be affected. Icebreaking activities could directly impact mammals by blocking their movements across the ice. If vessel size or drafts increased along with an extension of the season, all of these effects would be magnified.

The impacts of extending the navigation season would be expected to vary in intensity with relation to the distance of shallow areas from navigation channels and the size of vessels operating on the system. Because of this, winter navigation is expected to have little impact on open, deep-water areas. Impacts on the connecting channels and other restricted areas would be of the type outlined above. The smaller the river or channel cross section and the larger the vessel cross section, the more dramatic the effects would be. In general, it would be expected that winter shipping would result in some reduction in habitat for fish and wildlife in the restricted areas associated with navigation, and some loss of recreational opportunities in comparison to present conditions. The significance of these losses is not defined at this time and would require site specific analysis.

Operation of Larger or Deeper Draft Vessels

Some of the economic benefits projected for an improved Great Lakes Navigation System are based on the operation of larger or deeper draft vessels in some parts of the system. The length and width of the largest vessels operating above the Welland Canal would not be expected to change. Several of the largest vessels now operating in the upper Great Lakes are capable of drafting 34 feet or more. These vessels routinely draft as much as water levels allow and would take immediate advantage of any available water depths between port pairs. The operation of larger vessels in Lake Ontario and the St. Lawrence River would not occur until new locks were constructed that allowed such vessels to enter from the upper lakes or the Atlantic Ocean.

Possible impacts of the operation of larger or deeper vessels include changes in air and water quality and their subsequent effects on the biota. It is assumed that larger or deeper vessels would consume more fuel and emit more pollutants to the atmosphere. However, as large vessels are currently the most fuel-efficient means of bulk commodity transport, a net decrease in atmospheric pollution would result from using larger or deeper draft vessels rather than alternative modes of transportation.

Larger or deeper draft vessel operation could directly influence shorelines through increased erosion associated with the larger drawdown and surge waves they create. However, it has been demonstrated that drawdown and surge wave size is more directly related to vessel speed than to vessel size. As maximum vessel speeds are legally limited in the connecting channels of the Great Lakes and other near-shore areas, increased erosion due to the operation of larger vessels could be controlled by vessel speed limits enforced by the Coast Guard to some extent. Some minimum vessel speed is required to maintain maneuverability.

Water quality may be affected by the operation of larger vessels in three basic ways. It has been speculated that the operation of larger vessels would result in larger discharges of bilgewater that could cause degradation of water quality in harbor areas. This possibility does exist, but it must be noted that increased vessel size should reduce the number of vessels required to carry the same quantity of goods. This reduction in vessel passages should offset the increased discharge per vessel.

Other possible water quality effects are related to the resuspension of benthic sediments by prop wash. It can be assumed that larger or deeper draft vessels would require more power and may create more propwash, especially in turning maneuvers that occur around harbors and in the connecting channels. Increases in resuspended sediments would be limited to local areas and those areas immediately downstream. Additional possible water quality impacts could result from accidental discharges of toxic cargoes or fuel. As larger vessels in the Great Lakes are likely to carry mainly iron ore pellets, coal, or containerized goods, discharges of toxic cargo appears to be unlikely. Thus, the most likely environmental effect in the event of a disaster would be the release of fuel oil into the aquatic system. Current information indicates that larger vessels would not carry significantly more fuel than those currently plying the lakes. It also seems probable that in light of the better maneuverability of newer vessels, the likelihood of vessel accidents would not increase. Therefore, increases in water quality problems associated with vessel accidents seem unlikely.

Impacts on macrophytes, periphyton, and benthic invertebrates may result from changes in water quality or directly from physical disturbances. The larger drawdown and surge waves associated with larger or deeper draft vessels may dislodge these attached forms. Impacts would only be expected where vessels pass close to habitats used by these organisms and these impacts could be minimized or eliminated by control of vessel speeds.

Other aquatic organisms including phytoplankton, zooplankton, and fish would also be subject to the effects of increased drawdown and surge waves. Of these organisms only fish would be potentially affected by the operation of larger or deeper draft vessels. Increased turbulence may dislodge eggs from favorable locations or result in more rapid covering of such areas with silt.

The operation of larger or deeper draft vessels would not be expected to have a significant direct impact on birds or terrestrial wildlife of the Great Lakes area.

<u>Additional Vessel Passages</u>

Modifications to the Great Lakes Navigation System would likely have different effects on various segments of the shipping industry. For commodities where the modifications would not be likely to greatly increase the amount of material shipped (such as coal and iron ore), deeper channels and larger vessels would allow the same amount of goods to be shipped using fewer vessel passages. Some segments of the shipping industry would have to experience growth to make system modifications economically justified. St. Lawrence Seaway/Welland Canal modifications would be expected to increase traffic through that portion of the system and to other major ports such as Chicago.

Additional vessel passages in confined portions of the system have the potential to generate adverse effects. More traffic would mean more drawdown and surge waves, bow waves, and propeller induced turbulence. This increased level of disturbance could generate additional turbidity in areas of soft sediment. The higher level of suspended sediments could adversely impact plankton and planktivore populations. Evaluating the probable impacts would require detailed site-specific investigations. Direct impacts to fish populations would likely be limited to early stages of the life cycle. Egg and larval stages could be impacted by being displaced from favorable spawning and nursery areas, or being covered by settling suspended solids. Direct impacts to other components of the aquatic system could include possible disruption of the attached plant and benthic communities near to the navigation channel.

The passage of more ocean going vessels through the St. Lawrence Seaway and the Welland Canal would provide more opportunities for the possible introduction of additional aquatic nuisance species to the Great Lakes ecosystem. Reconstruction of the Welland Canal and the locks along the St. Lawrence River may provide an opportunity to incorporate features into the system that would help to prevent species from entering the system in ballast water.

Comparative Impacts of Alternatives

Anticipated Without Project Conditions

Changes that are independent of improvements to the Great Lakes navigation system will occur in the environment of the Great Lakes area over the next several decades. Most of these changes will be the result of decisions made by the major industries and the governments of the United States and Canada and will center on economic developments and environmental protection issues. The following paragraphs briefly describe how the current environmental conditions are expected to change around the Great Lakes.

Many major aspects of the Great Lakes environment are expected to show little or no discernible change during the life of the project. Among these are geology and topography. Soil types would also be expected to remain the same although there may be some changes in fertility resulting from weathering and agricultural practices. It is anticipated that air quality in the upper Great Lakes area would improve slightly over the life of the project if current emission standards are enforced. This prediction assumes no major changes occur in the industrial base of the area and that the use of high sulfur coal does not increase drastically.

Water quality throughout the upper Great Lakes would be expected to continue the gradual improvement seen in the past several years. Improved wastewater treatment facilities and more conservation oriented agricultural practices should reduce nutrient loading to the system and subsequently reduce oxygen demand problems in the hypolimnion of the lakes. Tighter regulations on industrial discharges and better understanding of the consequences of use of toxic materials would be expected to reduce the discharge of these substances. These improvements would probably outweigh negative impacts associated with increases in shipping activity and increases in the population of this area, including the increased probability of a vessel accident and subsequent oil spill.

Human development along shorelines is expected to continue, but at a slower rate than in the past. Current laws are expected to retard the rate of filling of wetlands and other commercial development of shorelands. During periods of high water, some previously developed areas are expected to be reclaimed by the lakes via erosion. However, if consumptive use of Great Lakes water or climate changes result in a significant reduction in the levels of the lakes, some wetland areas will probably be dewatered or shifted lakeward. Current indications are that lowering water levels would result in a net increase in the area of these productive habitats.

New wetlands or other valuable shoreline areas will be created in some locations as the result of the well-placed disposal of spoils from maintenance dredging and small-scale navigation improvement projects. In other areas, local losses of shorelands and wetlands may result from such projects. Changes in bottom configurations at disposal sites or around new construction will alter habitat important to periphyton, benthic invertebrates, and fish. It is possible that such changes will significantly impact some local populations, but if current environmental protection regulations are enforced system-wide detrimental impacts are not expected.

Primary productivity throughout the Great Lakes will probably decrease slightly over the next 50 years. Some local changes in macrophyte and periphyton productivity associated with habitat alterations due to water level changes or dredging, disposal or construction activities may occur. As previously mentioned, the enforcement of current regulations will prevent most habitat losses associated with dredging and construction activities. However, significant decreases in water levels due to increases in consumptive use of Great Lakes water or climate changes may occur. Based on observations of wetland changes in response to lake levels, these water level changes are expected to lead to overall increases in habitat for macrophytes and periphyton. However, continued losses in primary productivity may be expected along the near shore zones of the lakes and throughout Lake Erie as a result of improvements in water quality. Future net productivity changes are difficult to predict with any certainty at this time.

Primary consumers in the system, particularly aquatic invertebrates, will respond directly to changes in primary productivity and water quality. Although decreases in primary productivity will reduce food supplies for these organisms, this detrimental effect is likely to be offset by improvements in water quality. Overall it is expected that the quantity of invertebrates will change insignificantly and the quality in terms of suitability for fish food will change more as a result of competition among species (particularly between exotic and native species).

Improvements in water quality would be expected to lead to gradually improved sediment quality conditions in some areas. The combination of these improvements would be expected to result in expanded available habitats for desirable benthic macroinvertebrates. Changes in species composition would also result as organisms that are relatively pollution intolerant return to areas that they had previously abandoned. Due to decreased primary productivity, some decrease in food resource for benthic organisms could occur, but significant impacts on the biomass of benthos would not be expected. Overall, a gradual increase in the populations of pollution intolerant benthic macroinvertebrates would be likely.

Fish populations in the Great Lakes will be affected by a number of factors over the next fifty years. Human encroachment on wetland areas and other potential spawning and nursery sites, and decreased water levels would decrease reproductive capacity. Wetland increases resulting from climate induced lower lake levels would tend to offset these changes. In addition, gains would be expected associated with the placement of artificial spawning reefs and other structures that could be suitable for fish spawning. Local pollution abatement programs that would be expected to allow fish to return to areas from which they had previously been eliminated could also make available additional spawning sites. Changes in available spawning and nursery areas would probably be slight overall.

Commercial fishing in the upper Great Lakes would be expected to continue to decline as state governments impose additional regulations aimed at increasing the recreational yield of the lakes. Populations of prime sport species would increase as the result of these management efforts and improvements in water quality throughout the system. These increases in game fish populations could result in some slight changes in species composition throughout the system.

Birds and wildlife in Great Lakes coastal areas would be affected by commercial and residential development of the shoreline, the placement of dredged material removed during maintenance dredging operations, and the increase in wetland areas due to decreasing water levels. Of particular significance would be changes in wetland areas important to aquatic oriented species. Overall, losses would probably be limited and offset by improved management techniques, expanded wetlands, and the establishment of preserves and other protected areas.

One of the biggest unknowns in forecasting the ecological conditions in the Great Lakes over the next 50 years is the impact of aquatic nuisance species. Major changes have occurred in species composition and abundance, and energy flow, since the European settlement of the Great Lakes Basin as the result of the introduction of non-native species. Some introductions have been intentional such as carp and Pacific salmon, but most have been accidental. The majority have been detrimental to the ecological balance of the Great Lakes system. The introduction of the sea lamprey probably had the most dramatic effect, but the full effect of other species including a variety of benthic and planktonic invertebrates, and several species of fish, are still to be determined. It is difficult to predict how the presence of these species will affect the ecosystem of the Great Lakes and the rest of the nation over the next 50 years. It is impossible to predict how many additional species may enter the system over that time frame. It does seem likely that the rate of introduction of new species will be reduced by efforts to assure ballast water exchange and other measures being adopted for ocean going vessels. It also seems inevitable that those species currently in the upper four Great Lakes will become more widely distributed both in and out of the basin.

Threatened and endangered species would be expected to become re-established in some areas due to improved environmental quality and management efforts.

<u>Option 1 - Upper Great Lakes System Channels/ Harbors Deepening up to 30 Feet</u>

Implementation of this option would be expected to result in the use of deeper draft vessels on the Great Lakes system above the Welland Canal. These vessels would discharge more atmospheric pollutants to the environment on a per vessel basis, however fewer vessels would be required to carry an equivalent amount of cargo. Extensive improvement of the system would probably result in the diversion of some cargo from land based modes of transportation. It is likely that shifting cargo from trucks or trains to ships would result in a net decrease in atmospheric emissions attributable to cargo transport. Increased industrial development encouraged by the improved transportation system could have some negative impacts on air quality, but this would be limited by current emission standards. Modal shifts and industrial development would depend upon economic issues including the cost of transporting goods. Overall, implementation of this alternative would not be expected to significantly affect the air quality of the region.

Some increase in shoreline development would probably accompany major structural improvements of the upper Great Lakes system, as improved transportation facilities would attract industries. Additional changes would result from the placement of confined disposal facilities (CDF) adjacent to the shoreline, or the building of structures that could alter littoral drift. Changes associated with CDF construction could be significant if major dredging takes place. The environmental effects of these changes could be beneficial or detrimental, depending on specific locations. The effects of erosion on shorelands resulting from the operation of larger vessels would probably be slight provided vessel speed limits are enforced.

Dredging and construction activities associated with this alternative could result in significant local short-term changes in water quality throughout the harbors and connecting channels under consideration. In some areas long-term degradation could result from the a1teration of flow patterns or the leaching of contaminants from confined disposal facilities. However, these problems could largely be avoided through proper design and construction. Long-term improvements could result from the removal and confinement of heavily polluted sediments in some areas. Changes in the number and type of vessels using the system may have some effect on water quality as deeper draft vessels tend to generate more turbulence during passage and could re-suspend more sediment. This would be offset to some extent by the deeper channels in use and a possible lower number of vessel passages. Overall impacts on the water quality of the upper Great Lakes would be expected to be minor.

Macrophytes and periphyton would probably suffer some long-term loss of habitat at about half of the site specific areas considered due to CDF construction and channel widening. More significant losses are likely in the connecting channels, and in harbors that have long approach channels or extend considerable distances up a river. It is possible that CDF placement could result in some creation of new habitat if these structures are placed where they could effectively function as barrier islands, or if the CDFs are themselves managed as wetlands. However, habitat gains that could result from CDF construction are difficult to predict at this time. A net loss in macrophyte and periphyton productivity would be expected if this alternative was implemented, but the impact would probably not have a significant system-wide effect. Local loss of habitats provided by macrophytes would be more important than the loss of productivity.

Extensive dredging and construction activities and the water quality changes they evoke would cause some short-term local changes in phytoplankton and zooplankton populations. Where large amounts of nutrients are made available, phytoplankton productivity could increase dramatically followed by a short-term increase in zooplankton populations. Conversely, if large amounts of toxic materials or solids were suspended in the water column, plankton populations could decline. High levels of suspended solids could limit light penetration and reduce phytoplankton productivity, or these solids could stress zooplankton and make them more susceptible to disease.

Implementing this plan could result in the possible leaching of compounds from disposal sites, or changes in water flow patterns. If significant leaching occurred, the short-term impacts described above would be expected to persist. This seems unlikely. Alterations in water flow patterns, particularly around compensating works or CDFs, could change a lotic environment to a lentic environment more suitable for planktonic species. These long-term changes would be expected to be very localized and minor. Overall, system-wide impacts to phytoplankton and zooplankton populations that are associated with this plan would probably be insignificant and most local impacts would be short-term in nature.

Short-term local impacts on benthic invertebrates resulting from physical removal and changes in water quality would be expected to occur wherever dredging or construction takes place. In addition, virtually all site-specific areas would suffer long-term losses in benthic macroinvertebrate populations as the result of channel widening. These losses might be partially offset by subsequent gains in habitat at confined and open water disposal sites, but in many locations a net loss of high quality benthic habitat is expected. This is particularly true in the connecting channels and those harbors that have long approach channels, or channels which extend up a river. It is estimated that roughly one-third of the areas examined would fall into this category. Some of these local losses would be important and a net loss of undetermined significance is expected system-wide.

Impacts upon fish at specific sites would vary with respect to location. Short-term impacts associated with harassment, blasting, entrainment, and/or changes in water quality would be likely wherever extensive dredging occurred. Some of the impacts could be noticeable for several years if spawning success was reduced by disruption of migratory movements or incubating eggs. Long-term impacts would generally be attributable to loss of a limiting habitat. Of particular concern in this regard is the possible loss of spawning and nursery areas. Long-term negative impacts would be expected at some sites but further site specific analysis would be required to determine their significance.

It is possible that some harbor areas could benefit from the creation of spawning reefs associated with the open water placement of rocky materials, however this is unlikely at most sites reviewed. Additional impacts upon fish populations could result from reductions in productivity at lower tropic levels. Major dredging of all the locations involved with this alternative could result in noticeable system-wide decreases in the populations of some species, but it is more likely that impacts would be measurable only in the areas immediately around the harbors or near to the connecting channels. These impacts would have particular significance in areas around the harbors and connecting channels that receive extensive fishing pressure. Local losses would also be especially important to species that have limited habitats already, such as many threatened or endangered species.

Birds and wildlife would most likely be affected through the placement of dredged material. Destruction of wetland habitat via filling would be detrimental to aquatically oriented species. Conversely, any wetlands created in connection with dredged material placement would be beneficial. Terrestrial habitat may also result from dredged material placement if the area is not developed for industrial purposes. These areas would probably be particularly attractive to colonial birds such as gulls and terns. Upland placement could displace species from the area or, if placement takes place at a previously disturbed site such as a quarry, habitat in the area could be improved. Local impacts of terrestrial placement associated with this plan could be significant but cannot be assessed at this stage of the study due to insufficient information concerning placement sites. System-wide impacts of this plan on birds and wildlife would probably be insignificant for most species. Some wetland dependent species may be impacted if wetland losses occur adjacent to channels.

Option 2 – Deepen the Upper System and Rebuild the Welland Canal

This alternative would cause all the impacts identified for Option 1, and result in some additional effects. The reconstruction and expansion of the Welland Canal System would allow the movement of the largest Great Lakes vessels into Lake Ontario. This would be expected to result in the movement of more goods between the upper and lower lakes by vessel than would occur under the without condition. The increase in vessel traffic would be expected to result in less overland (truck and train) traffic and a greater net decrease in atmospheric emissions attributable to cargo transport than Option 1.

Some expansion of shipping facilities and associated industries in Lake Ontario would be expected in addition to that projected for the upper part of the system. This could result in the loss of some shoreline habitat if development extends beyond current industrial areas. As in Option 1, shoreline areas may also be affected in some areas where dredged material placement occurs. Impacts under this alternative could extend to Lake Ontario harbors. The net effects on shoreline areas could be positive or negative depending on how carefully modifications are planned and constructed.

Potential water quality impacts associated with dredging and harbor modifications would also extend beyond the upper Great Lakes into Lake Ontario under this option. Potential short-term effects could be expected at either end of the Welland Canal and at selected harbors during construction. Long-term water quality impacts would be limited to those associated with vessel passage. Deeper draft vessels would be expected to have marginally greater impact as they would generate larger waves and more propeller wash. The number of passages that would occur would depend on how much traffic moved from land based systems to vessels. Industrial growth in the area could also be spurred by reduced shipping costs. These types of impacts are unlikely to be significant beyond local areas of harbor expansion because major increases in vessel passages would not be expected.

Effects on primary production, and invertebrate and fish populations would also be similar to those described for Option 1, but extended to selected Lake Ontario harbors. Those impacts may be measurable in localized areas but are unlikely to have system-wide significance.

The major additional impacts associated with this alternative would be terrestrial. Replacement of the locks of the Welland Canal would likely involve the construction of a parallel series of locks so as to allow traffic to continue while construction is underway. This would mean that extensive excavation would be required in the vicinity of the current canal and lock system. Site-specific review would be required to assess the magnitude of potential impacts to terrestrial habitats and wildlife. Careful planning and mitigation should allow any impacts that do occur to be mitigated.

The modifications proposed under Option 2 would not be expected to increase the movement of ocean going vessels through the system. Therefore this alternative would not be expected to increase the threat of the introduction of additional invasive species. However, the design and construction of a new system of locks would allow planners to investigate possible measures that could be taken to reduce the threat of the introduction of new species to the upper Great Lakes below that which would exist without the project.

Option 3 – Provide for up to a 35-foot Draft throughout the System up to Detroit

As Option 2 built upon Option 1, this alternative extends a 35 ft. draft system from the Welland canal up to the City of Detroit and downstream through the St. Lawrence River to the Atlantic Ocean. This would likely involve extensive dredging in western Lake Erie as well as the St. Lawrence River and affected harbors. These modifications would allow larger ocean going vessels access to the entire Great Lakes and allow the largest Great Lakes vessels (Class 10) to move through the Seaway. It is anticipated that such modifications would result in significant changes in vessel traffic and port development. The types of environmental effects resulting from these modifications would be the same as those described in Options 1 and 2, but the magnitude would continue to grow.

More shipping and more development at ports would mean more emissions from navigation and associated industries than under the previous scenarios. However, the modal shift in transportation from land to water would result in a reduction in overall transportation emissions when compared to the without project condition. The significance of this reduction is yet to be determined. In addition, the reduced truck traffic would reduce the need for road repairs and traffic delays, both of which contribute to air emissions. Of course the extensive construction associated with this alternative would cause short-term, localized increases in emissions, but these effects would be overshadowed by the long-term benefits resulting from the shift to water based transportation.

Adverse effects on water quality would be greater under Option 3 than under the previous plans. The large increase in dredging associated with construction would result in significantly more sediment re-suspension during dredging and placement. Because of this there would be greater potential for the redistribution of contaminants and nutrients associated with the sediments. Increases in the number and size of vessels moving through Lakes Erie, Ontario and the St. Lawrence River would also potentially result in adverse water quality effects. Although a larger vessel passing through a larger channel would probably not induce significantly more sediment re-suspension than would occur under the without project conditions, in many areas these larger vessels would be moving through areas where they have significantly less clearance and take up significantly more of the channel cross section. In these areas greater drawdown and surge waves, and propeller turbulence would occur, often resulting (depending on the substrate) in a greater re-suspension of sediments. On the positive side, deepening channels to over 35 feet would likely remove the vast majority of contaminated sediments from the channel. This should provide some water quality benefits.

Impacts to primary productivity would be potentially greater under Option 3 than the previously discussed plans because this plan is more extensive. However, impacts to phytoplankton would not be expected to be significant, and impacts to attached plants would be largely limited to those areas where construction occurs. If suitable habitat exists in areas where dredging would occur, this habitat would be lost. This would primarily be along the sides of the channels to be deepened where the resulting side slope may cut into previously undisturbed areas. Additional adverse impacts could result from the increased number and size of vessels moving through the lower part of the navigation system.

The extensive amount of dredging and construction required for this alternative does provide additional opportunities for environmental enhancement. The fact that large quantities of material are being excavated means that placement of that material is a cost that is included in general construction expenses. Often the additional cost of placing the material for environmental benefits is negligible, so opportunities exist for wetland (or other habitat) creation. With careful planning these beneficial placements could offset the negative impacts on primary production.

Invertebrate populations could also be impacted more extensively by this option due to the more extensive dredging. Zooplankton effects would likely be limited to those associated with water quality changes during dredging, and changes in phytoplankton productivity. Benthic invertebrates would be affected by dredging, but the only long-term effects would be in areas that had not previously been dredged. This is because benthic populations in dredged channels are not very productive due to maintenance dredging and disturbance by passing vessels. The increase in vessel sizes and number of passages would not be expected to have a significant effect on benthic populations in the channel. Outside the channel, benthic and epiphytic populations would be influenced in a similar way as rooted aquatics. In areas where vessel passages result in areas adjacent to the channel becoming unstable due to the loss of vegetation or the sediment re-suspension, some invertebrate losses may occur. However, careful placement of dredged material that resulted in productive areas (such as wetlands) or stable sites (such as submerged reefs), could enhance local invertebrate populations. The overall impact on invertebrates would depend upon how effectively excavated materials are placed for environmental benefits.

Impacts to fishery resources would generally be expected to be more adverse than the previously discussed options strictly based on the magnitude of the modifications proposed. Dredging, dredged material placement, and construction over a larger area increases the possibility of damaging important spawning or nursery areas. Assessment of potential impacts would require extensive site specific investigations. Again, careful planning and placement of excavated materials could offset many of the potential negative impacts through the creation of wetlands and spawning reefs.

Terrestrial impacts would be limited to around lock construction sites and dredged material placement areas. Under this option, as under Option 2, new locks would likely be built parallel to the existing locks to allow continued operation during construction. The impacts associated with this construction may be important depending on site specific conditions. Overall, terrestrial impacts would be greater than under Option 2, but could likely be offset by careful site development and the construction of compensation areas.

The larger locks and deeper channels extending to the Atlantic would be expected to result in a significant increase in international trade through the system. This would result in increased opportunities for the introduction of new species into the Great Lakes ecosystem. As discussed in Option 2, the construction of new locks provides an opportunity to incorporate features to help prevent these introductions. The nature of possible features is unknown at this time.

Option 4 – Extension of up to a 35-foot Draft System throughout the lower Four Great Lakes

Under this alternative, locks and channels accommodating vessels drafting up to 35 feet would be constructed throughout the system from the Atlantic Ocean to Chicago. This would involve dredging the Detroit River, Lake St. Clair, and the St. Clair River channels as well as the involved harbors and all areas included in Option 3.

Environmental effects associated with this alternative would include all those described for Options 1 through 3 and those associated with deepening the Detroit/St. Clair system and select harbors in Lakes Huron and Michigan. Not only would deepening the Detroit/St. Clair system require extensive dredging (particularly in Lake St. Clair), but also likely involve the construction of compensating works to retard the flow of water from Lake Huron to Lake Erie. Extension of the 35-foot system to Chicago would be expected to result in increased traffic, particularly containerized goods from the Atlantic.

The shift from land to water based transportation for many goods moving to and from Chicago would result in significant reductions in transportation related atmospheric emissions and the easing of road congestion on the roads leading to ports such as Chicago. The increase in vessel traffic would likely spur additional development in the major ports. This coupled with the placement of additional dredged material both during construction and maintenance would have the potential to impact shoreline areas along the connecting channels and around the modified ports.

Water quality impacts associated with dredging, disposal, and vessel passage would again be increased due to the extension of the 35-foot system. Vessel passage impacts would be of particular concern in constricted harbors and the connecting channels of the Detroit/St. Clair System.

Impacts to the biotic community described for Option 3 would be extended through the Detroit/St. Clair System and into select harbors on Lakes Huron and Michigan. Assuming that compensating works maintain water levels on the lakes, the impacts would be restricted to constricted areas in harbors and the connecting channels. Of particular concern would be Lake St. Clair and the Detroit and St. Clair Rivers where the channels would require deepening by 9.5 feet below the without project condition. Dredging of this magnitude would result in the loss of habitat adjacent to the channels due to slope of the channel sides. This is particularly important in areas that are naturally shallow.

Fish and wildlife impacts would be associated with habitat losses due to dredging or ship induced turbulence. The additional dredging and construction of compensating works would increase the possibility that significant habitats could be adversely affected. Wave induced disturbance due to additional vessel passages would also tend to stress adjacent habitats and make them less valuable. Additional vessel passages for the Atlantic through the Seaway would increase the threats of the introduction of new species to the system.

Option 5 – Extension of up to a 35-Foot Draft System from the Atlantic to Duluth Harbor

Continuation of a 35-foot draft system into Lake Superior would require extensive dredging in the St. Marys River and Duluth-Superior Harbor. Compensating works may also be required in the St. Marys to maintain water levels in the river. The extension of the 35-foot system to Lake Superior may induce some additional international traffic to export grain.

The additional environmental impacts associated with the extension of the 35-foot system to Duluth (above those described for Options 1-4) would stem from modifications described above. Duluth Harbor is not naturally deep and currently requires frequent maintenance dredging. Deepening to allow vessels to draft 35 feet would result in the loss of some shallow water habitat adjacent to the channel. This would also be the case along the St. Marys River, which has extensive wetlands along its shorelines.

All of the impacts described for the Detroit/St. Clair System would also be of concern in the St. Marys River. Site-specific studies would be needed to determine which areas would be lost due to a 9.5-foot deepening of the channels. Vessel induced waves would also be of concern in several constricted reaches of the river. Such waves may damage wetland margins and erode these valuable habitats.

Summary

The modifications to the Great Lakes/St. Lawrence Seaway Navigation System being considered at this preliminary stage of the study include a range of major system-wide changes. As would be expected, the more extensive the proposed modifications, the greater the potential environmental impacts. Each of the considered options present potential environmental concerns. As the options are considered sequentially from 1 through 5, those concerns magnify.

Each of the options presented involve dredging. Deepening to allow a 30-foot draft would involve the removal of 4.5 feet of material in some channels, while providing for a 35-foot draft would result in the removal of 9.5 feet of material in some channels. In areas of soft sediment that are currently dredged, this could mean a widening of the channel by about 60 feet. Widening could cause significant damage to adjacent habitats in restricted areas. Dredging to allow a draft of 35 feet could generate hundreds of millions of cubic yards of material requiring placement. This would present a major challenge to planners finding placement sites, and an opportunity for the beneficial reuse of the material.

Construction activities identified at this point in the study involve the rebuilding and enlarging of the locks of the Welland Canal and the St. Lawrence River. On-site activities associated with this work would likely disrupt relatively large land areas. In addition, major deepening of harbors throughout the system would require rebuilding of many docks and other navigation structures. However, it seems likely that most of the area lost to construction could be mitigated. Site-specific studies would be required to accurately assess probable impacts.

Beyond the actual building of larger locks and deeper channels, the identified options have the potential to significantly change the effects of Great Lakes shipping on the environment. For the more extensive modifications discussed to be justified from an economic perspective, they would have to change the way goods are transported to the Great Lakes region. The amount of goods shipped, and the number of passages required to move these goods would dramatically increase. This increase in the number of passages, along with the increase in vessel size, has the potential to cause significant impacts on biota in constricted areas of the system. Control of vessel speeds would minimize these potential impacts.

Vessels entering the Great Lakes from the Atlantic Ocean have the potential to introduce new species to the region. Over the past century the introduction of new species by way of the navigation system has had a dramatic effect on the ecology of the Great Lakes. Building new locks would increase traffic and marginally increase the risk unless a procedure can be identified to prevent future introductions.

Accurate evaluation of the environmental effects of any of the identified options would require site-specific review of all areas to be modified, review of the projected fleet mix and traffic forecasts, and an analysis of how these changes would affect the biota of constricted areas. This evaluation should consider the positive effects of a shift from land to water-based transportation on atmospheric emissions and reductions in road damages, as well as the possible mitigative measures that could be taken to offset impacts to the aquatic environment. Detailed review of potential environmental impacts would be undertaken during the feasibility phase of the study.