# CHAPTER II

# OVERVIEW OF THE UPPER GREAT LAKES CONNECTING CHANNELS

## 1. Introduction

The Upper Great Lakes Connecting Channels serve as conduits for the waters of the upper lakes (Superior, Michigan and Huron) to feed into the lower lakes (Erie and Ontario - Figure II-1).

The setting for the Connecting Channels is the Great Lakes Basin. This basin is the product of complex geological, hydrological, climatological, biological and sociological processes operating over various scales of time[1]. These processes are not static but dynamic and thus, the system will continue to evolve. This report is, therefore, very much a snapshot in time. However, its implications are far reaching. Implementation of the recommendations will influence the nature and quality of our Great Lakes Ecosystem as it evolves.

The Upper Great Lakes Connecting Channels are integral components of the Great Lakes Basin. They function as the plumbing system of the lakes' basins funnelling large volumes of water, sediment and nutrients through relatively narrow channels. As such they have been an attraction to both wildlife and humans.

Nutrients and diverse habitat conditions have provided sustenance to large populations of numerous species of flora and fauna, particularly fish and waterfowl. The abundance of game as well as fresh drinking water attracted native Indian settlements. Europeans, in turn, were attracted to these channels for the additional benefits related to shipping; relative ease of

---

[1] For an overview of these process and additional references, the reader is referred to (1).

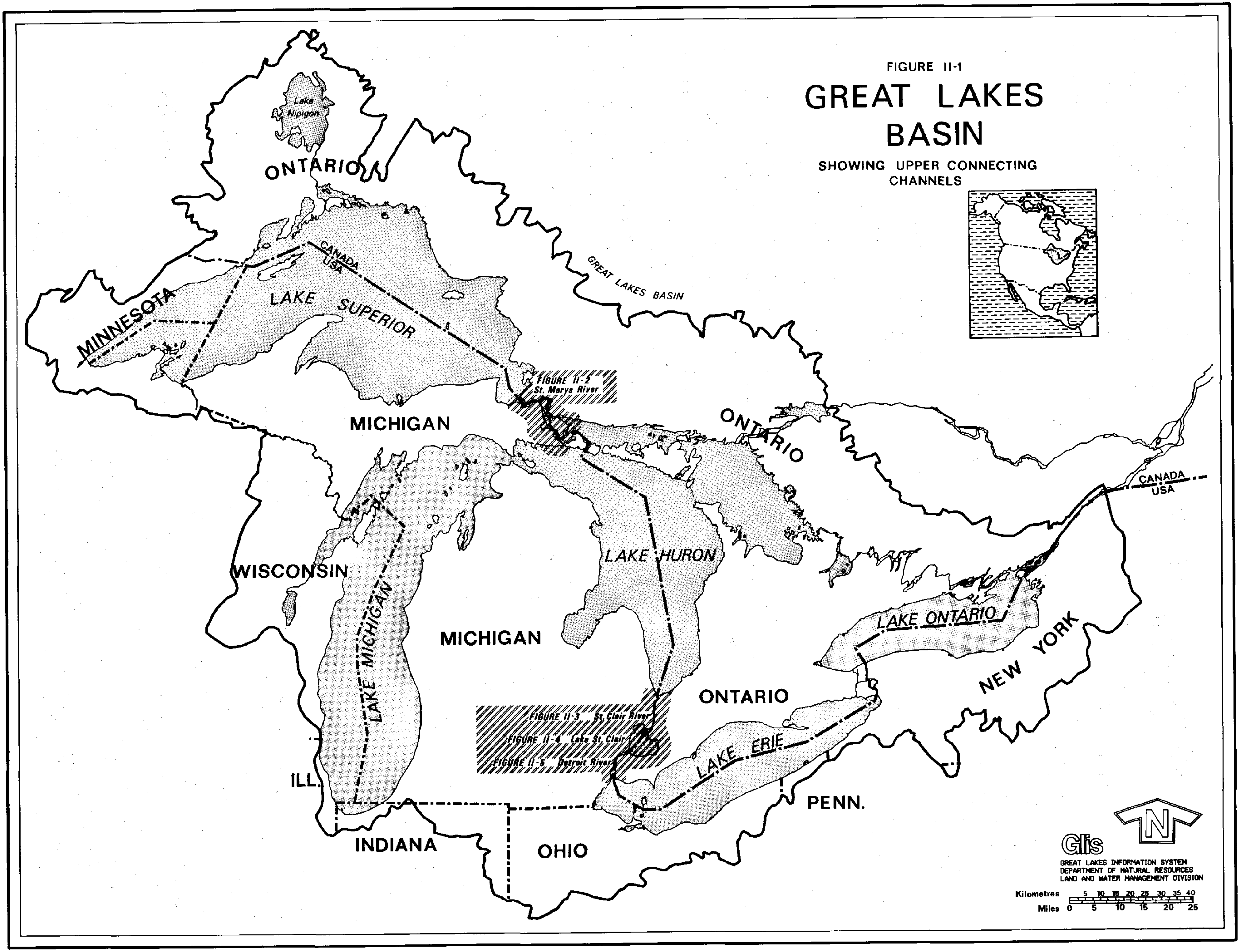


FIGURE II-1

# GREAT LAKES BASIN

SHOWING UPPER CONNECTING CHANNELS

crossing (each river is currently a major international crossing point); large volumes of water for cheap power, industrial processes and waste receiving; and recreational pursuits.

The vastness of the Great Lakes' water and fisheries resources must have appeared limitless to the early Europeans. However, physical damages as a result of dredging (channels), filling (wetlands), increased sedimentation and water temperature (related to forest clearing for agriculture), and over-fishing, along with pathogen loadings (from human waste) quickly impacted the ecosystem. In less than 100 years of settlement, by the early 1900s, these impacts were considered very serious and resulted in disease and death among dwellers along the channels.

Physical and chemical disruptions continued through the 1900s resulting in crashes of certain native fish populations and increasing occurrences of oil films, human waste, dead fish, algae and other visible problems. Less visible but just as serious types of pollutants - heavy metals and organic chemicals - were released into the ecosystem virtually uncontrolled during the mid-1900s. Mercury, lead, DDT, PCBs, and others were released as products of the rapidly growing North American industrial complex. The Great Lakes Connecting Channels (including the Niagara and St. Lawrence Rivers) were home to many of the industries manufacturing, utilizing, and discarding these contaminants.

Since about 1970 environmental concern and actions by federal, state and provincial governments have resulted in dramatic improvements. Industrial and municipal sources of contaminants have been controlled to various degrees. However, we have the legacy of historical pollution manifested in river and lake sediments (in-place pollutants) and groundwater contributions from active and inactive waste sites.

Continued improvements to the Great Lakes ecosystem must consider these, along with ongoing discharges, and inputs from diffuse sources such as urban and agricultural runoff and atmospheric deposition.

The remainder of this chapter will summarize characteristics of the St. Marys, St. Clair and Detroit rivers and Lake St. Clair. Each area is portrayed in Figures II-2 through II-5 and specific information is provided in Tables II-1 through II-4. These tables summarize watershed characteristics (II-1), water uses (II-2), land uses (II-3), and environmental concerns (II-4) comparatively for each of the 4 study areas. Each area is discussed in detail with regard to study findings and recommendations for remedial measures in Chapters VI through IX.

TABLE II-1

Watershed characteristics of the Upper Great Lakes Connecting Channels.

| | St. Marys River | St. Clair River | Lake St. Clair | Detroit River |
|---|---|---|---|---|
| Inlet | L. Superior | L. Huron | St. Clair R. | Lake St. Clair |
| Outlet | L. Huron | L. St. Clair | Detroit River | L. Erie |
| Length (Area)* | 101-121 km | 64 km | 1,115 $km^2$ | 51 km |
| Elevation Fall(m)* | 6.75 | 1.5 | - | 1.0 |
| Flow $m^3/s \times 1000$** | | | | |
| Minimum | 1.2 | 3.0 | - | 3.2 |
| Average | 2.2 | 5.2 | - | 5.3 |
| Maximum | 3.7 | 6.7 | - | 7.1 |
| Average Flow Vel. m/s* | 0.6-1.5 | 0.6-1.8 | 0.02-0.08 | 0.3-0.6 |
| Depth (m)* | Shallow-30 | 9-21 | 3.4 avg.<br>8.2 max. | 6-15 |
| Width (km)* | 0.3-6.4 | 0.25-1.2 | 39 | 0.66-3.0 |
| Retention Times | ~2 days | 21 hrs | 2-9 days | 21 hrs |
| Controlled Flow | Y | N | N | N |
| Land Drainage Area*** $km^2$ x 1,000 (cummulative total) | 49.3 | 146.6 | 159.0 | 160.9 |

* LTI document (2).
** David Cowgill, U.S. Army Corps of Engineers, pers. comm.
*** Calculated from (1) and (2).

TABLE II-2

Water use of the Upper Great Lakes Connecting Channels.

| | St. Marys River | St. Clair River | Lake St. Clair | Detroit River |
|---|---|---|---|---|
| Shipping | S | S | S | S |
| Commercial Fishing | L | N | F | N |
| Sport Fishing | S | S | S | S |
| Boating/Sailing | F | S | S | S |
| Swimming | L | F | S | O |
| **SURFACE WATER SUPPLIES TO:** | | | | |
| Drinking Water Intake | | | | |
| - Municipal | X | X | X | X |
| - Communal/Private | X | X | X | X |
| Industrial Intakes | | | | |
| - Iron & Steel | X | | | X |
| - Pulp & Paper | X | | | |
| - Petrochemical | | X | | X |
| - Refining | | X | | X |
| - Thermal Generating | | X | | |
| - Hydroelectric | X | | | |
| - Navigation (Locks) | X | | | |
| - Mineral (Salt & Lime) | X | | | |
| **RECEIVING WATER FOR:** | | | | |
| Municipal STP | X | X | X | X |
| Industrial | | | | |
| - Iron & Steel | X | | | X |
| - Pulp & Paper | X | | | |
| - Petrochemical | | X | | X |
| - Refining | | X | | |
| - Thermal Generating | | X | | X |
| - Mineral (Salt & Lime) | | | | X |
| - Fabrication (Auto) | | | | X |
| Ship Ballast | X | X | X | X |

N - Negligible Use
L - Limited Use
O - Occasional Use
F - Frequent Use
S - Significant - High Use
X - Present

TABLE II-3

Land use within 5 km of the Upper Great Lakes Connecting Channels' shoreline.

| | St. Marys River | St. Clair River | Lake St. Clair | Detroit River |
|---|---|---|---|---|
| Urban | F | F | O | S |
| Rural Residential | O | S | O | F |
| Agricultural | N | O | S | O |
| Recreational (Marinas/Beaches) | O | F | S | S |
| Wildlife Habitat/Open Space | S | F | F | L |
| Industrial | O | S | N | S |
| Waste Disposal | X | X | X | X |
| Native Lands | X | X | X | N |

N - Negigible Use
X - Present
L - Limited Use
O - Occasional Use
F - Frequent Use
S - Significant - High

TABLE II-4

Summary of contaminant concerns in the Upper Great Lakes Connecting Channels.

| Contaminant | Water | | | | Sediment | | | | Biota | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SM* | SC | LSC | D | SM | SC | LSC | D | SM | SC | LSC | D |
| Nutrients | | | | | | | | | | | | |
| - Phosphorus | SM | | LSC | D | | | | | SM | | LSC | D |
| - Nitrogen | SM | | LSC | D | | | | D | SM | | LSC | D |
| Bacteria | SM | SC | | D | | SC | | | | | | |
| Chlorides | | SC | | D | | | | | | SC | | D |
| Oil and Grease | SM | SC | | D | SM | SC | | D | SM | SC | LSC | D |
| Phenols | SM | SC | | D | | | | | SM | SC | | D |
| Pesticides | | | LSC | | | | LSC | | | | LSC | D |
| PCBs | | | | D | SM | SC | LSC | D | SM | SC | LSC | D |
| PAHs | SM | | | D | SM | SC | LSC | D | SM | SC | LSC | D |
| Other Organics | | SC | | D | | SC | LSC | D | | SC | | D |
| Heavy Metals | SM | SC | LSC | D | SM | SC | LSC | D | SM | SC | LSC | D |
| Mercury | | SC | | | SM | SC | LSC | | SM | SC | LSC | D |
| Cyanide | SM | | | | | | | | | | | |
| Habitat Alteration | | | LSC | | | SC | LSC | D | | SC | LSC | D |

* SM - St. Marys River    LSC - Lake St. Clair
D - Detroit River    SC - St. Clair River

## 2. St. Marys River[2]

The St. Marys River delivers the outflow of Lake Superior to Lake Huron (Figure II-2). It is partially controlled by locks and compensating structures to allow navigation and power generation. Thus, the river is not subject to large unpredictable fluctuations in flow rates. Sediments in the river range from sands and gravels, particularly in the upper reaches and near the rapids, to silts and clays. The finer material generally occurs in downstream locations and in embayments. The St. Marys River has an active sports fishery based primarily on trout, salmon, walleye, yellow perch, pike, and smelt. It formerly supported a major whitefish commercial fishery. The river is known to have 75 species of fish.

Water is withdrawn to provide the major source of drinking water[3] for a U.S. population of approximately 15,000 as well as process water for the steel industry (Algoma Steel Co.), pulp and paper processing (St. Marys Paper) and other smaller industries. Most of the industrial development is found on the Canadian side of the River which is also home to the largest population along the river (85,000). Other primary water uses include navigation and recreational boating.

The watershed draining into the river is predominantly forested with low intensity agriculture occurring on the relatively flat-lying plains or either side of the river.

Industrial and municipal effluents have resulted in contaminant problems in sediment and water related to phenols, cyanide, PAHs, PCBs, iron, zinc, phosphorus and ammonia. Contaminant problems have also resulted in impaired benthic fauna. Physical disruption related to power generation and navigation has also adversely impacted fish habitat. Past surveys of sediment, benthos and water quality indicate that conditions along the U.S. shore and in Lake Nicolet are good and these areas can support a variety of water uses. The zone of greatest impact in the St. Marys River is along the Canadian shore downstream of industrial and municipal discharges. This zone includes the Algoma slip, the area below the rapids, the Sault Ste. Marie waterfront and downstream of the East End Sewage Treatment Plant in the channel feeding Lake George.

---

2 Primary sources for sections 2 to 5 are (2,3).

3 Wells provide the primary source of drinking water for the Canadian population. It is supplemented with St. Marys River water as necessary.

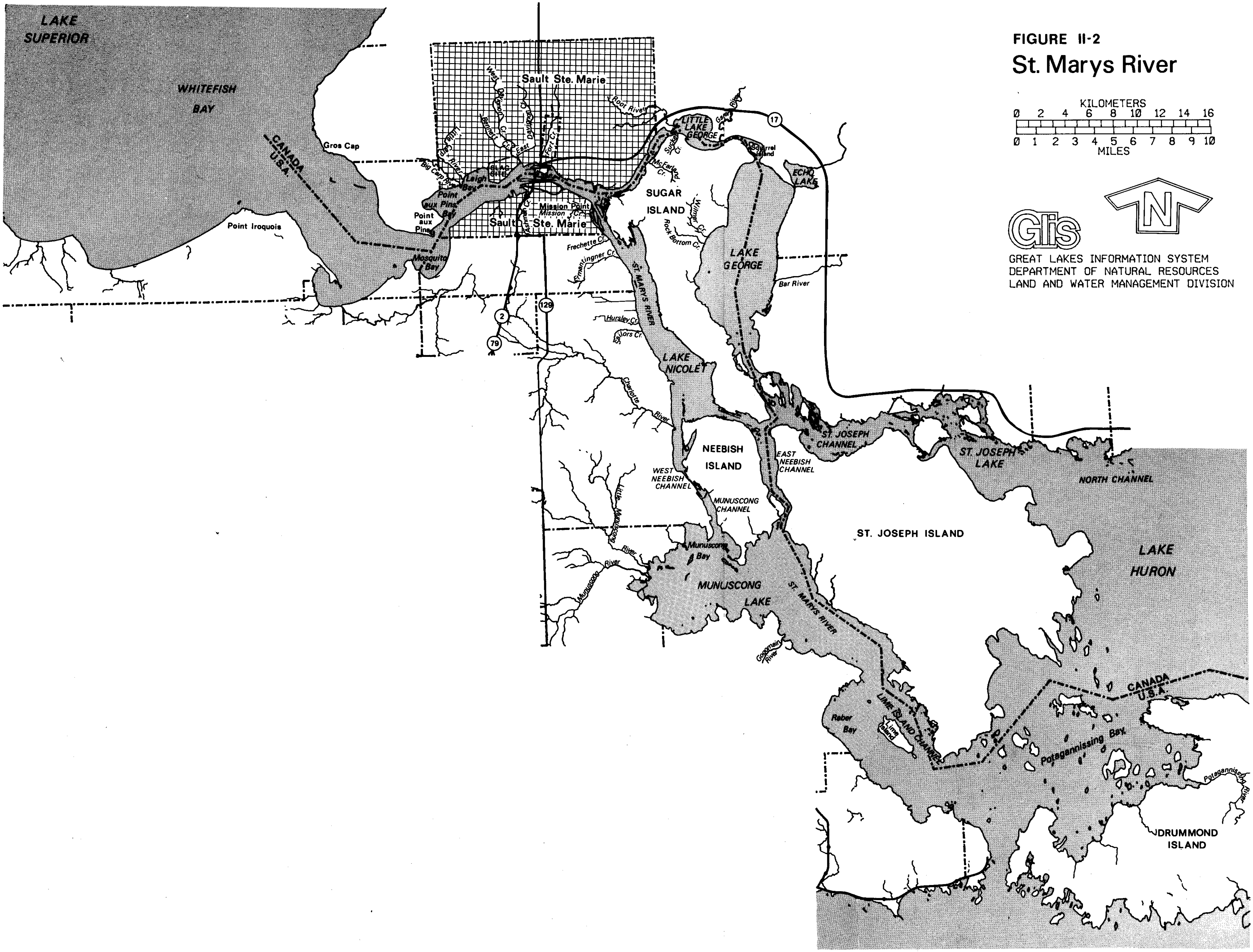


**FIGURE II-2**
**St. Marys River**

3. St. Clair River

The St. Clair River is not controlled in any manner. It serves as the natural outlet of Lake Huron and drains into Lake St. Clair where it has formed the only major riverine delta on the Great Lakes - the St. Clair delta, also known as the St. Clair flats (Figure II-3). The conditions which have contributed to the formation of this delta include: rapid deceleration of the flow from the river as it disperses into the wide shallow basin of Lake St. Clair; very high suspended sediment loads carried by the river from sources in the Lake Huron watershed; stable conditions at the river/lake interface since the channel was first established; and the straight channel of the St. Clair River with few islands or other depositional sites.

The bed of the river is characterized by relatively coarse fractions consisting of sand and gravel and by an erosional surface of clay till. This reflects the high energy environment of the river which acts as a conduit to Lake St. Clair and the delta for the finer material (fine sands, silts, and clays) originating in the Lake Huron watershed.

The St. Clair River provides a corridor for fish between Lakes Huron and Erie but also supports an indigenous fishery. Prominent species include walleye, muskellunge, rainbow trout, lake sturgeon, smelt, salmon, bass, catfish, yellow perch and freshwater drum. The St. Clair River and its delta are known to serve as habitat for fish during their sensitive life stages (spawning, rearing). The delta is unique, serving not only as an important fish habitat but also as habitat for other wildlife including waterfowl, reptiles, amphibians, fur-bearing mammals and plant species. This diversity is due, in large part, to the remaining extensive wetlands and wetland-upland complexes of the delta and its environs.

The St. Clair River serves as a major shipping channel; as a recreational resource (including boating, fishing, hunting, and swimming); a food source for native Canadians; a source of drinking water for U.S. and Canadian citizens; industrial process water for Canada's largest petro-chemical complex; and a receptacle for treated municipal and industrial effluents. Clearly, these uses conflict in terms of maintaining good water, sediment and biota quality.

The immediate shores of the river are used for a mixture of urban, industrial and recreational uses. Inland, the predominant land use is intensive agriculture.

Contaminant problems specific to the St. Clair River include sediment contaminated with PCBs, oil and grease, mercury, and other metals; and fisheries impacted by PCBs and mercury. Contaminants characteristic of the petro-chemical industry and found

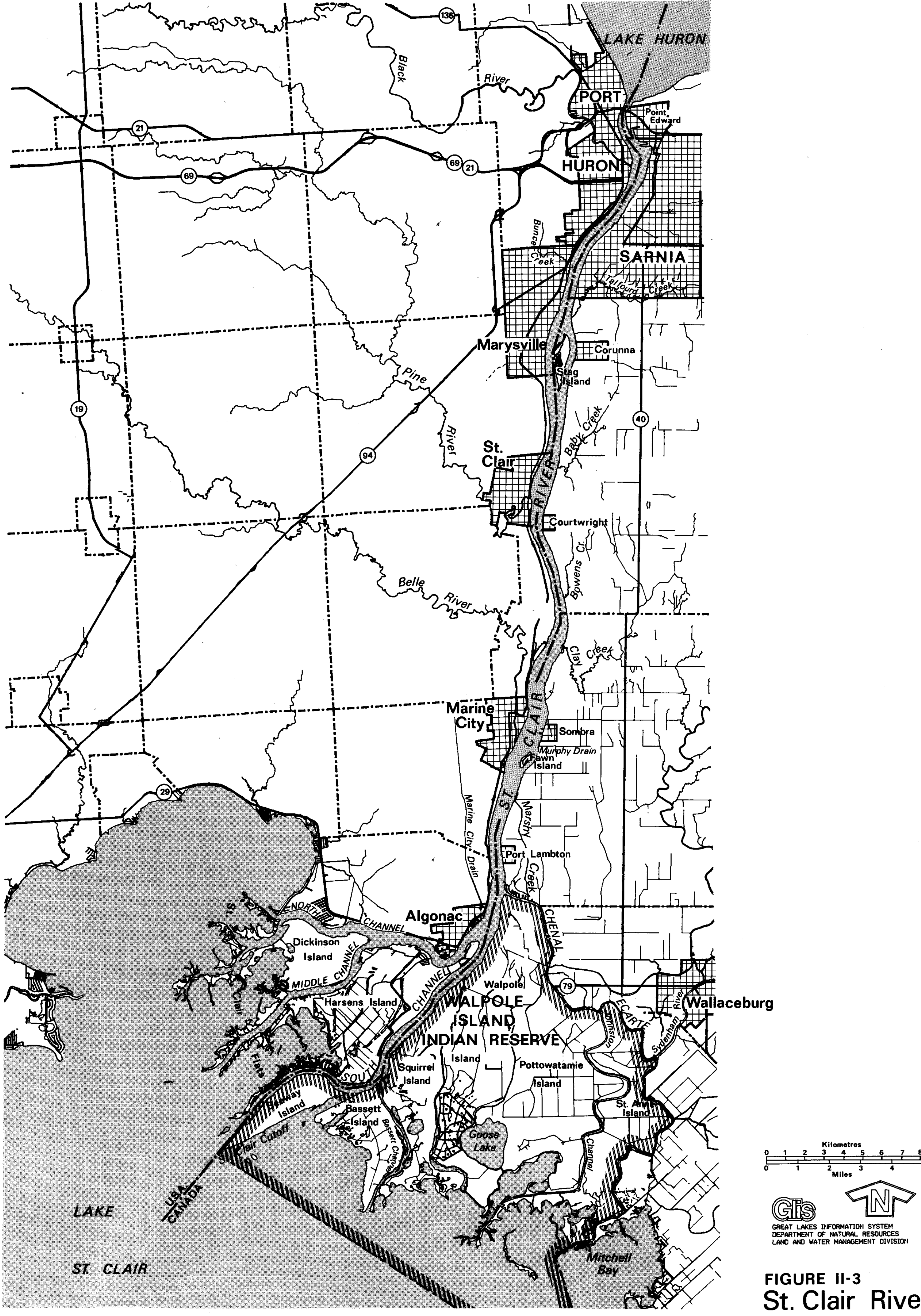


**FIGURE II-3**
**St. Clair River**

in elevated levels in biota, sediment and water include; hexachlorobenzene, hexachlorobutadiene, octachlorostyrene, carbon tetrachloride, perchloroethylene, and hexachloroethane. These chemicals are confined to a band of water approximately 100 m wide along the Ontario shoreline adjacent to the industrial area at Sarnia.

In addition to direct point discharges from industrial and municipal sources, concern for ongoing and potential contamination of the river has been identified for such nonpoint sources as: surface landfill sites, liquid waste disposal zones in deep geological strata ("deep wells"), urban runoff, and agricultural runoff. Even though the petrochemical industry is concentrated on the Canadian side of the river, municipal outfalls and similar nonpoint sources occur on the U.S. side.

Recent surveys of benthic organisms in the St. Clair River indicate that the benthic community is impaired in the immediate vicinity of the petro-chemical industry. However, the zone of impairment has decreased significantly since the late 1960s. This reflects improvements in industrial and municipal effluent quality throughout the 1970s and 1980s. Significant reductions of organic contaminants (80 to 90%) in certain outfalls have been achieved even since the initiation of the Upper Great Lakes Connecting Channels Study (4).

## 4. Lake St. Clair

Lake St. Clair is not considered one of the five Great Lakes, however, it is a large lake (Figure II-4 and Table II-3). It is a very shallow lake compared to its surface area, resulting in extreme variability in water levels over space and time due to short term climatic changes (winds, barometric pressure) and hydrologic flow regime (inflow-outflow).

The shallow character of the lake also influences sediment dynamics. The primary source for sediments is the Lake Huron watershed via the St. Clair River. Deltaic formation at the mouth of the river has, in a relatively short geologic time (post-glacial), resulted in the in-filling of approximately one-fifth of the lake area. Fine grained sediments, particulary clays, are deposited in the deeper portions of the lake. The majority of the lake bottom, however, consists of relatively coarse sands and gravels reflecting the high wave-energy environment. Sediment depth in the main body of the lake, in fact, averages only 7 cm overlying the glacial till. Thus, much of the material entering the lake from the delta and its major tributaries (the Clinton, Sydenham and Thames Rivers) ultimately moves out of the lake, through the Detroit River and into Lake Erie.

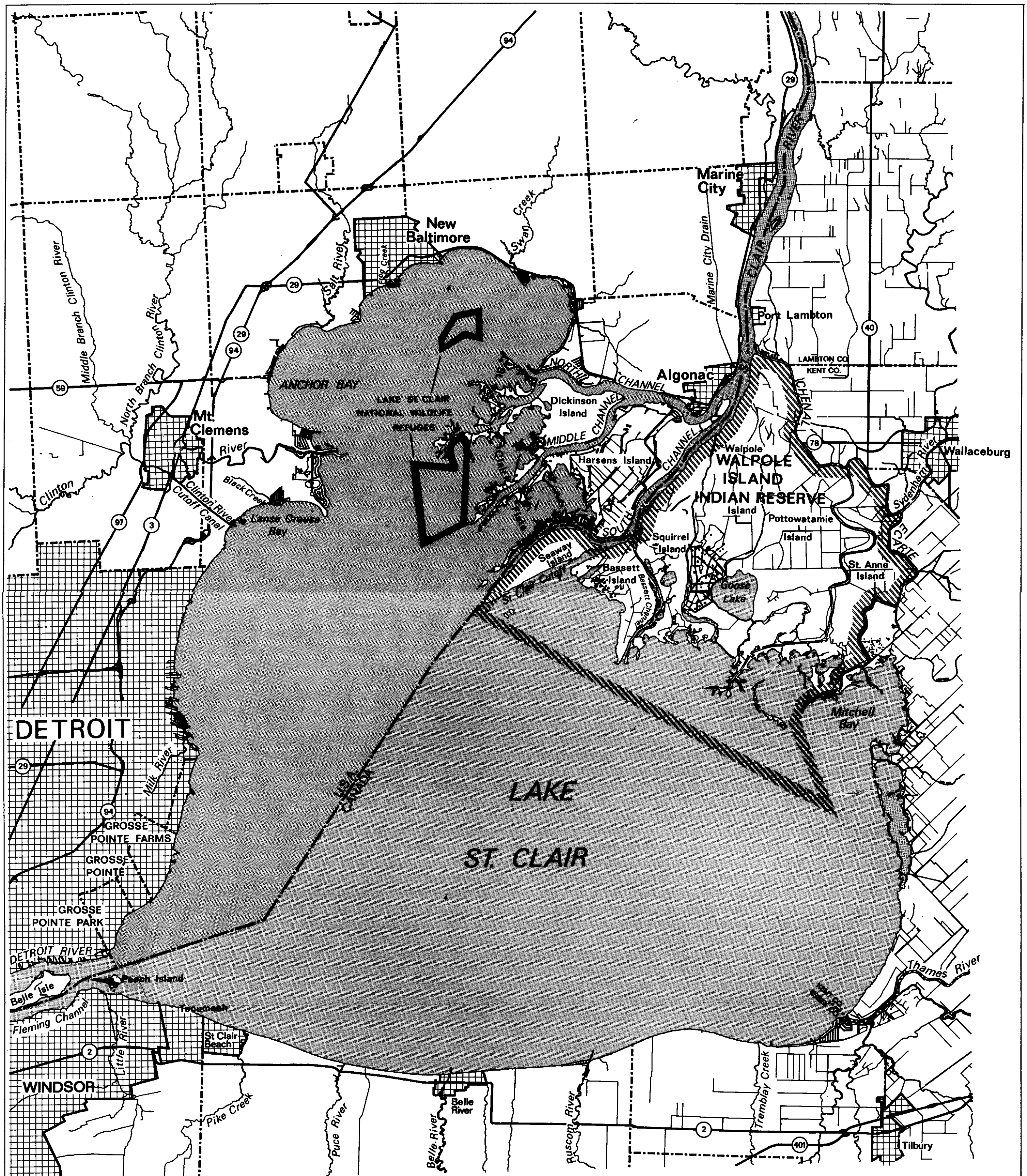


**FIGURE II-4**

**Lake St. Clair**

GREAT LAKES INFORMATION SYSTEM
DEPARTMENT OF NATURAL RESOURCES
LAND AND WATER MANAGEMENT DIVISION

Over 70 species of fish are known to reside in or migrate through Lake St. Clair. The lake is particularly known for its muskellunge fishing. Other warm water species common to the lake include pike, bass, perch, crappie, and bluegills. Walleye, salmon, trout, whitefish, smelt, and suckers are also part of the sport fishery. The delta area and Anchor Bay are known to be the most active spawning areas of the lake. Generally, the near shore areas and tributaries to the lake provide habitat which is crucial to the lakes' fishery. The impressive fisheries and other wildlife resources (both indigenous and migratory) owe their existence, in large part, to the extensive wetland communities in the delta and along most of the undeveloped shoreline of Lake St. Clair.

Direct uses of the lake are primarily recreational. This includes the largest number of registered boats on the Great Lakes as well as fishing, and hunting for fur-bearing animals and waterfowl. Other uses include drinking water and commercial shipping. Lake St. Clair is unique among the other UGLCCS areas in that there are no significant industries or major urban centres located on its shores (except for the northern portion of the Detroit Metropolitan area). However, several large communities are found on the tributaries which feed into the lake.

Surrounding land uses are primarily natural (wetlands) and intensive agriculture. Large expanses of the original wetlands have been drained for agricultural purposes. In Ontario, for example, over 90% of the original wetland area surrounding Lake St. Clair has been converted to agriculture (5). In fact, over 400,000 ha of wetlands in three contiguous counties have been converted since the late 1800s. This has undoubtedly exerted a very significant impact on the wildlife resources of Lake St. Clair and its environs.

Lake St. Clair is the only UGLCCS area which is not also classified by the IJC as an "Area of Concern". There is a lack of direct point sources of contaminants and/or heavily contaminated sediments. The lake does, however, act as a mixing zone for various organic and inorganic contaminants originating from upstream sources and from atmospheric deposition. These include industrial and municipal sources from 2 Areas of Concern (St. Clair and Clinton Rivers) and nutrients and pesticides from agricultural drainage via drainage ditches and the tributary rivers. Phosphorus loadings (primarily agricultural) and mercury contamination of the fishery are primary concerns in Lake St. Clair. Levels of mercury in fish have declined since the early 1970s and conservation authorities in southwestern Ontario (particularly the Thames River C.A.) have developed programs to reduce sediment loads derived from agricultural lands (and hence adsorbed nutrients/pesticides).

## 5. Detroit River

The Detroit River is the furthest downstream Connecting Channel of this study. It connects Lake St. Clair with Lake Erie (Figure II-5). Flow in the Detroit River is complex due to numerous islands and channels, particularly in the lower half of its reach, and to unique effects from fluctuating water levels in Lake Erie. Wind set-up and barometric pressure changes can cause the western portion of Lake Erie to rise 2 to 2.5 m during storms. This is greater than the total elevation change of the Detroit River from head to mouth (< 1 m). When such conditions occur, the river flow slows down and actually reverses for short distances.

Bottom sediments in the Detroit River vary from clay to boulders and bedrock. Overall, sediments tend to be coarse (sand and gravel) due to medium to high current velocities which transport most of the suspended materials into the western portion of Lake Erie. Minor depositional zones for fine material (clays, silts) occur in the river adjacent to islands (particulary downstream of the islands) and the near shore (mostly along the Canadian side). Bedrock forms the river bed in some portions of the lower channel such as in the 10 km reach between Fighting and Bois Blanc Islands.

Although fish spawning and nursery habitats are less available in the Detroit River than in Lake St. Clair, the river sustains a diverse fishery. Both resident (rainbow smelt, alewives and gizzard shad) and migratory species are known to be present. Species common to this river include walleye, bass, and yellow and white perch. The river is considered to have a fairly healthy fishery in terms of numbers and diversity given its history and degree of pollution and habitat alterations (dredging, filling, bulkheading, etc). However, these activities, due to large scale urbanization, have clearly restricted plant and other wildlife abundance and diversity relative to the study areas. During spring and fall migrations, the lower Detroit River, encompassing the Wyandotte National Wildlife Refuge, is especially critical as a feeding and staging area for several waterfowl species.

The Detroit River watershed is the most urbanized of the four areas covered in this study. It is home to a population greater than 5 million and is one of the world's most heavily industrialized areas. This industry includes a vast automotive complex including fabrication and assembly as well as many metal and plastic based support industries. Numerous other types of manufacturing also occur. Water uses include drinking water, recreational activities (boating and fishing), shipping, industrial cooling and process water withdrawals, and municipal and industrial waste discharges.

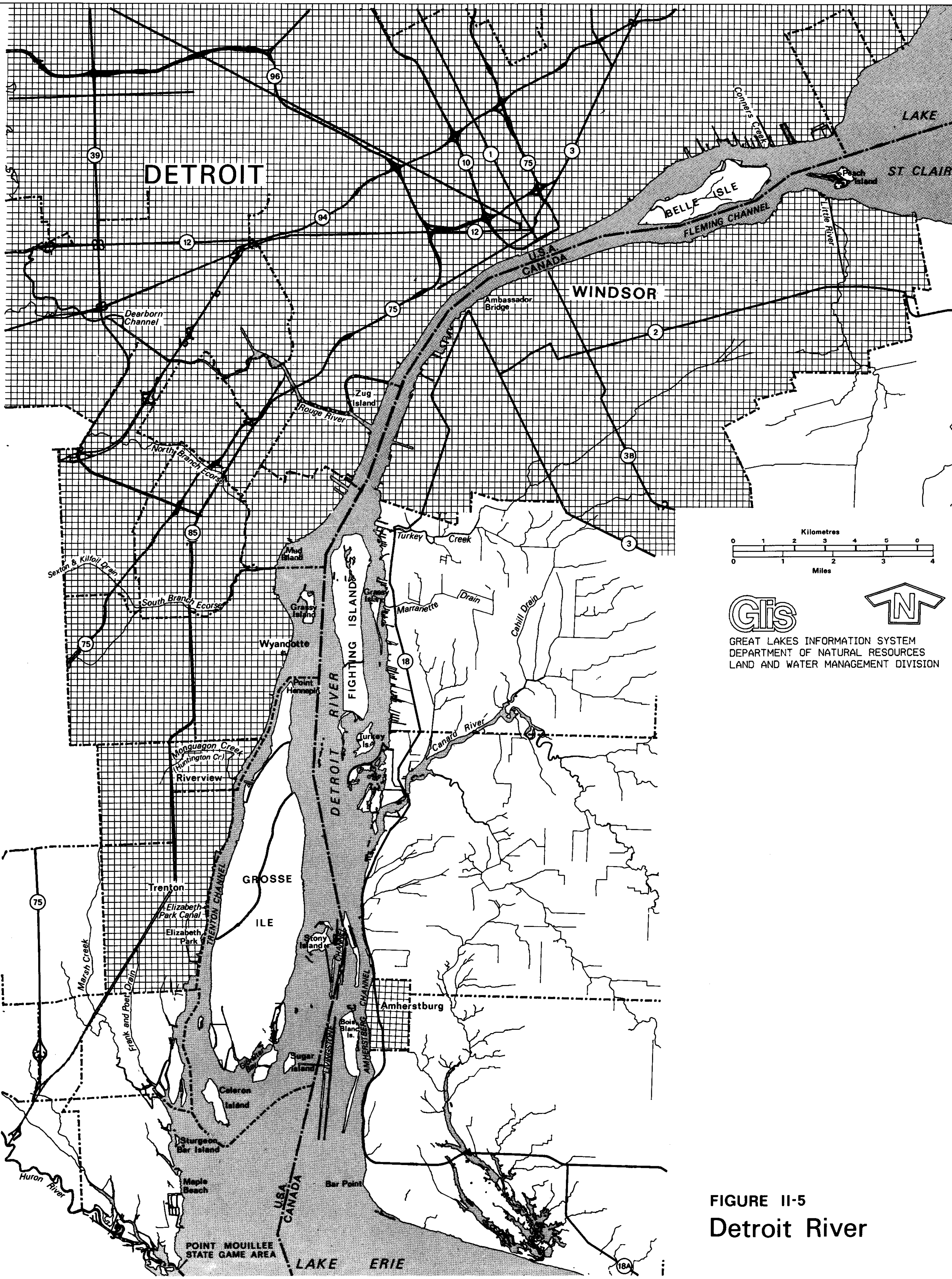


FIGURE II-5
**Detroit River**

Surrounding land uses are principally urban (U.S.) and agricultural (Canada) although numerous recreational areas are present (e.g. Belle Island, Boblo Island and Dieppe Park). A particular concern is the restricted river access due to urban and industrial developments along the waterfront, particularly on the U.S. side.

Contamination problems in the Detroit River include: sediments contaminated with PCBs, oil and grease, mercury, and other metals; water quality violations for phenols, iron, and fecal coliform; and an impacted fishery (particularly by PCBs), waterfowl and benthic community. Surveys of benthic communities show a zone severely impacted by contamination off-shore and just downstream of Zug Island. The remainder of the river downstream of this island, but confined to the U.S. shore, also shows evidence of severe impairment. Normal communities are found upstream of Zug Island and along the entire Canadian shore.

Contaminants originate from point and nonpoint sources including numerous municipal and industrial outfalls, urban runoff, combined sewer overflows, agricultural runoff, and shallow groundwater contributions impacted by many waste sites. In addition to these, the river receives contaminants from upstream sources including 3 IJC Areas of Concern (St. Clair River, Clinton River and Rouge River).

## 6. References


1. U.S. Environmental Protection Agency and Environment Canada. 1987. The Great lakes: An Environmental Atlas and Resource Book. U.S.EPA, Env. Can., Brock U. and Northwestern U., Toronto and Chicago. ISBN 0-662-15189-5. 44p plus wall map.

2. Limno-Tech. 1985. 1985 Summary of the existing status of the Upper Great Lakes Connecting Channels data. unpub. manuscript prepared for the UGLCC Study, March 1985, Limno-Tech Inc. 156 p. plus appendices and bibliography.

3. Great Lakes Water Quality Board. 1987. 1987 Report on Great Lakes Water Quality. GLWQB, International Joint Comm., Windsor, Ontario. 236p.

4. Ontario Ministry of the Environment and Environment Canada. 1988. Status report of the recommendations of the 1986 St. Clair River Pollution Investigation Report. OMOE and DOE, Toronto.

5. Snell, E.A. 1987. Wetland distribution and conversion in southern Ontario. Lands Dir, Env. Can., Ottawa, Working Paper #48. 53p.